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MACHINERY

September, 1912

METHODS USED IN ERECTING PLANERS

FOUNDATIONS, ALIGNMENT, SQUARING UP, ERECTING COUNTERSHAFTS, ETC.

BY EDWARD K. HAMMOND

Edward K. Hammond†

Disappointment is sometimes experienced in the performance of new machinery, owing to its failure to produce work of the standard expected. In most cases, however, the machine itself is quite capable of properly doing the work for which it was sold, and an investigation by an expert will usually show the trouble to be due to one of two general causes; the machine is either improperly used, or it has been incorrectly set up. Either error will make production of accurate work impossible, and incorrect methods of setting up a machine will also often cause it to be seriously damaged. It is the purpose of this article to explain the correct methods of setting up a planer, the information presented being based upon methods developed by the Cincinnati Planer Co., Cincinnati, O.

In setting up machines of this type, the following requirements must be fulfilled. A solid foundation must be provided for the planer to rest upon. The bed must be true and set level upon the foundation and square with the lineshaft; it must bear evenly upon the foundation and be adequately supported by it. The cross-rail must be exactly parallel with the table. It will be evident to any machinist that a planer cannot give satisfactory results unless the table runs perfectly true and the cross-rail is parallel with it. The necessity for a solid foundation, upon which the planer bed is evenly supported, is just as important a factor in securing accurate work, although it is not so generally appreciated. Where a planer bed is not given adequate support, its weight will cause it to be sprung out of shape, and the inaccuracy of the ways which is produced in this way will manifest itself in the work produced on the machine.

The best practice is to set planers upon a concrete foundation and the Cincinnati Planer Co., in common with most reliable builders, furnishes foundation plans giving details for the construction which has been found suitable for the size of machine to be installed. Fig. 1 shows one of these foundation plans for a 62-inch x 62-inch x 14-foot Cincinnati planer. This plan calls for the use of leveling blocks between the planer bed and the foundation, one of these being illustrated in Fig. 2. The sliding members of these blocks are lubricated with graphite, to make sure that they will work smoothly, and by means

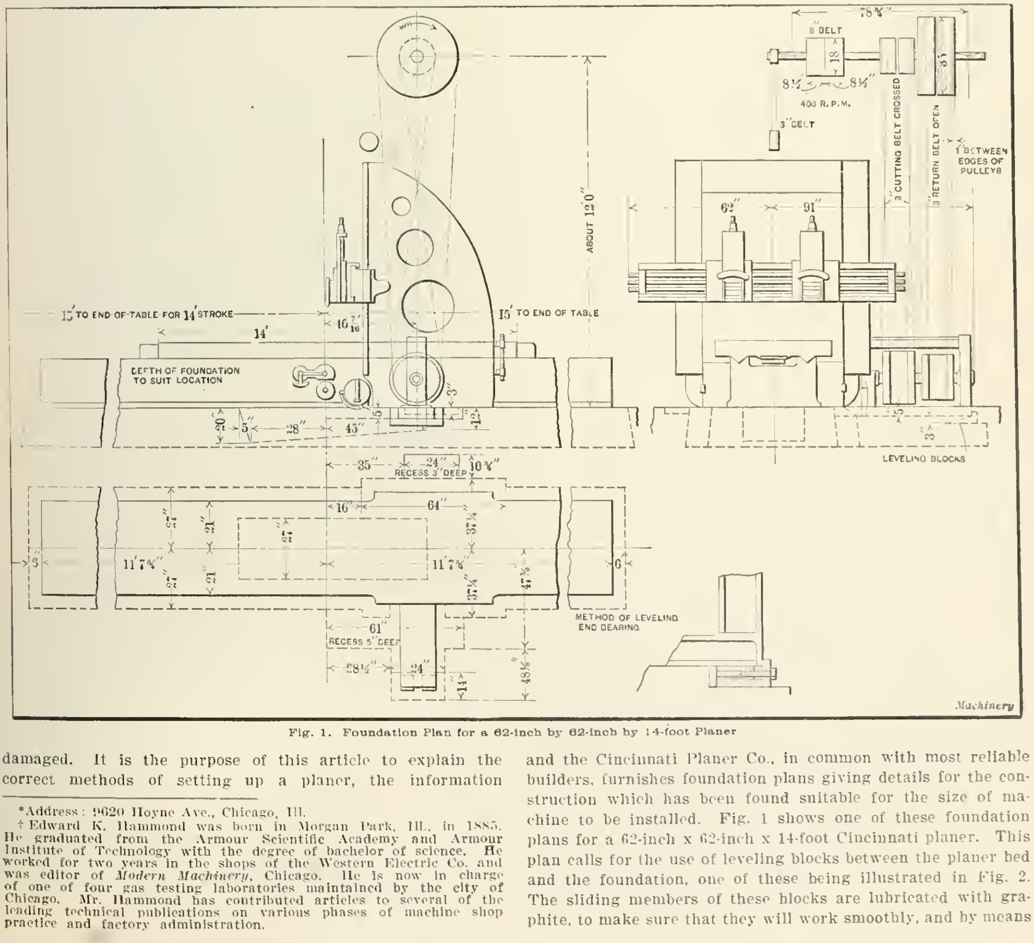

Fig. 1. Foundation Plan for a 62-inch by 62-inch by 14-foot Planer

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of the adjusting screws, each individual block may be set to exactly the required point to bring the planer bed to an accurate level. Where the planer has feet, these rest upon the leveling blocks, but where the bed extends right down to the foundation, the blocks are distributed in the way best suited to carry the weight of the bed and protect it from being strained at any point. Average conditions require leveling blocks in the foundation at intervals of four feet. These blocks not only provide a rapid and accurate method of leveling, but also make it possible to correct a considerable amount of error that may be found in either the planer bed itself or in the foundation, thus bringing the machine back to an accurate level in either case.

In preparing this type of planer foundation, the concrete is filled in to within about eight inches of the floor line. The leveling blocks are then placed in position and carefully adjusted with a long straightedge so that tissue paper will be held tightly on any block when the straightedge is passed from one position to another. After the blocks have been placed in position with the required degree of accuracy by this adjustment, the concrete is filled in almost to the level of their upper faces, spaces being left to allow access to the adjusting screws. These spaces should be provided with covers to keep chips and dirt away from the screws.

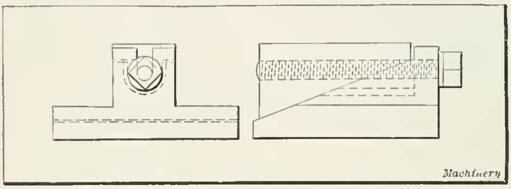

Fig. 2. Leveling Block of the Type used in a Concrete Foundation

The use of heavy concrete foundations and leveling blocks of this type make the initial cost of installation rather high, but it is possible, in this way, to secure a higher degree of accuracy in planer work than is usually considered practical. This increased accuracy permits the saving of a great deal of time in scraping the work after it has been planed. The time required to keep the planers themselves in proper working condition is also reduced when they stand upon accurate foundations, because all unnecessary strains upon the machines, due to lack of adequate support, are eliminated.

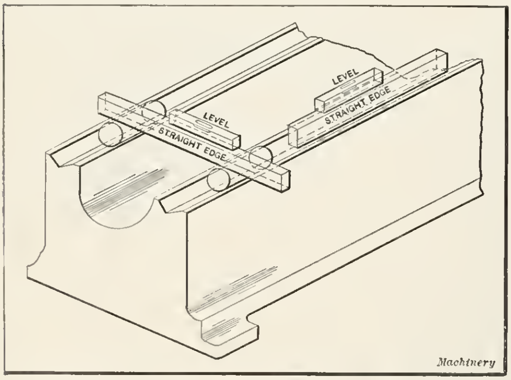

Fig. 3. Method of Testing the Level of a Planer Bed in Two Directions

An idea of the efficiency of this form of foundation for a planer may be gathered from tests which have recently been made in the shops of the Norton Grinding Co., Worcester, Mass. After a year of constant use, the table of an 18-inch x36-inch planer with an 18-foot bed was tested with a 15-foot straightedge, and it was found that tissue paper could be held at any three points on the table, with the table in any position on the bed. When a planer is able to meet such a severe test, the claim for a greater accuracy in its output will be readily granted, as very few planers successfully meet such a test when mounted on any other form of foundation.

There has recently been considerable discussion concerning the advisability of bolting down planers to the foundation. The claim is made that a machine which is heavy enough to do its work well will not move at reversal, and the belt pull can never left it from the floor. Experience has shown that the only fastening necessary for a planer standing on a concrete foundation and leveling blocks, is to drill the plates and put in one-half-inch pins on each side of one or more pairs of legs, to prevent endwise sliding. In certain cases where this method of fastening was used, the pins were originally set so that they did not touch the planer feet, and the machine has never moved enough to bring them into contact. The use of foundation bolts was discarded on account of several objectionable features for which they are responsible. Among these the following may be mentioned: When a planer is bolted to a wooden floor and a heavy weight is placed near it, the planer is bound to follow any temporary settling of the floor which occurs; this sets up a strain in the entire planer. The same objection applies when permanent settling occurs in any form of planer foundation, and springing or deformation of the bed is bound to take place if it is bolted to the foundation at the time when the settling takes place. The presence of foundation screws also presents the possibility for careless workmen to attempt to use them to level the bed. This is obviously poor practice, because any leveling that is accomplished through the tightening of foundation screws, is done by springing the bed out of shape.

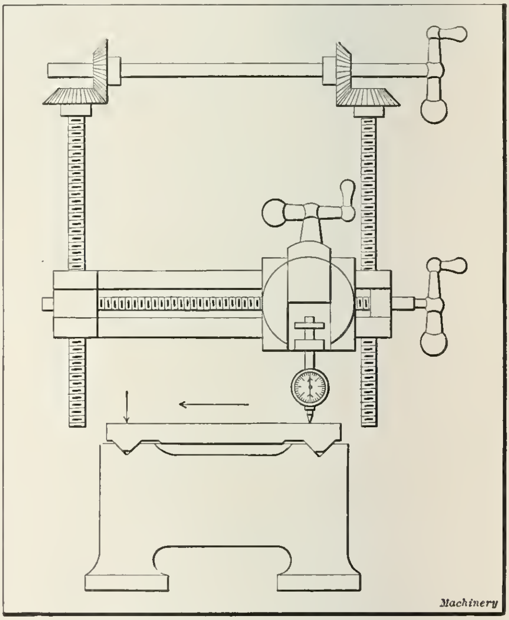

Fig. 4. Testing the Alignment of the Planer Cross-rail with the Table

A More Simple Form of Foundation

A more simple method of supporting a planer consists of preparing a preliminary foundation upon which the machine is placed. Iron wedges or cedar shingles are then used to raise the bed to a height of about one inch above the level of the foundation, and also to bring it to a level position. A mortar is now made, consisting of one part of Portland cement to one part of sand, which is used to raise the foundation to the level of the bottom of the bed. Where this method of constructing a foundation is followed, care must be taken to tamp in the mortar firmly under the bed. A foundation of this kind is less expensive than the one previously described, but it is also far less serviceable in the long run.

Placing the Planer on the Foundation

In placing the planer on the foundation, care must be taken to have the bed set exactly square with the line shaft in order to provide for a proper operation of the driving belts. After this condition has been fulfilled, the bed must be accurately leveled in both the lenghtwise and crosswise directions. This is done by removing the table and using a good spirit level to determine the direction in which the leveling blocks must be adjusted to bring the bed into the required position. If a level, which is long enough to reach across the bed is not available, a shorter instrument may be used on the top of an accurate straightedge which is parallel on both sides.

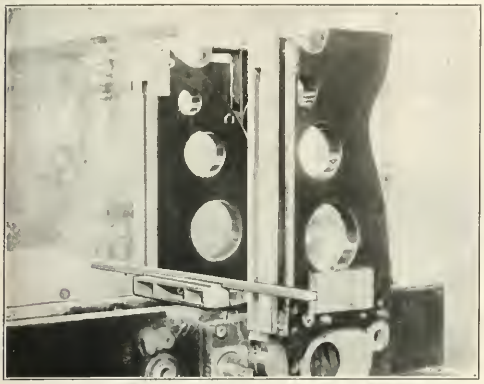

Fig. 5. Method of Bringing the Houeinge Square with the Ways

The beds of the planers built by the Cincinnati Planer Co. and many other firms, have the surfaces at the top of the Vs planed exactly parallel with the ways. If it is known that this method has been followed by the firm which built the planer that is being set up, these surfaces can be used as a support for the spirit level. Fig. 3 shows the proper method of procedure where the top surfaces of the bed have not been accurately lined up with the ways. In this case the ways themselves are used in leveling the bed. For making the crosswise adjustments, two cylindrical bars, of exactly the same diameter and of suitable size to fit in the Vs, are used as supports for the spirit level or straightedge. For the lengthwise adjustments, the level is set directly in the Vs. The bed is left a trifle high at the center, because the pressure of the tool and the weight of the housings come at this point; this causes a little more deflection and a slightly greater tendency for the foundation to settle. By observing the precaution of having the bed a little high at this place, the ways will, in the end, be brought to an accurate level.

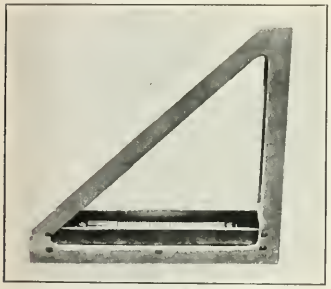

Fig. 6. Special Square used to Determine Vertical Alignment of the Houeings

A series of tests should be made along the entire length of the bed to make sure that it is level in both lengthwise and crosswise directions. Such a series of tests should also be repeated at frequent intervals for some time after the planer has been set up, as there is a probability that the foundation will settle, thus disturbing the alignment. Where such settling is detected, the machine is easily brought back into position by means of the screws in the leveling blocks.

It is not necessary to level, in the lengthwise direction, a planer bed which only has legs at the ends, because the distance between the legs is never great enough to cause a deflection in the bed. Consequently, if the bed is a little high at either end, it will still plane straight, because the table will travel in a straight line and there is no tendency for its bearings in the bed to get out of alignment.

Special care, however, ought always to be taken in testing the lengthwise level in all other cases, as all planer beds do not have their ways scraped to a straightedge. Where the bed is merely scraped to fit the table, it insures a bearing, but does not show that the ways are straight, and in such cases, the provision of an absolutely level foundation is required to enable the bed to straighten itself out into proper alignment. When the bed has been brought to a satisfactory level, the Vs of both the bed and the table are thoroughly cleaned to remove grit and dirt, and the oil pockets in the bed are filled with a supply of good machine oil. The table is then replaced upon the bed and the next step is to see that the cross-rail is in proper alignment with the table. For this purpose, a distance rod or some form of surface gage is clamped in the planer tool-post to measure the distance between the rail and opposite sides of the table.

Fig. 4 shows the method of making these measurements with a dial test indicator, which has the advantage of showing the exact amount of any error that may be found in the alignment of the cross-rail. The same general method of procedure is followed with a distance rod; in this case, a piece of hard paper would be used as a feeler. The distance between the table and the cross-rail is measured first at one side of the table and then at the other, as indicated in the illustration. If this test shows the cross-rail to be out of alignment, the error is removed by adjusting the nuts on the elevating screws. These screws are a sliding fit in the bevel gears and carry fine threaded adjusting nuts which rest on the top of the bevel gears. By means of these nuts, the elevating screw at either side of the table can be raised sufficiently to bring the cross-rail parallel with the table. This adjustment should always be made by raising the low side of the rail. If the adjustment was made by lowering the high side of the rail, there would be a little backlash in the adjusting screws. This backlash would allow the rail to work out of the desired alignment with the table.

It was formerly considered necessary for a planer to plane off its own table after having been set up on the floor where it was to be used. Modern practice has discarded this method of procedure. The planers built by leading manufacturers plane their own tables before they leave the shops. Consequently, they require no further finishing, providing the bed has been set up as it ought to be. In fact, the practice of planing off a table is wrong, because if it is necessary to remove any error in the table by planing, it shows that the foundation is not properly leveled, and the trouble should be eliminated by adjusting the leveling blocks.

Additional Operations on Large Planers

Small and moderate-sized planers are usually shipped to the purchaser's plant fully assembled. In such cases the method of setting up which has been outlined puts the planer into condition to be belted to the countershaft; but in assembling large planers which have been taken down to facilitate shipment, or to make repairs on machines that have been damaged in transit, great care must be observed to bring the housings into proper alignment. After the bearings, shafts, and gearing are put into place in the bed, the housings are brought into position and tested to see that their

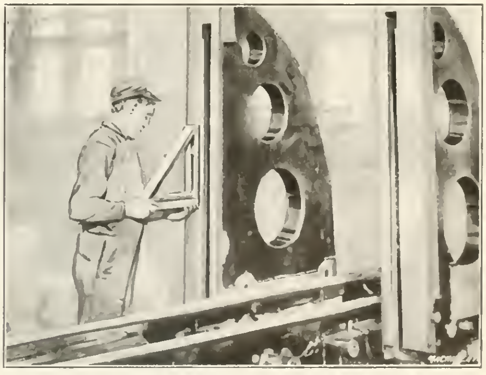

Fig. 7. Testing Vertical Alignment of Housing Parallel with the Bed

faces are square with the ways and that they are in the proper vertical alignment in both the lengthwise and crosswise directions.

The method of bringing the housings square with the ways is shown in Fig. 5. The fixture used for this purpose fits into the Vs and a straightedge is held by a shoulder as shown; the housings are then lined up with the straightedge. A special square shown in Fig. 6 is used to determine the vertical alignment of the housings. This square is fitted with a special spirit level which has been graduated to make each ⅛-inch space correspond to an error of 0.001 inch in 4 feet in the alignment of the housings. The method of using this square is illustrated in Figs. 7 and 8, where the alignment of the housings is being tested in two directions. The square is held against the face of one housing and the position where the bubble stops is noted. The square is then shifted to the corresponding face of the other housing and the position of the bubble is again noted. The same tests are made for the other pair of faces on the housings. If the position of the bubble is found to differ for either set of tests, the square shows the amount of error and the direction in which the adjustment must be made to bring the housings into proper alignment. When necessary adjustment has been made, so that any error which exists is within 0.001 inch in 4 feet, which corresponds to one graduation on the spirit level, the holes in the housings are reamed and they are then doweled into place on the bed. The cross-rail is next mounted in position on the housings and brought exactly parallel with the planer table, by the method previously described. The remaining parts of the planer are now assembled and the machine is then ready to be belted to the countershaft.

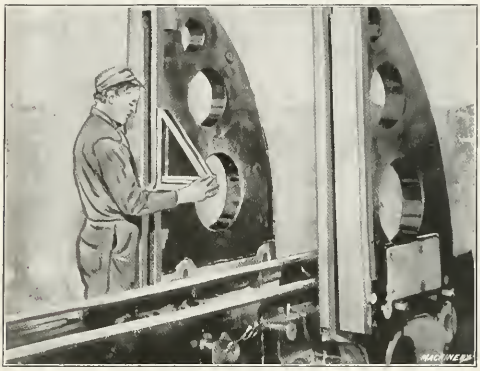

Fig. 8. Testing Vertical Alignment of Housing at Right Angles with the Bed

Erecting the Countershaft

In setting up the countershaft, care must be taken to have it perfectly level and parallel with the lineshaft; it must also be accurately located according to the requirements of the foundation plan, as shown in Fig. 1. This plan also gives instructions regarding which is the open and which the crossed belt. The importance of having the countershaft correctly located in relation to the planer lies in the fact that the belts will not shift properly if it is too far in front of or behind the proper position. After the countershaft is placed in position, the loose pulleys and hanger boxes must be given a copious supply of machine oil, and care should be taken to see that the pulleys and shaft turn freely. The collars on the shaft must be set to permit a little end play in the boxes, but not too much.

Some shops are in the habit of overlooking the superior driving and wearing powers of double belting in order to keep the first installation cost as low as possible. Economy in this direction is ill-advised, and double belting of the width specified in the foundation plan ought always to be used. The "cutting" belt, which is the crossed belt in most cases, should be crossed so that the side running back to the countershaft is on the inside next to the housing of the planer. The importance of this arrangement lies in the fact that the side of the belt operated on by the shifter forces the other side with it and enables the reversal to be made in less time than would otherwise be possible.

After all of the belting is in place, all of the pulleys and gearing in the planer should be rotated by hand, to make sure that everything runs freely, before the power is turned on. The gears should be given a good coat of heavy oil, and all of the bearings, loose pulleys, and oil holes must have a liberal supply of the best machine oil two or three times a day for the first week after the planer is placed in service. This precaution will often prevent serious wear while the machine is running itself into smooth running order. In the case of large machines, the further precaution of running them idle for a day or two before starting on heavy work should always be observed.

The time spent in putting new planers into proper operating condition is of little value unless care is taken to protect them from injury while in use. Consequently, some advice concerning the methods of protecting planers from damage will not be out of place in this article. In order to produce accurate work, the ways of a planer must be true, and, owing to their exposed position, special care must be taken to protect them from injury. Several methods are in common use. In planing short work, the ends of the ways may be covered with boards or canvass to keep chips and dirt out of them. A more elaborate method of securing protection for the Vs has been designed and patented by Mr. W. A. Thelin, foreman of the planer department of the Bullard Machine Tool Co., Bridgeport, Conn., where this method has been used for keeping the planers in good operating condition for a number of years.

Fig. 9 shows this device. The two spools at the end of the planer bed have strips of canvass wound on them which are slightly wider than the Vs. These strips are attached to the table, as illustrated, and as the table moves forward, the strips of canvass are unwound from the spools and keep the Vs covered. On the return stroke, the spools rewind the canvass strips through the action of a spring-actuated shaft on which the spools are mounted. Two rollers, carried on counterweighted arms, hold the canvass clear of the ends of the bed, and when the table comes forward to the end of the ways, the arms are swung down by means of blocks on the under side of the guards. An advantage in the use of these guards lies in the fact that they are equally available for all lengths of work and act automatically in protecting the ways from scoring or cutting without hindering the operator in any way.

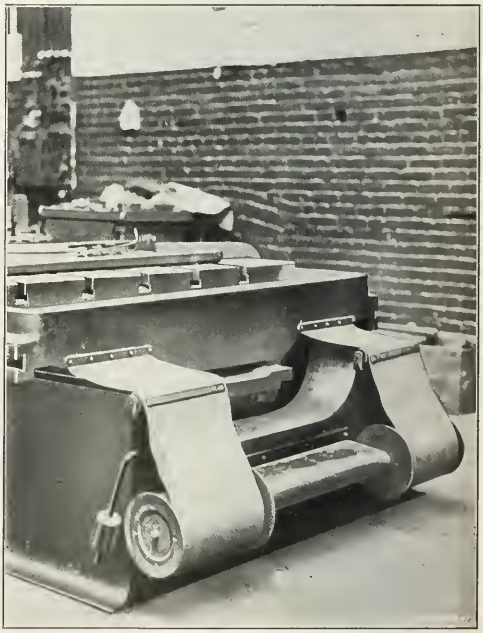

Fig. 9. Automatic Guard for Protecting Planer Ways from Damage

Another form of planer protection consists of suspending a canopy of canvass over the machine. This prevents chips or dirt from dropping from the ceiling, or from overhead cranes, onto the planer ways, but does not offer protection to the machine from the chips which it is making, and care ought always to be taken to avoid brushing chips or dirt off the table into the ways, or to allow such material to collect around the bull wheel. A point ought always to be made of running the table out to the end of the bed, so that it completely covers the Vs and gearing, before starting to brush off chips or to clean out the T-slots.

Some mechanics do not realize how easily the shape of a planer table can be seriously altered. If they did, more care would be taken in placing heavy work in position. A planer table ought never to be used as an anvil or straightening plate, and care should be taken to prevent heavy castings from falling on it more often than is absolutely necessary. The blows caused by carelessness in handling castings that are being placed in position on the planer table not only cause bruises, but they have a slight peening action which changes the shape of the table more rapidly than is generally supposed. Damage of this kind may be guarded against by laying short boards on the table for the work to be lowered upon. These boards are then easily removed by raising the work first at one side and then at the other.

Care in setting up a machine and in caring for it after it has been placed in service are of equal importance in enabling it to continue to produce accurate work for a reasonable operating life. The methods outlined will be found to pay excellent returns on the time spent in following them, in the form of a decrease in the time required to keep the planers in good working order, in an increase in the accuracy of the planer work, and in an increase in the length of the operating life of the machines.

* * *

An article in the *Zeitschrift des Vereines Deutscher Ingenieure* records a number of tests made with belting. These tests indicate that the tension when the flesh side of the belt runs onto the pulley can be 12.5 pounds per inch of width greater than the tension when the belt is run with the hair side in contact. The limiting speed with the hair side of the belt towards the pulley, is about 60 per cent of that with the flesh side towards the pulley.

ALIGNING PULLEYS FOR QUARTER-TURN BELT DRIVES

BY M. H. BALL[*]

The aligning of pulleys on shafts which are at an angle of 90 degrees to one another—or what are commonly known as quarter-turn drives—and the laying out of holes for the belts in an intervening floor, are problems which are met with so infrequently by the average machinist or millwright that the methods to be used are apt to be forgotten. Sometimes considerable time is, therefore, spent on this work, and a great deal of wasted effort might be saved if instructions given in a simple way were available. The object of this article is to show how work of this kind can most easily be done.

The rule for the alignment of the pulleys is as follows: The center of the face of one of the pulleys at a point level with the center of its shaft, must be in the same vertical line as the same point on the other pulley. The exact condition required is indicated in the plan views of the accompanying illustration. The direction in which the pulleys are to turn determines which of their sides must be in line, as it is always the sides from which the belt leaves the pulleys which should line up. Fig. 1 shows how the pulleys should be set when the lower pulley turns to the left, as indicated by the arrow. Fig. 2 shows the setting when the lower pulley is driven in the opposite direction. The rules given apply to the aligning of pulleys at other angles as well, an example of which is shown in Fig. 3.

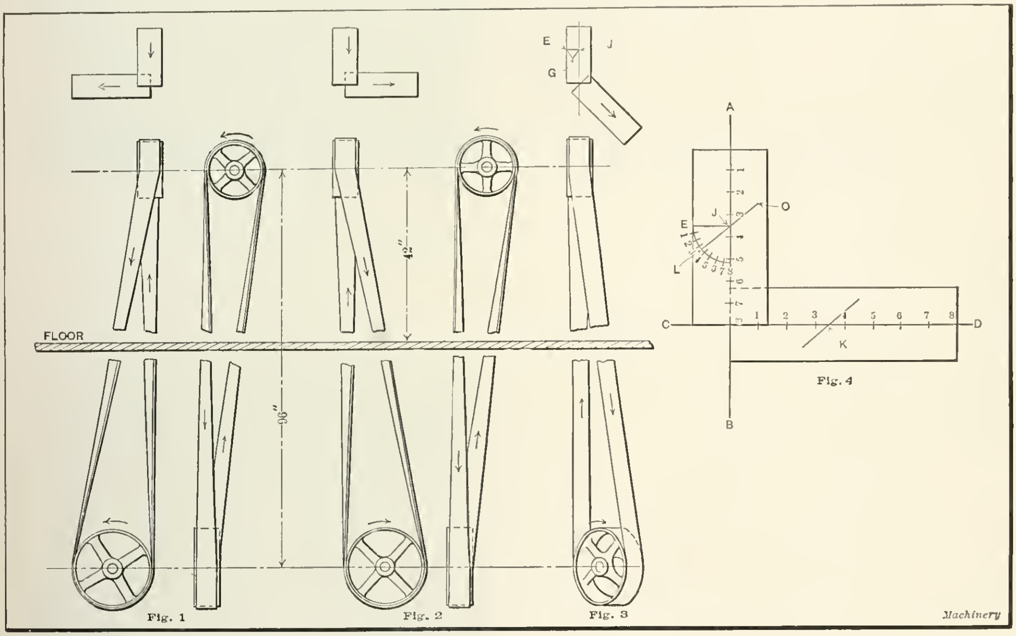

Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figs. 1 to 4. Method of Aligning Pulleys and Laying-out Holes for the Belt in an Intervening Floor

The second problem met with in many cases of this kind is the laying out of holes in the floor for the belt. Fig. 4 shows a method of laying out the floor holes for the drive indicated in Fig. 2. First draw an outline (plan view) of the two pulleys on the floor in full size, directly below and above the respective pulleys to be connected by the belt. A starting point for this layout can readily be found with a plumb bob. Then draw the center lines AB and CD through the faces of the pulleys, and divide the diameter of each pulley into eight parts, as shown, numbering the divisions 1, 2, 3, etc. The numbers of the divisions must start from the sides of the pulleys which are opposite the arrow points shown in the plan view indicating the direction of rotation. Next, measure the distances from center to center of the shafts and from the center of the

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upper shaft to the floor. In the example shown the distance from center to center of the shafts is 96 inches, and the distance from the center of the upper shaft to the floor is 42 inches. As 96 ÷ 8 = 12, each division on the diameter of the pulleys is equivalent to 12 inches. Further, 42 ÷ 12 = 3½, which represents the number of spaces that the center of the belt will be from the center points of the sides of the upper pulley, as indicated at *J* and *K* in the engraving. Draw the line *EJ* through the point thus located in the rectangle representing the upper pulley. Then strike an arc with *J* as center and *EJ* as radius, as indicated, and divide it into eight equal parts. As we are working on the top side of the floor, and as our measurements from the floor to the upper shaft determine how many spaces we are to set off, start numbering these divisions from the point *E*, the line *EJ* being parallel to the face of the upper pulley; then set of 3½ spaces from *E*, thus determining point *L*, and draw line *LO* through *J*, making *JO* equal to *LJ*. This line indicates the position of the center of the belt at the floor line and a line of the same length parallel to it through *K* indicates the other center line of the belt at the floor line.

The lay-out for an angle of other than 90 degrees, as indicated in Fig. 3, differs only in that the arc on the pulley outline extends only from the line *EJ* to the line *GJ*, Fig. 3, this latter line being parallel to the face of the lower pulley. Any number of divisions, either more or less than eight, may be used in the lay-out if it would be more convenient.

* * *

INCREASING BOILER CAPACITY BY MECHANICAL DRAFT

The United States Bureau of Mines makes the statement in Bulletin 18," The Transmission of Heat into Steam Boilers," just issued by the Bureau of Mines, Washington, D. C., that the present steaming capacities of steam boilers can be tripled or quadrupled by forcing over the heating surfaces three or four times the weight of gases now passed over them, as follows: "With well-designed mechanical-draft apparatus this greater weight of gases can be forced through the boilers at small operating cost. It is possible to increase the capacity of many of the present boilers in this way without reducing their efficiency much; in fact by proper arrangement of the heating surfaces the efficiency can be made higher than the present rating. The efficiency of any boiler can be increased by arranging its heating surfaces in series with respect to the path of hot gases. New boilers of high efficiency can be constructed by making the cross section of the gas passages small in comparison with the length.

"Nearly a hundred years of practical investigation of boiler and furnace problems has resulted in little advance. Perhaps the main reason why many of the investigations failed to bring about progress was that boiler and furnace were considered a unit and were investigated together. Various combinations of boilers and furnaces have been built and tested without thoughtful planning. Many of the published results of such tests confuse the performance of the boiler and the furnace in such a way that it is difficult, if not impossible, to tell which of the two should be blamed or praised for the poor or good results obtained from the combined apparatus. Evidently many persons have thought that the combined efficiency could be greatly increased by some mysterious manipulation.

"The principles governing the combustion of fuel in boiler furnaces and the absorption of heat by boilers have been little understood. The dogmas that the area of grate should have a certain ratio to the area of the heating surface, and that it takes ten square feet of heating surface to make one boiler horsepower, seemingly had become so thoroughly fixed in the mind that they were hardly ever questioned. It is only within the last decade that a few engineers have broken away from the old rule-of-thumb methods and have begun to investigate the functions of the boiler and furnace separately. Their studies seem to mark the beginning of advance in steam-generating apparatus.

"The boiler is the metallic vessel that contains water and steam and absorbs heat; consequently it should be studied as a heat absorber. The furnace is that part of the steam-generating apparatus in which the potential energy of the coal is changed into heat; consequently it should be studied as a heat generator."

* * *

Whenever possible put the supporting ribs in castings directly under the load, and not at the sides of the load, as is often done.

TRUCK FOR MOVING HEAVY MACHINE TOOLS

The truck shown in Fig. 1 was designed to meet the requirements in the warehouse of the Fosdick Machine Tool Co., Cincinnati, Ohio, where there was no crane and it was necessary at times to move the completed machines about. As the illustration clearly shows, this truck is of simple construction and has three wheels. These wheels are furnished with Hyatt roller bearings, and it is possible for one man to put a machine on the truck, pull it into the warehouse. and place it wherever desired. The machine is held to the truck by three bolts *A*, which are provided with ball bearing thrust washers *B* under the nuts.

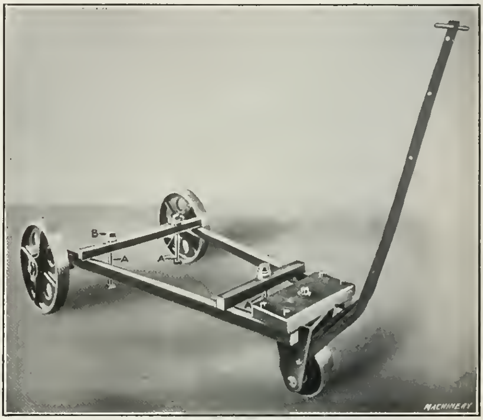

Fig. 1. Roller-bearing Truck designed by the Fosdick Machine Tool Co. for handling Heavy Machine Tools

The manner in which a machine is lifted and carried by this truck is shown in Fig. 2, where a 3-foot radial drill weighing 3600 pounds is shown ready to be moved about. The bolts *A* going through the cross bars are inserted in the T-slots of the base of the machine, and by turning the nuts with a ratchet wrench, the machine is easily raised from the floor. The entire weight of the machine is taken on the truck, which, as before mentioned, has roller bearings in the truck wheels, thus enabling it to be moved about easily. The ball bearing thrust washers under the nuts on bolts *A* facilitate the raising of the machine. These trucks have been built in several sizes, the largest being designed to carry a 4-foot radial drill, which weighs approximately 6000 pounds.

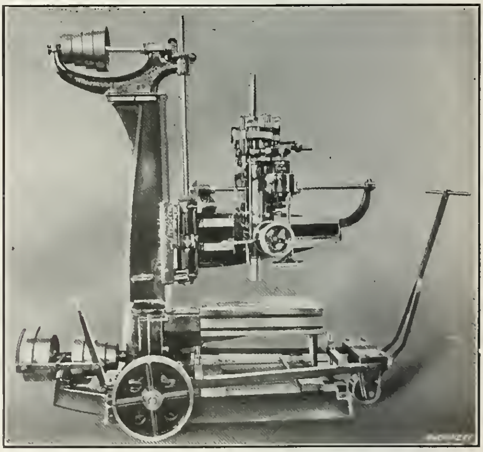

Fig. 2. A Three-foot Radial Drill raised from the Floor and ready to be moved

* * *

Keeping a machine in good order is one thing and eternally tinkering with it is quite another.

WATCH MOVEMENT MANUFACTURE*—3

METHODS, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO.

BY DOUGLAS T. HAMILTON†

To produce the small parts of a watch such as staffs, pinions, screws and jewel settings, requires the use of specially designed machinery. It is the methods employed in the producing of these parts, and the care taken in their manufacture, that raises or lowers the value of a watch. Automatic machinery has been a great boon to watch manufacture, but if all parts thus made are not carefully inspected and assembled, there is very little gained by producing them automatically. All parts that enter into a South Bend watch, whether made on automatic machines or otherwise, pass through careful inspections, and all are assembled by expert watchmakers. In the following a few of the special machines used will be described.

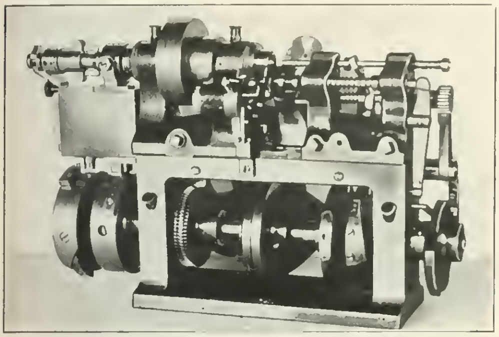
Fig. 26. Automatic Pinning Machine for Bridges

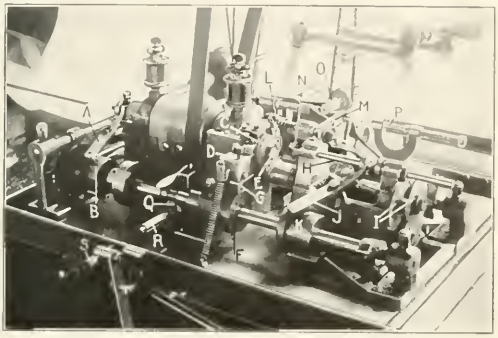

Fig. 27. Automatic Machine for Producing Small Watch Screws

Pinning or Doweling Bridges

The most expensive watches consist of one front plate and several bridges, these forming the bulwarks for the movement. The bridges are pinned and screwed to the front plate and retain the jewels which act as bearings for one end of the staffs. The more important operations on the bridges are: Blanking and shaving in the punch press, facing, stoning, drilling in a jig, counterboring, recessing and pinning or doweling.

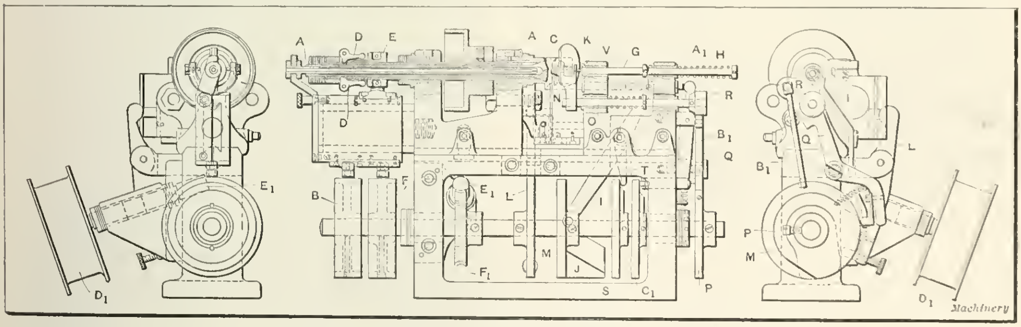

Fig. 28. Construction of the Pinning Machine shown in Fig. 26

The pinning is accomplished in the automatic machine shown in Fig. 26, which is similar, in appearance, to a small automatic screw machine. The construction of this machine is more clearly shown in Fig. 28. The wire from which the pins are made is fed by a feeding tube A by means of a finger which is operated by cam blocks on wheel B. The chuck C is closed by fingers D, operated by a sleeve E and cam blocks on wheel F.

The wire is gaged to the desired length by a spring actuated stop G which is forced forward against the tension of the coil spring H by means of yoked lever I and cam J. The circular cut-off tool K, working at an angle of 45 degrees with the axis of the spindle, is then brought in through the medium of a rack and gear, by lever L and cam M. Before the pin is cut off, stop G drops back, and carrier N held on shaft O is operated or rotated into position by cam P, rack-lever Q, and pinion R. When in line with the work, the carrier is forced forward by cam S and lever T, thus gripping the pin and then dropping back.

The bridge in which the dowel or pin is to be inserted is held in a cage into which it is placed by the operator. Now as the carrier drops back, cam P, rack-lever Q and pinion R rotate the carrier into a position where the pin is in line with the hole in the bridge; then carrier N which is provided with a spring plunger V ejects the pin, inserting it in the work when acted upon by plunger A_1, lever B_1 and cam C_1. The main drive shaft, carrying the various operating cams, is driven by a pulley D_1 through a worm E_1 and worm-wheel F_1. The various cams are so timed that while the pin is being inserted in the work, another pin is being fed out and cut off, these operations being performed automatically.

Small Automatic Screw Machine

A large number of the cylindrical parts which are used in a watch are produced on the Brown & Sharpe automatic screw machine, but most of the small screws are made on special screw machines, one of which is shown in Fig. 27. The stock—the exact size of the head of the screw—is fed through the spindle by a feed finger operated by lever A and cam B.

The body of the screw, or portion to be threaded, is reduced by a circular form tool C held to a block D, as shown. This block is fulcrumed at E, and is operated by a cam F pressing against the hardened shoe G. It will thus be seen that the cutting edge of the tool, when in operation on the work, passes through an arc. This method of presenting the tool to the work has been found to give better results on small work than feeding the tool in a horizontal plane, as is the usual practice.

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* The second installment of this article was published in the June number of MACHINERY. The fourth and last installment will occur in an early issue.

† Associate Editor of MACHINERY.

The thread is cut by a small mill- or spring-die held in the forward end of spindle *H*. This spindle is rotated from the rear driving shaft through the change gears *I*, and is advanced by yoked lever *J* and cam *K*. The cams *F* and *K* are so timed that the form tool is raised out of the way to let the die reach the work, the shoe *G* dropping down onto the cut-away portion of *F* at the proper moment. The die in traveling onto the work rotates in the same direction as the spindle, the latter reversing to run the die off when the desired length of thread has been cut.

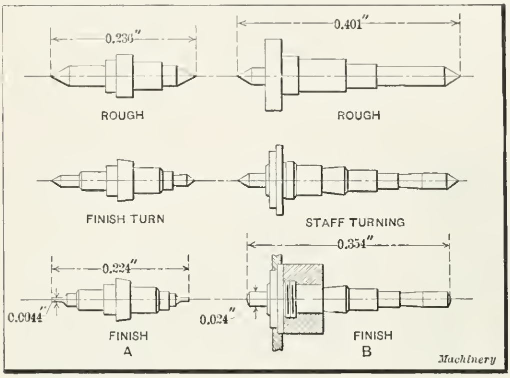

Fig. 29. Various Turning Operations on the Center and Balance Staffs

After the thread is completed, the cut-off blade *L* operated by a cam on the rear shaft comes into action, and severs the screw from the bar. Just as the screw is breaking off, a bushing held in arm *M* is rotated into position to grip the screw, by means of a fan gear *N* and a friction pinion not shown. The arm then rotates back into position in front of the slitting saw *O*, which by means of a cam and the fulcrumed holder in which it is retained, travels down past the head of the screw and cuts the slot. Spring plunger *P* is now forced forward by a cam, and ejects the slotted screw from the bushing. This cycle of operations is repeated until the bar is used up, when the camshaft is stopped by means of a simple device. This consists of a worm and worm-wheel *Q* which feed out a shaft *R* until it comes in contact with an adjustable stopscrew *S*, thus operating a lever which disconnects the driving clutch.

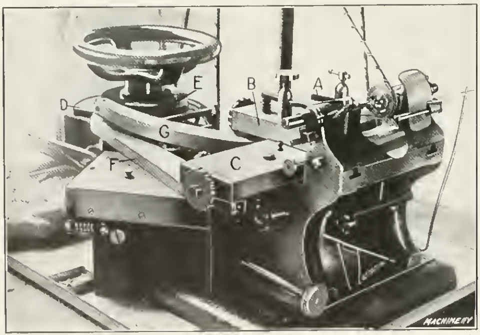

Fig. 30. Multiple Shoulder Staff Turning Machine

Staff Turning

The wheels composing the watch train are held on staffs, the ends of the latter running in jewels retained in the lower plate and bridges. Most of these staffs are provided with a number of shoulders of different diameters, as shown in Fig. 29, where *A* represents the various operations on the balance staff, and *B* the operations on the center staff. The last operation on the center staff shows the center wheel and pinion assembled.

One of the machines used for multiple shoulder staff turning is shown in Fig. 30. The staff to be turned is held on female centers, and is driven by a small dog. The turning is accomplished by a single turning tool *A*, held to the tool-slide *B*, which, in turn, is connected to a longitudinal slide *C*. Only one-half of the staff is finished at each setting, it being reversed to finish the other end. The movements of the turning tool *A* are controlled automatically by plate cams *D* and *E*. The lower cam *D* traverses the slide *C*, and hence moves the turning tool across the work by means of lever *F*, the ratio of the arms of which is 4 to 1. The top cam *E*, operating lever *G*, controls the in-and-out movements of the turning tool, and thus governs the diameter of the staff. The arms on lever *G* have a ratio of 8 to 1, thus enabling greater accuracy to be obtained on the diameter of the staff. The heights of the lobes on the cams, of course, are made equal to the movements required, multiplied by the ratios of the arms of the levers.

The lobes on cams *D* and *E* are so laid out and timed that all shoulders on the staff are faced as well as turned to a given diameter. One girl operates two machines, removing a staff when finished and inserting a rough one. The machine is stopped automatically by a tripping device, not shown. The operator sits on a chair which is provided with wheels running on a track. This enables her to get from one machine to the other quickly and with very little effort.

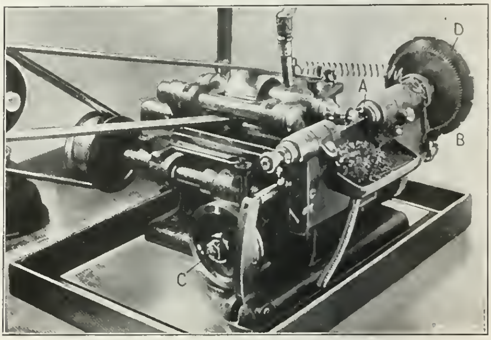

Fig. 31. Automatic Three-cutter Pinion-cutting Machine

Cutting Pinions

Watch pinions, as a rule, are made of steel and are formed-turned and cut off in special automatic staff machines. Then they are placed one at a time on an arbor, the latter being placed between the centers of the machine shown in Fig. 31. The driving center is corrugated, while the dead center is of the female type and is held in a spring-actuated spindle or tailstock. As a rule, three cutters are used: The first is a thin saw; the second a roughing cutter; and the third a finishing cutter.

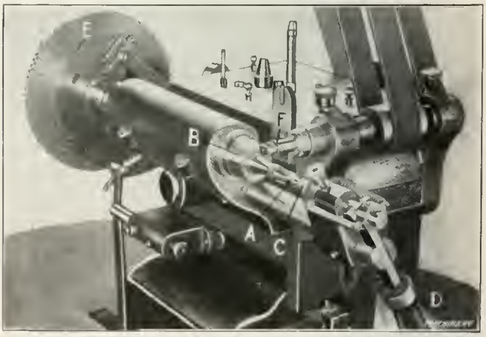

Fig. 32. Machine for cutting the Teeth in the Brass Wheels

The spindle *A* carrying the corrugated center is indexed by means of an indexing disk *B* and a ratchet. After the work has made one complete revolution, a cam held on cam-shaft *C* shifts the table, bringing the next cutter into operation. The spindle again makes one complete revolution, when the cam shifts the table, bringing the last or finishing cutter into line. This makes one cut around the pinion, after which the table drops back to the starting position, and the machine is stopped by an automatic tripping device. The index plate *D* is provided with the same number of notches as there are teeth on the pinion.

Cutting Brass Wheels

The brass wheels, which in connection with the pinions compose the watch train, are blanked out and shaved by subpress dies in the punch press. The arms of these wheels are all equally spaced and made of an equal width. The automatic machine used in cutting these wheels is shown in Fig. 32. Eleven of the wheels are held on the arbor *A* which has a tapered shank fitting in the indexing spindle *B*. The forward end of the arbor is supported by a spring center *C*, which is withdrawn from the arbor by pressing on the handle *D*. The indexing disk *E* has the same number of teeth as that required in the wheel and is indexed automatically by a ratchet device.

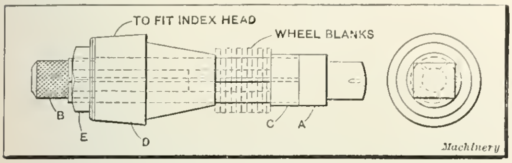

Fig. 33. Arbor used on the Machine shown in Fig. 32 for Holding Brass Wheels

The cutter *F* is held on an arbor placed in the spindle of the machine. The head carrying the cutter spindle is raised on the return stroke of the cutter by a cam located beneath the head. The table carrying the work is advanced at a uniform speed by a constant-rise cam held on a cam-shaft at the rear, and an automatic arrangement stops the machine when one stack of wheels has been completed.

The arbor on which these wheels are held while the teeth are being cut is shown in Fig. 33. It consists of a central arbor *A* which has five slots cut in it of the same width as the arms of the wheel. A hole is bored part way through this arbor, and a plug *B* is inserted to prevent it from collapsing. A washer *C* of the same diameter as the shoulder on the arbor is put on it as shown; then the wheels are put in place and the tapered sleeve *D*, which fits the index head, is next slipped over the arbor. Collar-nut *E* is then screwed onto the threaded end of the arbor, thus clamping washer, wheels and sleeve together.

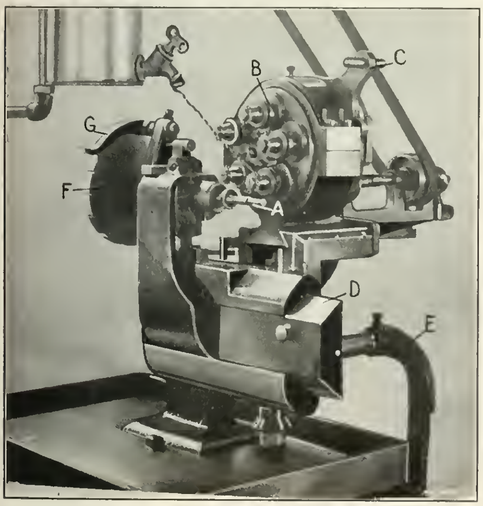

Fig. 34. Machine for Cutting Brass Escape Wheel Teeth

As these wheels are blanked out and shaved in the punch press, it is evident that the inside of the rim is practically the only place to work from, if a wheel having a rim of an equal width throughout its circumference is desired. By working from this point, and using a milling cutter which will finish the tops of the teeth, it is an easy matter to produce a wheel which will be perfectly balanced.

Cutting Brass Escape Wheels

The escape wheel, so called because of the function it performs in a watch, is made from either steel or brass. The brass wheels are cut by sapphires, seven of which are used as fly-cutters, while the teeth in the steel wheels are produced by hardened steel cutters. Each of these cutters forms one part of the tooth, which differs considerably in shape from an ordinary gear tooth, as can be seen by referring to Fig. 8 in the May number.

The machine used for cutting the teeth in brass escape wheels is shown in Fig. 34. A stack of these wheels is held on arbor *A*, the latter being retained in the indexing spindle. The teeth are completely formed by five cutters held in the revolving head *B*, each cutter shaping some part of the tooth. The cutter spindles are driven by gears enclosed in the head. The cutter head itself is indexed by hand to bring the desired cutter into operation, this indexing being effected by means of the handle *C*. The table or slide *D* is traversed by hand by means of the lever *E*. The work is also indexed by hand with the ratchet wheel *F*, the latter being held in the desired position by pawl *G*. The teeth in these escape wheels are so delicate that it would be practically impossible to produce them by means of an automatic machine, great care being required on the part of the operator to turn out a perfect wheel.

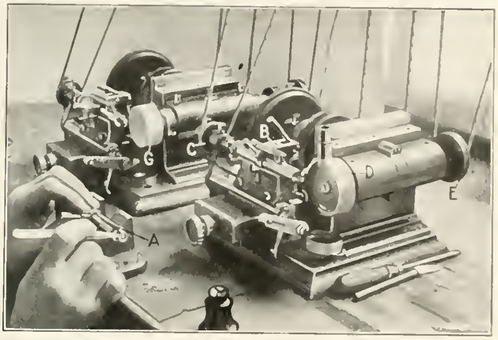

Fig. 35. McGinty Staff Cone Grinding and Polishing Machine

As it is impossible here to give even a short description of the making of all the parts of a watch movement, only those methods which involve the use of some interesting mechanical device or appliance have been selected. After the steel parts such as pinions, staffs, balance staffs, etc., have been made, they are hardened and tempered. This leaves them in such a state that it is necessary to lap and polish them to the desired size, at the same time improving their appearance.

Grinding and Polishing Machine for Staff Cones

The staffs on which the wheels are held have a coned bearing, which must be of exact size to fit the hole in the balance wheel jewels inserted in the wheel. The staff to be ground is placed in a quill *A*, the operator using a pair of tweezers for this purpose, as shown in Fig. 35. The quill is then placed, and held by clamp *B*, in that part of the machine shown to the right in the illustration, which is used for the first operation—grinding. The spindle of the quill *A* is driven by a grooved pulley *C* and a small dog, the latter coming against a lug on the quill spindle. The staff is held between pump centers and a faceplate, and the grinding is accomplished by a diamond charged lap *D*, which is rotated by pulley *E*.

The spindle carrying the lap is moved back and forth by a cam which, in turn, is operated by a worm and worm-wheel. This cam is provided with a gradual rise for feeding the lap against the work. When the desired diameter is reached the machine is stopped by means of a trip-stop.

The machine shown to the left is used for polishing the cone on the staff, and is identical in construction with that just described, with the one exception that the lap is given an oscillating movement by means of a crank *F*, shown in Fig. 37. This latter illustration also shows more clearly the construction of this machine. The lap is made of celluloid and is coated with Vienna lime, obtained in Austria. It is kept in contact with the work by means of a cam that has a cut-away portion, allowing the lap to drop back when the cone has been lapped to the correct diameter.

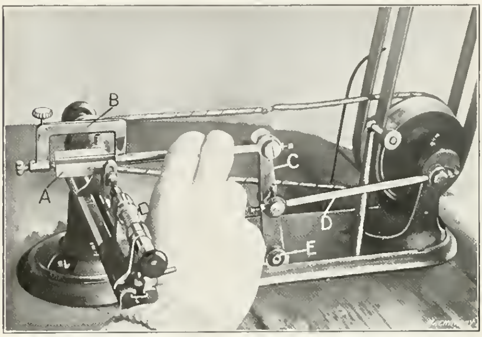

Fig. 36. "Wig-wag" Polishing Machine for Pinions and Staffs

Before this machine—nicknamed the McGinty cone polishing and grinding machine and known by this name wherever watches are made—was perfected, the grinding of these cones was done by hand by skilled staff makers, who made this a special business. Naturally, when this machine was invented, it was jeered at by these expert cone polishers. About this time the old song "Down went McGinty" was at the height of its popularity, and each time this machine returned to the tool-room for improvements, the polishers would strike up the old refrain. However, after much experimenting the machine was perfected, and at the same time was nicknamed "The McGinty cone and polishing machine." It is now operated by girls who do better work and more of it than was formerly accomplished by expert polishers.

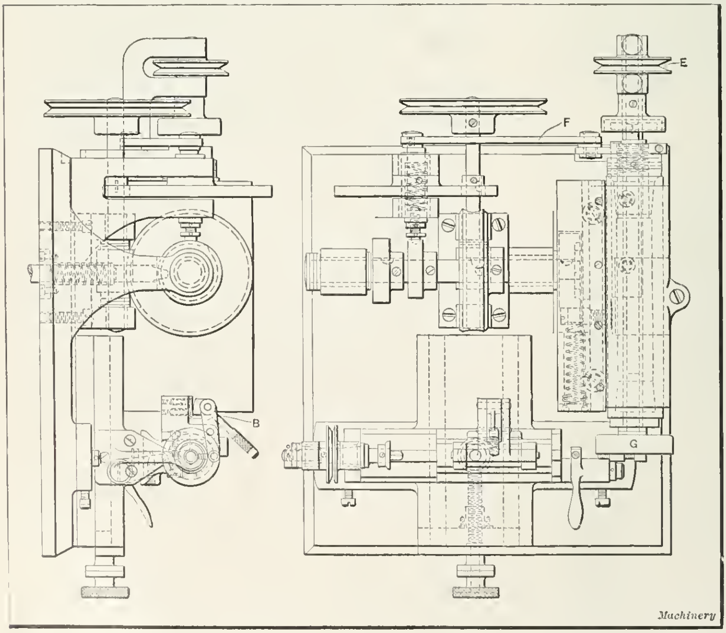

Fig. 37. Construction of the McGinty Staff Cone Grinding and Polishing Machine shown in Fig. 35

Polishing Pinions and Staffs

The pivot ends of pinions and staffs are polished by means of "wig-wag" polishers, one of which is shown in Fig. 36. The pinion is held in a "balloon" chuck provided with a pump center, and the polishing is done with a wing polisher *A* made of machine steel. The wings are ground on a special fixture, to an included angle of 45 degrees, and these lapping edges are charged with rouge mixed with pure lard oil. The wing polisher is held in a bracket *B* which is fastened to a bell-crank *C*, the latter being operated by a connecting-rod fastened on the end of the driving shaft.

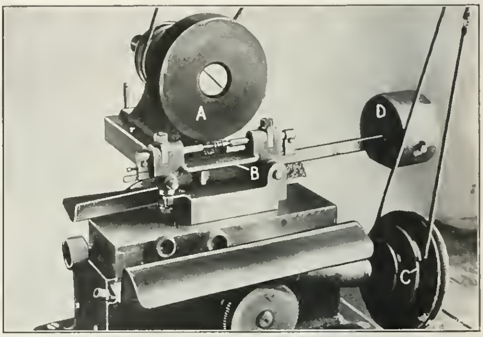

Fig. 38. Pinion Leaf Polishing Machine

In operation, after the part to be polished is placed in the chuck, the frame holding the wing polisher is brought down and the latter kept in contact with the work, as shown in the illustration. As bell-crank *C* is fulcrumed at *E*, the action of the eccentric transmits an oscillating movement to the wing polisher. The machine is furnished with an idler pulley, so that it can be stopped by operating a foot lever, when inserting the work in the chuck.

Polishing and Grinding Pinion Leaves

As previously stated, all steel parts are hardened and tempered, and the pinions are no exception to this rule. After hardening, the leaves or teeth of the pinions are lapped in the machine shown in Fig. 38. The pinion is held between centers, which are retained in a stationary slide *B*. A circular lap *A* made of fiber, and provided with annular grooves, is charged with emery and driven at a high rate of speed. This lap is fed across the work by a cam in one direction and is returned by a coil spring. The cam is operated by a worm and worm-wheel driven from the grooved pulleys *C*.

Traversing the lap across the work rotates the latter on the center, so that all of the leaves are lapped. Weight *D* keeps the adjustable center in contact with the work.

Grinding the Teeth of Steel Escape Wheels

Steel escape wheels are hardened and tempered, which, of course, distorts their teeth, making it necessary to grind them. This operation is accomplished in the machine shown in Fig. 39. The escape pinion is held on an arbor *A* and is brought in contact with the fine laps shown at *B*, three of which are located at different angles to each other. When grinding, the operator grips the yoke *C* with one hand, swinging it around so that different portions of the escape tooth are brought in contact with the faces of the various grinding wheels. When one tooth is completed (it is ground in three different places) the arbor carrying the escape wheel is indexed by means of dial *D* and pawl *E*. This cycle of operations is repeated until the escape wheel is completed, 45 grinding operations being necessary for each escape wheel.

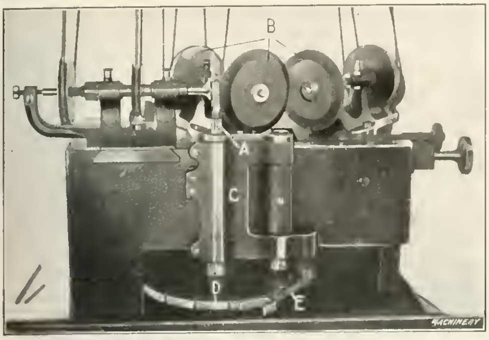

Fig. 39. Polishing Machine for Steel Escape Wheels

* * *

GRADUATING MACHINE OF NOVEL CONSTRUCTION

A graduating machine without a pawl and ratchet for indexing the work is shown in Fig. 1. The manner in which the indexing of the work is accomplished is rather unique, and is also very accurate, as there is a positive movement for each indexing, and no chance for a pawl to slip or get out of order. This device is of a very simple construction and is much smaller than the average graduating machine employed on the same class of work.

The graduating device consists essentially of a worm and worm-wheel for rotating the work, and a five-lobed cam, driven by two spur gears having a ratio of 5 to 1, for imparting the necessary movement to the graduating tool. The work *A*, Fig. 1, which in this instance is the base for the slotting attachment used on the Rockford milling machines, is held on a spindle by a washer and nut, the spindle being located in a holder *C* provided with a boss resting on table *D*, and adjustable in a slot cut in the latter. This holder is held in the desired position by two set-screws and a cross bar *E* fitting in a notch in the holder and located under the table.

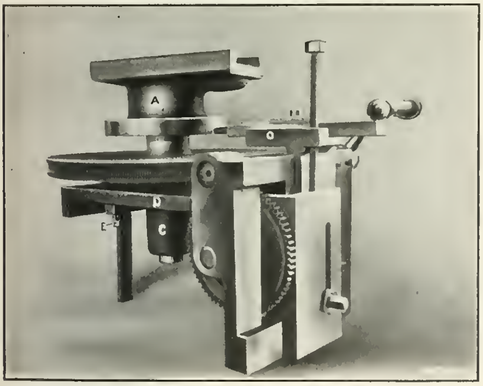

Fig. 1. A Graduating Device in which the usual Indexing Ratchet and Pawl is dispensed with

The worm-wheel *F*, Fig. 2, on the boss of which the work rests, is fastened to the spindle and is rotated by a single, right-hand worm *G* (10 threads per inch) operated by the handle shown. This worm is held rigidly to shaft *I*, but gear *K* is held on a sliding key allowing the shaft to move laterally. The five-lobed cam *J*, for imparting the required movement to the graduating tool, is rotated by spur gears *K* and *L*, which have a ratio of 1 to 5, so that for every complete revolution of the worm, cam *J* makes 1/5 of a revolution. One lobe on this cam is longer than the others, thus making every fifth line longer than the other four.

The graduating tool is held in a holder clamped to slide *O*, which latter fits in a dovetailed groove cut in the frame of the fixture. The adjustable block *P* for moving the graduating tool to the correct height, is fastened to slide *O* by a collar-head screw *Q* and is adjusted by screw *R*. This block is provided with a shoe projection *S*, which rests on the five-lobed cam, thus providing a means for raising and lowering slide *O*.

The indexing device is ingenious, consisting simply of a 10 threads per inch, single worm, one end of which is provided with a cam face having a throw of 0.100 inch per revolution. The boss of the bearing with which this cam is in contact is also provided with a cam face having an equal throw. A pin driven into this boss would serve the same purpose as the cam face, but would not give as smooth an action. Now, when the worm is rotated in a right-hand direction it travels to the left, as shown by the arrow in Fig. 2, owing to the action of its cam face, and in so doing does not transmit any movement to the worm-wheel.

This action may seem rather singular, but it is easily explained if we consider the worm-wheel as a stationary nut and the worm as a screw free to move laterally. In this case the worm-wheel is held stationary by friction and the weight of the work, while the worm is forced to the left due to the action of its cam face. As there is sufficient clearance between the two bearings, it will be seen that the worm, when being rotated, is free to travel, carrying the shaft *I* along with it in the direction of the arrow. When the end of the rise on the cam is reached, however, the worm, actuated by spring *T*, suddenly slides to the right a distance of 0.100 inch and carries the worm-wheel around through a space of one tooth.

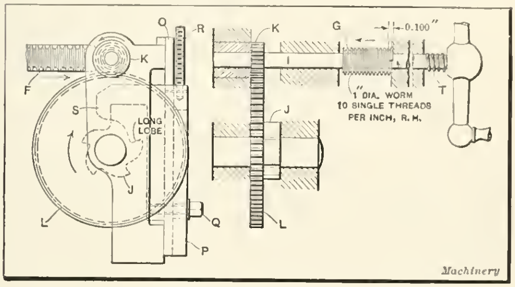

Fig. 2. Diagram showing the operation of the Indexing and Graduating Mechanisms

The five-lobed cam is so timed with the cam on the worm that when the worm-wheel remains stationary, the graduating tool is producing the line. Then, as the graduating tool drops away from the work, the worm is suddenly pulled to the right by the action of the spring, indexing the work for the next graduation.

The worm-wheel shown in the illustration has 360 teeth and is used for graduating in degrees. Two other worm-wheels are used in connection with this device, one provided with 125 teeth and the other with 100 teeth. The worm-wheel having 125 teeth is used for graduating dials to read in thousandths of an inch, which are used on screws with 8 and 4 threads per inch, while the worm-wheel having 100 teeth is used for dials placed on screws with 10 or 5 threads per inch.

While some of the constructional features of this graduating machine could be improved on, the principle of indexing is unique and will no doubt be appreciated. It was designed and built in the shop of the Rockford Milling Machine Co., Rockford, Ill., where it has given entire satisfaction.

D. T. H.

THE MAKING OF BUSHINGS FOR DRILL JIGS*

PROPORTIONS OF BUSHINGS, MATERIALS USED, TURNING, HARDENING, GRINDING AND LAPPING OPERATIONS

BY F. B. JACOBS†

The making of a set of ten or twenty jig bushings is often looked upon as a long and tiresome operation with something of a degree of uncertainty as to results. This is especially true in some of the smaller shops as very few manufacturing concerns outside of the larger ones have anything like an effective system as applied to this class of work. It is not the intention of the writer to describe anything new but simply to outline the method employed in many of the medium sized shops in the Eastern states for getting out accurate jig bushings with a minimum amount of expense and trouble.

After the jig is bored the holes should be stamped 1, 2, 3, etc., and a chart drawn up as shown in Fig. 1. This need not be an elaborate affair as an ordinary pencil sketch will answer all practical purposes. The value of this chart is apparent, as the toolmaker can at a glance find any dimension for a bushing, thus saving much time that is generally spent in taking repeated measurements. For convenience the bushings are divided into three classes: Liners, shoulder bushings and slip bushings. If there are any solid bushings without shoulders that are used without slip bushings they can be listed with the liners. The letters A, B, C, etc. correpond to the dimensions of the bushings which are filled out in the chart in the spaces reserved for them. Two spaces are reserved under the column C for drill and reamer bushings that are to fit the same liner. The numbers 1, 2, 3, etc. correspond to the figures stamped on the jig to designate the different holes.

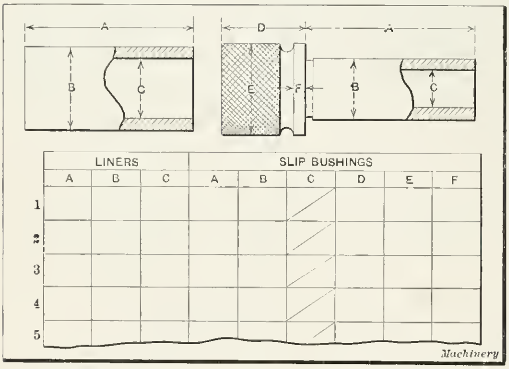

Fig. 1. Arrangement of Table of Jig Bushing Dimensions

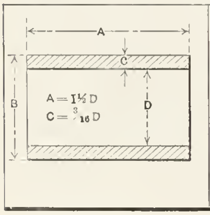

Fig. 2. Proportions of Lining Bushings

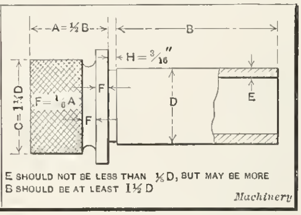
A = ½ B
B
H = 3/16″
C = 1¼ D
F = 1/6 A
F
F
D
E
E SHOULD NOT BE LESS THAN ⅛ D, BUT MAY BE MORE
B SHOULD BE AT LEAST 1½ D
Machinery

Fig. 3. General Proportions of Slip Bushings

Very few manufacturers agree on a standard for the proportions of jig bushings, each preferring to follow their own ideas. In many cases they are left to the discretion of the toolmaker himself. The proportions shown in Figs. 2 and 3 will generally answer in the majority of cases. When it is necessary to make bushings of unusual length they are often relieved as shown in Fig. 4. Solid bushings should have a shoulder as shown in Fig. 5, when it is intended to have stop collars run against them.

In Fig. 7 are shown three methods of holding bushings to prevent their turning: *A* shows a bushing having a pin inserted which slips in a slot cut in the lining bushing; *B* shows a bushing having a slot milled through the collar, a pin being located in the jig to engage this slot; and *C* illustrates a more elaborate device that is sometimes used. The stop button which is fastened to the jig prevents the bushing from being drawn out of the liner while withdrawing drills or reamers, as well as preventing its turning.

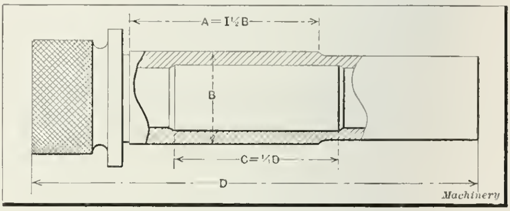

Fig. 4. Proportions of Bushings of Special Length

Bushings are generally made of a good grade of tool steel which insures hardening at a fairly low heat thus avoiding to a great extent the danger of fire cracking. They can be made in much less time from ordinary machinery steel which will answer all practical purposes, provided they are properly casehardened to a depth of 1/16 inch. Where many bushings are to be made a large percentage of the cost of stock can be saved by using machinery steel.

There are several methods followed in turning jig bushings. Some toolmakers prefer to "chuck out" the hole to the desired size and then finish the outside of the bushing by placing it on an arbor; others prefer to turn up the bushings two at a time, end to end, cut them apart and then bore as the final operation. This is an excellent method to follow when making large bushings. The most rapid method, however, is to chuck out the hole and finish up the outside at one setting using bar stock held in the chuck of a rigid engine lathe. This method is not always practicable on large bushings.

ALLOWANCES FOR GRINDING AND LAPPING BUSHINGS

Operation	Diameter of Bushings in Inches					
	½	1	1½	2	2½	3
A	0.008	0.010	0.013	0.016	0.020	0.025
B	0.0005	0.0005	0.0007	0.0008	0.0009	0.001
C	0.008	0.010	0.013	0.016	0.020	0.025
D	0.0003	0.0005	0.0007	0.0008	0.0009	0.001

A—Grind outside; B—Lap outside after grinding; C—Grind inside; D—Lap inside after grinding.

In making allowances for grinding and lapping, many toolmakers neglect to leave enough, which is the cause of many bushings having to be made over again on account of not finishing out. On the other hand many toolmakers leave too liberal an allowance for finishing thereby causing themselves a lot of unnecessary trouble and labor. The allowances given in the accompanying table can be safely used when the bushings are made somewhere near the proportions shown in Figs. 2 and 3, but for extra long bushings more liberal allowances should, of course, be made.

Before hardening the bushings should be plainly stamped with the size and purpose for which they are intended, "15/32 drill," "1/2 ream," etc. They should not be stamped with dull, worn out figures that are used by Tom, Dick and Harry on everything, but with a set of plain sharp figures reserved solely for this purpose. It is poor practice to try to stamp the words "drill," "ream," etc in a straight line, as not one man out of a hundred can do this and turn out a respectable looking job. If, however, the words are laid out on a slight curve the results are more satisfactory as slight irregularities of alignment are not then so noticeable. Anyone can prove this to his own satisfaction by a little experiment with a steel alphabet and a block of cast iron. Sharp clean figures and letters neatly laid out not only improve the appearance of the toolmaker's work, but also save the drilling operator a lot of time as sharp clean-cut figures can be read at a glance.

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* For additional matter on jig making and jig design see: "Locating Jig Buttons," June, 1912; "A New System for Locating Holes to be Bored on the Milling Machine," April, 1912; "Some Jig and Fixture Designs," January, 1911, and the articles there referred to. See also MACHINERY'S Reference Books Nos. 41 42 and 43, "Jigs and Fixtures."

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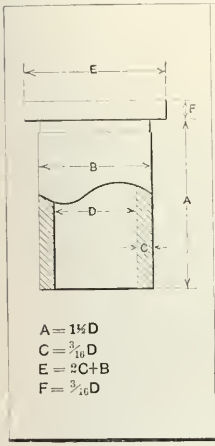

Fig. 5. Proportions of Shoulder Bushings

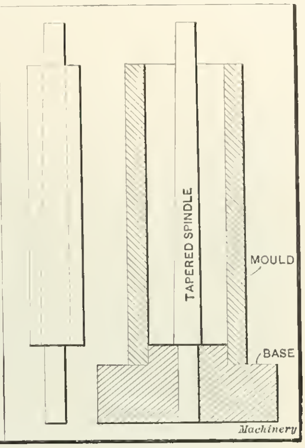

Fig. 6. Lead Lap and Mold used for Casting it

In hardening bushings made of tool steel they should be brought up to an even red heat in a clean fire, and the heating should never be hurried. If heated quickly the bushing is very likely to heat unevenly which invariably results in a warped piece that will not finish out. Gas furnaces are excellent for heating bushings preparatory to hardening. If, however, a gas furnace is not available a good clean charcoal fire in the forge will answer the purpose.

As soon as the bushing has been brought up to an even red heat it should be dipped in water warmed just enough to take off the chill. The bushing should then be brought up to a "sizzling heat" and left to cool in the air. Some toolmakers draw bushings to a medium straw color. This is a mistake as it only tends to shorten their life.

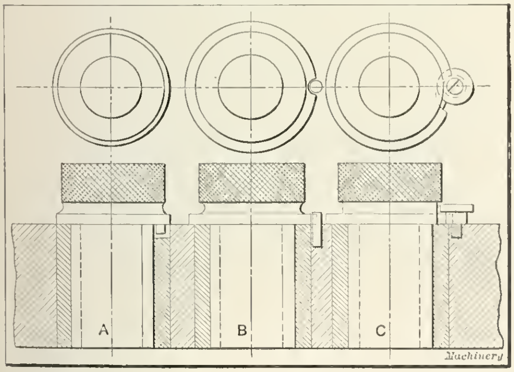

Fig. 7. Methods used for Preventing Jig Bushings from Turning

Grinding and Lapping

There are four methods in common use for finishing holes in jig bushings, *viz:* Lapping with a lead lap, lapping with a lead lap followed by a cast-iron or copper lap, internal grinding, internal grinding followed by a cast-iron or copper lap for removing the last 0.0005 inch. The first method is dead wrong as it invariably results in bell-mouthed holes, especially when the toolmaker charges the lap while in use, which is very poor but at the same time very common practice. The second method is correct for holes too small to be ground conveniently. The third method is wrong as the grinding wheel, no matter how fine, leaves innumerable very fine scores and high spots. These high spots soon wear away leaving the hole oversize. The last method is correct and should be used whenever possible.

In Fig. 6 is shown a lead lap with a steel tapered spindle, and a convenient mold for casting the laps. This mold is provided with a base having a hole to receive the spindle that the lap is cast on. A number of laps can be cast in this mold at one heating of the metal and afterward turned to the size required. Fig. 8 represents a familiar form of cast-iron lap. This lap is split in three places, and provided with a taper-end screw for expanding it to compensate for wear.

Laps should always be charged before—not while they are in use. A good way to charge a lap is to lay it on a cast-iron plate on which some of the abrasive material has been sprinkled. A cast-iron plate small enough to be conveniently handled is then held on the lap and moved back and forth with a regular motion. The lap being rolled between two surfaces picks up a certain amount of the abrasive material. A lead lap can be charged in this manner very rapidly, as the grains of abrasive material readily imbed themselves in the soft metal. A cast-iron lap, being of a harder material, requires more time to properly charge.

Until the last few years emery was the abrasive generally used for lapping. At the present time, however, aloxite, a product of the electric furnace, is displacing emery as it cuts faster, producing excellent results in a comparatively short time as compared to emery. Nos. 90 to 150 are used in connection with lead laps for roughing operations. For the final finishing with cast-iron laps flour aloxite is used. When not in use any abrasive used for lapping should be kept in a covered box to protect it from dirt and other foreign substances. A small chip or piece of grit will often cut a deep score in a piece of work—which neither improves its finish or workmanlike appearance.

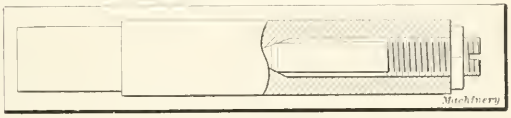

Fig. 8. Usual Form of Cast-iron Lap

Laps should always be run at a fairly low speed. Fifteen to twenty feet surface speed for a lead lap used for roughing, and twenty to twenty-five feet surface speed for a cast-iron lap used for finishing are about right. A high surface speed causes the lap to wear out without cutting as rapidly as it should. Many toolmakers make the mistake of running laps too fast, often causing unsatisfactory work.

For light lapping the work can be held by hand but with a heavy roughing cut it is best to hold the work with an ordinary lathe dog, care being taken to see that the dog is not clamped so tightly as to spring the work out of shape. Lead laps should be split to compensate for wear, and the spindles should have a groove cut along their entire length to prevent the lap from turning.

Before testing with a size plug the work should be washed out with benzine or gasoline to remove all traces of the abrasive material, a few grains of which will wear the size plug below standard size in a surprisingly short time. Washing in benzine or gasoline also brings the work to the same temperature as the size plug, which is important where extreme accuracy is required.

Many toolmakers look on the finishing of jig bushings by internal grinding as a rather uncertain method, whereas it is a comparatively simple process when the following important factors are carefully considered. First, proper selection of grinding wheels; second, correct wheel speeds or at least as near as the design of the machine will permit; third, correct alignment of the headstock in regard to the travel of the platen; and fourth, proper truing of wheels.

Wheels for internal grinding should be of a medium grit, soft grade and open bond. As a rule the grit should never be finer than 60 grit; in fact a coarser grit can often be used to advantage. Wheels with fine grit cut slowly, fill up readily, glazing and invariably heating the work and causing chattering and other troubles too numerous to mention. In fact the only argument in favor of a fine grit wheel is that it leaves a smooth surface. However, no matter how smooth the surface appears to be, even under a powerful glass, it will have to be lapped to remove the wheel marks for the reason previously stated. When we stop a moment to consider that 0.0005 inch will perfectly lap out the marks left by a 60 grit wheel, there is not much room for an argument in favor of 70, 80, and finer grit wheels.

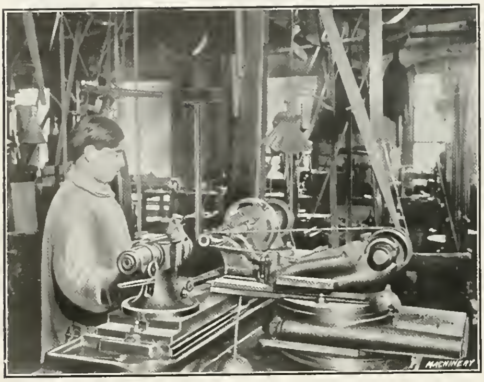

Fig. 9. Grinding the Holes in the Bushings

For the internal grinding of jig bushings on a Brown & Sharpe No. 2 universal grinder, as shown in Fig. 9, the writer has used aloxite wheels, 1½ inch diameter, ⅜ inch face, 60 grit P grade, D-495 bond, with excellent results, the wheel speed being 12,000 R. P. M. The bushings averaged 2½ inches long, 1¾ inch hole. The holes were rough bored 0.015 inch being left for grinding. The grinding time per bushing, including chucking and truing up, was twelve minutes each and the finish left was good, 0.0005 inch being sufficient to lap out the wheel marks. Reference is made above to the holes being rough bored; this is good practice as the rather rough surface tends to wear the wheel just a little while removing the fire scale thus preventing the wheel from glazing. Once the scale is removed from the hole, the wheel should not glaze readily provided it is of the proper grit and grade.

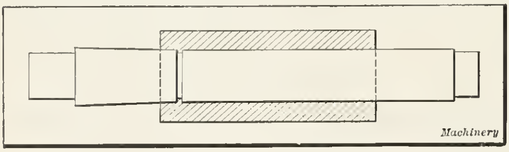

Fig. 11. Arbor for Holding Bushinge

Wheels for internal grinding should in theory be run at a surface speed of 5000 feet per minute. This, however, is a general rule open to exceptions. A safe practical rule to follow is to speed up the wheel if it wears away too readily, and to reduce the speed where the wheel shows a tendency to glaze. A little attention to this rule will often save much trouble. The toolmaker should bear in mind the fact that it is much easier to adjust the speed to suit the wheel, than it is to try to keep on hand a large variety of wheels to suit all speed conditions.

Assuming that the work in question is to be done on an ordinary universal grinder, the headstock must be set parallel with the travel of the platen to produce straight holes. A practical way to determine parallelism is to clamp a piece of round stock in the headstock chuck, letting it project from the jaws a little farther than the length of the holes to be ground. This piece should have a groove turned in it for the wheel to dwell in during reversal. This test piece is then ground in the regular way with the wheel used for cylindrical work, the headstock being adjusted by means of its swivel base until the test piece is ground parallel. Before calipering, the wheel should be allowed to grind until very few sparks are visible. When once this test piece has been ground straight the setting can be depended on to produce straight holes, provided, of course, that the swivel adjustment of the headstock and the angular adjustment of the platen are not disturbed. To try to straighten up the headstock by calipering the work while the internal grinding is in process is at best a difficult job, and the operator is never quite sure of accurate results.

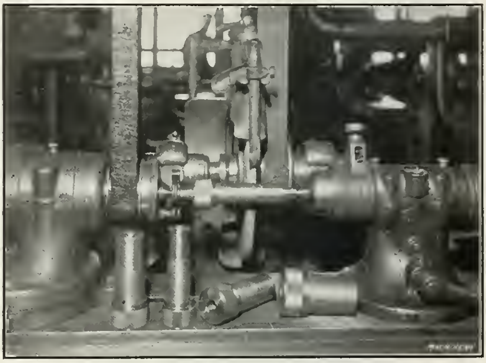

Fig. 10. Grinding the Outside of Slip Bushings

It is common practice to true wheels for internal grinding with a diamond fed by hand, using the eye as a guide. This is poor practice as the wheel is seldom turned parallel, one edge being left to do all the cutting, which, of course, glazes it readily. A more practical way to true these comparatively soft wheels is to feed them past the end of a carborundum rub, in 20 grit H grade. The rub can be held in a suitable holder strapped to the platen of the grinder, or held firmly by hand against the end of the work. As a carborundum rub shows high efficiency when used for this purpose and costs practically nothing as compared to a diamond it is worth considering.

In holding work in the chuck for internal grinding, it is well to exercise due care to see that the work is not clamped hard enough to spring it out of shape. As a rule it does not require much pressure to hold work of this nature as the grinding cut is comparatively light. Attention is again called to Fig. 9 where it is seen that the chuck used in this case is of the variety commonly used on tool lathes. It is my opinion, based on practical experience, that this chuck is an improvement over the chucks commonly supplied with universal grinders, as it is more substantial and has reversible jaws which can be used independently or universally.

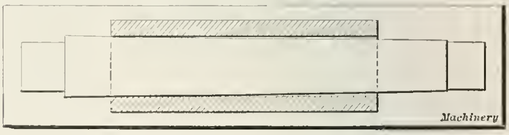

Fig. 12. Improper Fit of Bushing on Ordinary Arbor

As it is general practice to grind internal work dry a certain amount of expansion from frictional heat is always present. For this reason considerable care has to be used in calipering the work with the sizing plug. As the plug is many degrees cooler than the work it is liable, on being inserted, to contract the bushing suddenly, causing bushing and plug to "freeze" together firmly. This can be avoided by cooling the work with a plug that is known to be undersize before calipering with a plug of the desired size. The final calipering should also be done with a plug that is undersize to allow for the final finishing by lapping.

When a wheel of 60 grit is used, a hole one inch or under in diameter should be left approximately 0.0005 inch under size. This amount is sufficient to lap out the wheel marks and leave a dead smooth mirror finish to the hole. This is a general rule based on the fact that a certain amount (in this case 0.00025 inch) is enough allowance to lap out the marks left on a surface by a grinding wheel, and that should suffice for all holes regardless of size. With comparatively large holes, one and one-half inch diameter or over, it is better, however, to make allowance for finishing, owing to the fact that the area of contact of wheel and work is generally not so great and the ground surface is not quite so smooth.

In regard to the external grinding of bushings, there are two important points that should be given consideration, *viz:* the selection of wheels and method of holding the work. The wheel should be fast cutting and at the same time it should hold its shape and leave a good finish—not the painfully fine finish that delighted grandfather while experimenting with the toolpost grinder, but a good dead finish from which the wheel marks can be readily lapped.

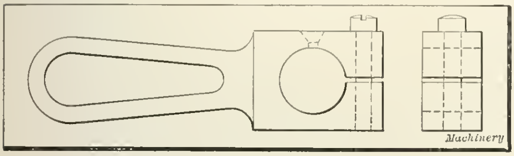

Fig. 13. Lap for Finishing Outside of Slip Bushings

For this work in connection with a Brown & Sharpe No. 2 universal grinder I have obtained excellent results with an aloxite wheel 12 inches diameter, ½ inch face, 5 inch hole, 405 grit, N grade, D-497 bond, the wheel being run at a speed of 1800 R. P. M. In grinding some slip bushings as shown in Fig. 10, the finished surfaces averaging 1½ inch diameter, and 2½ inches long, a work speed of 75 feet per minute was used. The traverse feed of the work was the fastest that this machine was capable of giving in connection with the above work speed, and was approximately an advance of one-fourth the width of the wheel for each revolution of the work.

The finish was excellent and the grinding time for each bushing, removing 0.012 inch, was five minutes. This was accurate work, 0.0004 to 0.0005 inch being left for the final finish by lapping. The above wheel is known as a combination grit, in a medium soft grade and an open bond, and I consider it a great improvement over the hard bonded straight grit wheels used in many toolrooms.

The above work was not done with the idea of establishing a record for this class of grinding, but the object was to show a grinding machine operator what could be done in the line of cutting down production costs by the use of a modern grinding wheel. His time for grinding the same bushings, using a wheel in straight 60 grit, M grade, made by a reliable manufacturer, was fifteen minutes each. He had to use a fine traverse feed, the finest that the machine was capable of giving with a 65 feet per minute work speed to get the desired finish, and to avoid chattering and undue heating of the work.

When a number of bushings are to be ground one after another it is best to mount them on arbors of the same length when practicable to do so, thus saving considerable time generally spent in re-setting the platen, which has to be done whenever the tailstock is moved to accommodate arbors of different lengths. An arbor for holding bushings should be made as shown in Fig. 11. The straight part should be a good fit in the bushing, a slight taper on the remainder of the arbor being sufficient to prevent the bushing from turning on the arbor. When bushings are held on an ordinary arbor or mandrel the operator is never quite sure that the hole and the outside of the bushing are concentric, as one end of the arbor owing to its taper does not quite fill the hole. This is illustrated in Fig. 12. Both Figs. 11 and 12 are somewhat exaggerated to illustrate the principle.

In grinding lining and solid bushings due allowance must be made for a driving fit in the body of the jig. There are three methods in common use for making driving fits on this class of work: First, grinding the bushing until the lower end just enters the hole, the bushing being slightly tapered to bring it to a snug fit when pressed into place; second, grinding the bushing straight for its entire length, leaving it just enough oversize to make a good driving fit; and third, grinding the bushing for nearly its entire length just enough oversize to make a good driving fit, and grinding about one-eighth its length just enough undersize to enter the hole.

The first method is not considered strictly first class practice as the bushing contracts more at the top than elsewhere owing to the taper which leaves the hole in the bushing tapered. The second method is very poor practice as the bushing is very liable to cramp while being forced in place which results in an unsatisfactory job as the hole in the jig is generally sheared by the sharp end of the bushing. The third method is correct as the part that is ground to fit the hole acts as a pilot, thus insuring the proper starting of the bushing, and the body being straight insures even contraction.

In making allowances for driving fits 0.001 inch for each inch diameter of the bushing is considered practical where the holes are one inch or over, and where the holes in the jig are bored smooth. If the holes are rough bored a more liberal allowance is required. After the lining bushings are driven in place they require re-lapping as they always contract a little.

The outside of the slip bushings should be finished by lapping to a dead smooth finish as otherwise they will soon wear loose. This should never under any circumstances be done with emery cloth, but with a cast iron lap as illustrated in Fig. 13. The abrasive used in this case should be of flour grit with lard oil as a lubricant, the abrasive and oil being applied through a hole in the top of the lap. The work should be lapped with a regular even motion to insure its being straight, and should be brought to the temperature of the room by being cooled in benzine or gasoline before testing for a fit. The lapping should be carried to a point where the bushing is a wringing fit in its liner, but not tight enough to stick when left alone for a moment.

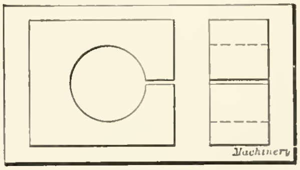

Fig. 14 A Cast-iron Lap which may be used in Emergency Cases

The lap shown in Fig. 14 is often used in an emergency; it is readily made from cast iron and held with an ordinary machinist's clamp. It is practical but not as handy as the lap illustrated in Fig. 13.

After the grinding and lapping of the slip bushings is complete, their tops can be finished by lapping on a carborundum stone, in medium grit, wet with gasoline. A regular motion should be used across the face of the stone without turning or altering the relative position of the bushing. This lapping gives the bushings a workmanlike appearance, and as the dimensions stamped are left black from the action of the fire in hardening, they can be read at a glance.

* * *

In a brief article in *Canadian Machinery*, Mr. Charles T. Main emphasizes a point on which there is a great deal of narrow misunderstanding. Many men possessing technical knowledge seem to believe that they serve their own best interest by keeping it to themselves, whereas, as Mr. Main says, an engineer possessing information, not of a private nature, of benefit to the profession in general, should be broad enough in his outlook to publish it for the benefit of his brother craftsmen. He will find on looking at the matter even from a selfish point of view, that he will not be the loser, for it will bring him into greater prominence and call attention to the fact that he is the man to be employed or consulted in work involving this particular experience. Such men should always be glad to impart to others any information available.

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FINE SCREW THREAD STANDARDS

The Navy, U. S. or Sellers standard screw threads have been widely adopted in America, and are satisfactory for the general run of machine work. They have been used for years in the construction of locomotives, cars, steam and gas engines, mining machinery, farm machinery, etc. But satisfactory as the U. S. standard has been, time has shown that it has limitations of use. The automobile is the most prominent example of a highly developed machine in which the need of finer screw threads was manifested. The jar and vibration incident to high speed and rough roads loosened screws and nuts threaded to the comparatively coarse U. S. system, and finer screw threads were required to prevent loss of parts and rapid deterioration. The French car manufacturers recognized this fact early in the development of the automobile.

In April, 1906, the Association of Licensed Automobile Manufacturers adopted a fine pitch screw standard ranging from ¼ to 1 inch diameters inclusive, and varying by sixteenths to ¾ inch and by eighths to 1 inch. This standard was extended to 1½ inch diameter June, 1911, by the Society of Automobile Engineers, the successor of the A. L. A. M.

The need of a fine pitch screw thread system to supplement the U. S. system is also being felt in the machine trade generally. In order to provide for this need it is proposed to adopt the S. A. E. standard and extend it upward to say 4 inches diameter in harmony with the pitches from ¼ to 1½ inch now existing. Replies to a circular letter sent by MACHINERY to the machine building trade indicate that many concerns have adopted the S. A. E. standard screw threads where fine pitches are required, and would gladly use them for most purposes in larger sizes if they were provided.

The extension and general adoption of the S. A. E. standard would undoubtedly simplify the special thread tool problem for the tap and die makers and relieve them of making many special fine thread taps and dies now demanded. The general adaptability of the two standards is set forth in an extract from a letter from a well-known builder of special machinery:

> "The A. S. M. E. and S. A. E. standards for diameters and pitches of screws adequately supply our wants for screws of fine pitches. We rarely find the necessity for any finer pitches in the diversified types of machinery and devices that we are called upon to design or construct, and this occurs only when some peculiar condition of design demands it. From our observation and experience in the design and construction of typewriters, sewing machines, adding machines, tabulating machines, type casting machines, ticket vending machines, auto capsule machinery, knitting machinery, Lanston pneumatic keyboards, etc., we can see no reason why another standard of finer pitches than those obtainable in the A. S. M. E. and S. A. E. standards should be established."

* * *

THE INFLUENCE OF SHOP CONDITIONS

In a comment on the value of well-equipped shops and pleasant working conditions, the *Engineer* (London) remarks that good machine tools mean good workmen to run them. A manufacturer of machinery who had recently reconstructed his machine shop, converting an old-time, dingy shop into one containing the best equipment, arranged and lighted so as to provide for the highest efficiency, stated that he found it much easier to obtain high-class workmen as soon as it became known that they were to operate high-class machine tools.

It is a mistake to believe that all machine operators work for wages only. Many men operating machines in obscure corners of a shop take considerable pride in the work they do, and they enjoy an opportunity to use the best and most accurate machines. Another of the erroneous, old-time ideas which are apparently giving way to a sounder appreciation of the workman's feelings, is that the average machinist, having to perform work in which he cannot possibly keep clean, does not care whether his surroundings are clean and comfortable or not, but is satisfied to work under conditions of any sort. The new plants being erected all over the country show that employers are realizing the value of light, airy and comfortable workshops, and that the additional investment required is money well spent, as it increases the efficiency of the men and lessens discontent, which is the most subtle cause of inefficiency the manager has to deal with. Other conditions being equal, the firm with a clean, light and well-equipped plant will have much less difficulty in getting along with its workmen than one with a dark and dirty shop. It is not without reason that the industries where labor troubles are most frequently encountered are those where the workmen are employed under unsanitary or uncomfortable conditions.

* * *

INVESTMENTS IN UNDEVELOPED INVENTIONS

If the history of "frenzied finance" and dishonest promotion is ever accurately written it will include many cases of patent exploitation wherein inventors and investors were fleeced by smooth-tongued sharpers who promised to develop and market valuable inventions. Some of the most ingenious discoveries and mechanical designs of the times are hopelessly tied up in litigation resulting from the organization of companies and sale of stock before the inventions were developed.

Capital is necessary to place most inventions on the market, and no matter how meritorious a device may be, considerable argument and persuasive ability on the part of some one having faith in it are generally required to obtain the necessary funds from capitalists. The reluctance of capitalists to invest in unknown possibilities is not shared by clerks, bookkeepers, laborers, servant girls and others eager for large returns on small investments, and this fact is shrewdly turned to advantage by promoters who paint in bright colors the probable returns, quoting perhaps the experience of the original investors in telephone stocks as an example of enormous profits yielded by an invention. Inexperienced people who turn over their money for investment in stocks whose value is problematical are too often bitterly disappointed.

A safe rule to follow is to invest nothing in an undeveloped invention unless you have first-hand knowledge of its scope, its novelty, the probable market, and the character of the men who are promoting it. Even when you possess this knowledge the chances for failure are many, and the investment should be made with full appreciation of the possiblity of loss. Widows, orphans and others whose capital is their only resource should steer clear of mechanical promotion schemes generally. Although not usually conceived with the dishonest intent characteristic of mining schemes, they are nevertheless hazardous investments, quite likely to result in loss.

STANDARDIZATION OF MACHINE TOOL PARTS

It is a proper function of the engineer to conserve as well as to produce. Production with waste is abhorrent to the engineer who fully appreciates his economic relation to the manufacturing world. In fact, engineering is the science of producing efficiently, which means the elimination of false movements and waste effort, the utilization of waste products and the substitution of mechanical power for human muscular effort. The elimination of waste carried to the logical end in engineering work would put an end to competition, but that is a condition of society too far removed from present possibilities for serious consideration now. What we can do is to work for those results which in a competitive world may be agreed on as being for the common good.

In the manufacture of machine tools there is little in common as regards sizes and shapes of those parts in the design of engine lathes, planers, shapers, drilling machines and other so-called machine tools made by the various builders for which interchangeability is highly desirable. It is plain to any unprejudiced person acquainted with the conditions of use that certain standards might be adopted by machine tool builders with advantage to themselves and their customers.

For example, take the floor plan of a dozen different makes of sixteen-inch lathes, and it will be found that, although the variation may be little, practically twelve different layouts of foundations will be required. This is a wasteful and undesirable condition, and it would seem that two foundation plans, one for light and the other for heavy designs, should suffice. Surely this is a difference on which it should be comparatively easy to reach common ground for agreement. A similar understanding might be applied to the spacing of bolt holes in countershaft hangers, and any other features affecting the installation.

The more vital matters on which agreement is desirable are standards for lathe spindle noses, dimensions of tee-slots, direction of feed for a given direction of rotation of a feed handle, general position of handles, dimensions and taper of taper shanks and sockets, number of threads per inch of lead-screws, etc.

The matter of agreement of lathe spindle noses is so important that some manufacturers adopted private standards years ago, and specify them when ordering new equipment. One system that has proved satisfactory is the common U. S. standard bolt screw thread sizes. With this system, chuck and faceplates can be sized with standard taps thus simplifying the home making of special lathe attachments.

The Society of Automobile Engineers has worked out several important improvements in manufacturing conditions by which useless duplication of sizes of stock parts have been eliminated. The work of this society is most commendable and constitutes a worthy example for other societies and associations of manufacturers, to imitate.

* * *

THE VALUE OF COST SYSTEMS

In speaking before the American Society of Swedish Engineers recently, Mr. H. L. Gantt, of scientific management fame, pointed out that there are two distinct objects to be accomplished by cost systems and records of factory performances. One purpose of a cost system should be to enable those occupying responsible positions connected with the production to obtain such information as may enable them to devise new and better methods and improve old ones, and to have definite information at hand showing to what extent the new methods actually are more economical than those of former practice. In some shops, however, Mr. Gantt found that the cost system was not kept with this object in view. Very few people connected with the production end of the factory were permitted to make use of the data recorded, and the cost system merely afforded those in charge an opportunity for criticism and fault-finding. No effort was made to devise more economical methods, or to locate the trouble in a systematic way when one month's performance did not come up to that of a preceding month. The executive used the record merely to hold up before his superintendent and foremen, telling them that they did not run their departments as they should.

A cost system run in this way is almost worse than useless; it creates discord and does not serve to increase production. The real purpose of such a system should be to show at any moment if production is falling behind; and a systematic effort should then be made to find the cause, not merely by blaming an individual, but by locating with accuracy the exact conditions which are the cause of the decrease. These conditions may be beyond the control of any of the persons ordinarily blamed. In a machine shop they may be due to hard castings or other defects in the material supplied to the department. They may be due to improper heating and ventilation of the plant. They may be due to unavoidable changes in the personnel. Whatever the cause, it should be ascertained; and unless the cost system accomplishes this, it is of little value because merely blaming a man does not enable him to remedy a defect. He must first find the cause, and the cost system should help him to do that.

Of equal importance is the function of the system which enables foremen, superintendents, designers and others vitally interested in production to determine the value of new ideas; and in order that the cost system may fulfill its purpose in every respect, men in responsible positions within the factory must be given access to the cost data compiled.

* * *

THE PATENT THAT GEORGE DIDN'T TAKE OUT

BY A. P PRESS

George was a good toolmaker, and when he was not making tools he was playing whist, and although he was an expert at both, I think his abilities in the whist playing line rather lapped over his toolmaking capacity.

Now we have all played whist, and when you have a good sized party in the dining room and parlor, the next morning the floor is covered with the scrap punchings where the score is punched out of the cards.

So as they sat at the breakfast table one morning, with the floor covered with chips, Mrs. George said:

"George, why couldn't you put a pocket on the punch, so as to catch all these little pieces? They are awful hard to sweep out of the carpet."

"Sure thing," said George, and that morning after he got a long chip started, and the boss had gone out for an hour, he turned up a pretty little brass sleeve, and soldered it on to the under side of the punch. He put a threaded cap on the end, so he could unscrew it and empty out the punchings.

He took it home that night, and his wife was enraptured. They used it the next whist night, and his friends all complimented him on the success of his invention.

"Why don't you have it patented? There is a fortune in it if you get hold of somebody to push it for you."

When you get the patent microbe started in a man's brain, it is a pretty hard thing to exterminate it, and George went down to see a patent lawyer the next afternoon.

"Yes," said the lawyer, "that is a pretty good thing, but you ought to have a better looking sample than that. You should get a nicer looking punch, and put it on that."

That night after supper, George got busy. First he sent the oldest boy down to the hardware store and told him to get the nicest ticket punch he could find. The kid came back, and George undid the package, took it out, and there was the cutest little punch you ever saw, with a pocket on it to catch the chips and patented some ten years before!

The microbe was exterminated from George's brain.

* * *

A German contemporary publishes an article in which the writer discusses the theoretical principles of the Tesla steam turbine described in MACHINERY, November, 1911, and also referred to in a note in the July number. The German author points out that the efficiency cannot exceed 50 per cent with the construction employed, and on larger sizes the efficiency would be proportionately less.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT—3

CONSIDERATION OF THE MOST IMPORTANT OBJECTIONS TO SCIENTIFIC MANAGEMENT

BY FORREST E. CARDULLO*

Enough has been said to show that laws and economic conditions have a very great effect upon our industries and the efficiency with which they are conducted. Changes in the law which decrease efficiency are usually objectionable and changes are usually more far-reaching and important than most men believe to be possible. While the engineer usually considers such matters to lie entirely outside his work, yet they affect it so vitally that he will before long be compelled to give them his attention, and to apply to them the same hard-headed and rigorous analysis that he now gives to the design or construction of a piece of machinery. When he does, the lawmaker will regard his efforts skeptically, the financier will regard him as a meddlesome bungler, and most men will regard him as a gross materialist without proper regard for the higher things of life.

In the same way that we have previously classified and examined the sources of industrial inefficiency, let us classify and examine the objections which may be raised against scientific management. These objections come from three sources, the employer, the employe and the public.

Objections of Employers to Scientific Management

Taking first the objections raised by the employer, they usually arise either from a misunderstanding of what scientific management is or from a misconception of the fundamental principles of industrial administration. The objection most often raised is that scientific management very greatly increases what some men term the "expense burden" and what others term the "overhead charges." This is true and yet it is not an objection to scientific management if it can be shown that the total cost of manufacturing a given product is reduced by thus increasing the overhead charges. The introduction of a drafting-room or of a pattern-shop into an establishment which has previously purchased such work outside, will increase the overhead charges, but most plants find it cheaper to maintain drafting-rooms and pattern-shops in spite of this fact. If four men are employed, it is just as well to have one of them constantly engaged in planning the work of the other three, and keeping them supplied with tools and material, as it is to have each one plan his own work and run his own errands.

The question of whether scientific management unduly increases the expense burden is one which can only be answered by experience and in the terms of dollars and cents. If the cost of doing a given piece of work is reduced by scientific management, the question of the ratio of the overhead to the direct charges is of no consequence. If, on the other hand, the cost is increased by scientific management no other argument is necessary in order to condemn the system, and the ratio of the direct and indirect expenses is a matter of purely academic interest.

While some employers are willing to admit that the cost of manufacture is reduced when scientific management is employed, they advance the argument that while direct labor may be discharged when it is not employed, the men in the planning department cannot be discharged without destroying the efficiency of their organization, and so must be retained at considerable expense during periods of industrial depression. Similarly, while the wage cost is cut off entirely when men are discharged, the extra fixed charges upon the larger plant usually called for by scientific management, do not cease when times are slack, and that, therefore, in those industries which are particularly subject to periods of depression, scientific management will be a failure, although during periods of prosperity, it may show a reasonable saving in costs of manufacture. To this objection two answers may be made. First, when scientific management shows a gain after taking account of the periods of depression, it ought to be adopted. Second, if scientific management enables a firm to manufacture more cheaply than competitors, that firm will be able to accumulate a surplus so that it can continue to manufacture and store its product when it would otherwise have to be sold at a loss. Furthermore, it will be able to undersell its competitors, will do a fairly large business in dull times, and will therefore be able to operate its business with less attention to industrial conditions than is given by other firms. If scientific management is able to show a saving at any time, the chances are that it will be able to show a saving all of the time.

A third objection often raised to scientific management is that when a shop is run as systematically as this method of management requires, a sudden change in plans is impossible without seriously disarranging the work, so that the rush order or the special job does not receive the attention which it should. The answer to this objection is that scientific management should contemplate all of the conditions likely to arise in the plant and should provide special means for expediting certain work when that is necessary. If such special means are not provided, the system is imperfect and is not scientific management since it is not adapted to the needs of the particular plant.

A great many objections raised against scientific management come from men who have seen shops in which scientific management has been attempted by managers, superintendents or others, who did not understand what it was. Such men have often attempted to combine scientific management with conventional systems, and while they have sometimes developed improvements, they have often fallen into ludicrous blunders. Such blunders cannot be charged to scientific management, and when it is claimed that scientific management has failed in specific instances, it is well to investigate the case, and see whether the failure is one of scientific management or of unscientific management.

Objections of Workmen to Scientific Management—Wearing Out Men

On the part of workmen there is considerable objection to scientific management. I believe that it usually arises from an idea that efficiency lowers wages and throws men out of employment. This objection, however, is rarely if ever alleged, but others are sought to take its place. The first one, and the one worthy of most serious consideration, is the objection that under scientific management men are urged and compelled to work at such a pace that their health and vitality suffers. Now it is doubtless true that men can be overworked in certain industries, but it is equally true that it is very difficult to overwork men in most industries unless the hours are unusually long. What is termed overwork is usually a matter of unsanitary laboring or housing conditions or insufficient nourishment. For instance, a man may be compelled to work in a cramped position or exposed to great heat or poisonous vapors, he may be compelled to eat and sleep in a hot and dirty tenement, or his wages may be too small to buy nourishing food. If the adoption of scientific management lengthens the time during which he is exposed to unsanitary conditions, his health will suffer, but this is not a matter of overwork but a matter of industrial sanitation. Scientific management recognizes the fact that workmen are often exposed to unsanitary conditions, but the scientific method is to change the conditions and not to reduce the amount of work required.

When we come to discuss the trades usually carried out under sanitary conditions, and requiring a considerable expenditure of muscular effort, we will find that the amount of effort required to accomplish a given task may be reasonable for some men but unreasonable for others. Whether a task is too severe or not, depends on the strength and endurance of the individual workman. Tasks possible for a vigorous man are impossible to one who is ill or weak. Men lacking in strength or vigor are not fitted to engage in certain occupations and they should be transferred to other occupations for which their physical defects do not unfit them. For instance, a man whose strength is unequal to the tasks demanded of a hod carrier or blacksmith helper may be very well fitted to become storekeeper's assistant or to operate a punch press.

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In this connection it must be noted that a man is not like a machine, but that the wear and tear of the body are repaired by periods of rest. So long as the degree of exertion required of a man is not such as to produce discomfort when continued for several minutes, and so long as proper rest periods occur at suitable intervals throughout the day, the man will not be overworked, but after becoming accustomed to his task will be able to continue his work week after week without any diminution of vigor. If he is properly nourished and works and lives under sanitary conditions, such a man will be just as vigorous and long-lived as though he were engaged in some less laborious occupation.

As a matter of fact it does not pay to wear men out. If men are caused to work at such a rate that their vigor diminishes, they will in their lifetime do less work than they would had they worked at a slower and less exhausting pace, and both the industry which employs them and the community in which they live will suffer accordingly. On that account we need have no fear that scientific management intends to overwork men, although in isolated instances men may be overworked under scientific management either because they are not fitted to the task to which they are assigned or because the one assigning the task was not experienced enough or careful enough to assign a proper task.

One of Mr. Taylor's early successes was to increase the amount of pig iron carried by laborers by properly training them for the task. The amount of pig iron carried after proper training and selection was about forty tons against a previous record of ten tons per day. The first laborer trained for this task was a man named Schmidt, and one of Mr. Taylor's critics thinking the task excessive and severe, very justly inquires, "What became of Schmidt?" Mr. Taylor informs me that Schmidt is at the present time well and hearty and still capable of strenuous tasks and financially much better off than he would be had he not been helped by scientific management.

Harder Work without Corresponding Pay

The second objection raised by workmen against scientific management is that the men are expected to "work very much harder" without receiving a corresponding increase in pay. Often by the introduction of scientific management, a man's output will be increased three or four fold while his wages will be increased not more than from thirty to sixty per cent. The average workman feels that under such circumstances his wages should be increased in the same proportion as his output. When, however, we come to analyze the matter, we find that the workman's contention is not true and that he ought not to expect his wages to be increased in that proportion.

When a man receives his wages, he is paid for several things. In the first place he is paid for his time. In order to get a grown man of potential value as a workman to come and sit in an office and do nothing for eight hours a day, or even to amuse himself in some manner, it would be necessary to pay him something, and probably it would be hard to find men willing to undertake such work, if it may be called work, for a dollar a day. In the second place he is paid for his physical effort. Work requiring no knowledge or experience and which merely requires physical effort does not usually command very good pay. Of course it commands more pay than does the mere expenditure of time, but certainly the effort which an ordinary laborer puts forth, cannot be estimated to command more than 75 cents to $1 a day, and I doubt if the average laborer who receives $2 per day would be willing to take a job at $1.50 per day which did not require any expenditure of effort. A third element for which a man is paid is the ability to receive and understand instructions. A fourth element is skill or dexterity, which enables him to perform a task quickly and well. A fifth element is a knowledge of the details of a trade, which is usually attained by experience and observation.

Let us suppose that a man is engaged in the turning of heavy pieces of steel and that by means of scientific management (*i.e.* by furnishing him proper tools, by standardizing the material, and by informing him of the proper speeds and feeds to use) his output is increased three fold. The time required is the same as before. That portion of his wages which he receives for time expended should therefore be the same as before. The effort required is three times as great as it was before. Since, however, the most of his time is expended in watching his machine and only a small portion of it in changing tools and work, the pay which he receives for the effort expended is very small, and the increase in pay due to the increased effort is proportionately small, certainly not more than 25 to 30 cents per day. The dexterity which he has, and the knowledge of the details of his trade, are no greater than before, and these elements do not call for any inccrease in his wages. A larger measure of ability to follow instructions is required, and this element of his pay should be increased. Of the five elements of his pay two require an increase, and three should remain unchanged. Altogether the increase in pay required by the extra effort and by the increased ability to follow instructions is quite modest, and if the man receives thirty or forty per cent increase in wages, he has received all that he can in fairness ask for. The only way in which we can fix a fair rate of pay is by reference to the rates received by other men engaged in substantially similar occupations. The application of scientific management in different industries will result in different increases in efficiency. In some lines a workman's efficiency will be increased only 20 or 30 per cent, while in other lines it may be increased five hundred or even one thousand per cent. If the work done in the two lines is similar, the pay of the workmen is probably nearly equal before the introduction of scientific management, and ought to be equal when they have attained their best efficiency.

Let us take as an example a foundry in which two different molders are engaged, one on light brass molding and the other on heavy iron molding. Let us suppose that each is paid at the rate of forty cents per hour, that the brass molder puts up twenty flasks a day, and that the iron molder puts up two. Let us suppose that as a result of a careful time study it is found that the brass molder can, without tiring himself unduly, put up thirty flasks a day, while the iron molder can put up six. Each man is then working at his best rate, and while it might be possible for him to do a trifle more work, it can only be done at the expense of his physical welfare. If now, the pay of each is increased in proportion to this increased output, it will be seen that the brass molder will get a fifty per cent increase and the iron molder a 200 per cent increase, the brass molder receiving 60 cents per hour, while the iron molder receives twice as much, or $1.20 per hour.

Now, when you come to think over the results of the application of time study in these two cases, it will be plain that if the work of the brass molder was formerly worth 40 cents an hour, that of the iron molder was worth only 20 cents an hour, and it would be highly unjust after the change in conditions had taken place, to pay the iron molder twice as much as the brass molder. In other words, for work requiring substantially the same intelligence, the same effort, and the same training, workmen should receive substantially similar pay, and this pay should be based upon what constitutes a fair wage under the best conditions, and when they have reached their best efficiency.

The same thing which applies in the case of two molders will apply in the case of two different trades in the same industry, or for that matter, in different industries. If the efficiencies of the workmen engaged in two different trades were unequal before the introduction of scientific management, it follows that injustice will be committed if the increase in wages in each trade is made proportional to the increase in output after, in each case, the workmen have attained their best efficiency.

Another way to look at the matter is to treat it as though the workman were selling his labor under the same conditions as any other commodity. Whenever there is a great reduction in the cost of manufacturing a given product, we expect that there will be a corresponding drop in the price, and usually this is true. The cost to the workmen of doing a given piece of work is the cost of living. The fact that he does a much larger amount of work than he did before does not increase his cost of living, and consequently the cost to him of doing a given amount of the work is materially reduced, being in the case we have chosen, only one-third of what it was before. Under such conditions the employer may reasonably expect that there will be a decrease in the labor cost, and while the workmen should expect to get higher wages, the employer expects with reason, to pay a lower price per piece. When the workman has an opportunity to do a larger amount of work without any increase in the cost of living, and to receive for his work a larger wage, he is in exactly the same position as the merchant, who by reducing his price is enabled to sell a larger quantity of goods in a given time, to turn over his capital oftener, and to make a larger profit in the course of a year, although he makes a much smaller profit on each article sold.

Finally, we must consider that when a man's efficiency is increased as a result of the application of scientific management, only a small part of this increase in efficiency is due to his own effort and that the most of it is due to the study and effort of the employer. Accordingly any gain which is realized must be divided between the employer and the employe, and usually with the public in the form of lower prices, in order that the public may absorb the larger output resulting. If the employe is to receive all the benefit resulting from scientific management, which would be the case if wages were increased in proportion to output, then it would be no object for the employer to utilize scientific management and its adoption would be of no advantage to the community. If the employe realizes a third of the gain due to scientific management, he has had his share, and must recognize that the other two-thirds belong respectively to the employer and to the community.

On being not required to think, but to carry out Instructions

A third objection often urged by workmen against scientific management is that they are not required to think, but merely to carry out instructions. They feel that when they receive complete instructions as to the method of performing work, it places their work upon a lower plane, transforming them from intelligent workmen into automatons. As one man has expressed it, "I like to think I think, even if I don't think." The answer to this is that Americans have in the past laid undue stress on originality and not enough on ability to follow instructions. If ten men are given explicit instructions as to exactly what to do and how to do it, very seldom will it be that one out of the ten will do exactly as he is told. On the other hand, if ten men are given a puzzle to solve, most of them will succeed within a reasonable time in solving the puzzle. The solution of a puzzle or the origination of a method of work really does not require any higher order of intellect than the exact following of a described method, and is, in the majority of cases, a gift of considerably lower social value.

I have had considerable experience in writing out exact directions informing men in the junior and senior classes of an engineering school, how to perform certain experiments—for instance, how to calibrate a gage. Three men out of five when given the directions for calibrating a gage will read them over and then go to work to calibrate the gage by a method of their own, which is usually incorrect. In the same way, it will be found that when a workman is given a piece of work to do, he will perform the work by a method of his own which is usually incorrect, in that it is not the most efficient method. This brings up the question of whether, for his own amusement, a workman ought to be permitted to adopt inefficient methods of work. When it is put in this blunt manner, every workman will admit that he ought to adopt the most efficient methods of work, and when he realizes that his wages are reduced and his employment endangered if he follows inefficient methods, he will usually be perfectly willing to follow instructions.

The use of instruction cards does not, however, take away from a workman the power of initiative. When a workman succeeds in devising a better method of doing a piece of work than that devised by the planning department, his method will be adopted, and he will receive a reward for devising it. If a workman shows himself capable of devising good methods of work, a place will soon be found for him in the planning department in which he can use his superior ingenuity to his heart's content. Because he has been accustomed to the use of the best methods, he will have a very much better fund of experience to draw upon than a man who has always worked in shops in which the workmen devise their own methods, and on that account his work will be of a superior character.

The use of instruction cards does not prevent a workman from thinking about his work, or from striving to originate new methods, in case he has any originality. Instead, when working from instruction cards, he has constantly before him examples of the best methods of doing work, and his experience is very much superior to that of a man who works in a shop where the workmen devise their own methods.

A man who is minded to do so can advance very much faster in a shop under scientific management, provided he is willing to study and learn. To the intelligent workman such a shop is a trade school, which will help him to a better understanding of his trade, and a chance for larger usefulness.

The argument that scientific management destroys the workman's power of thinking is a fallacy, because it assumes that the only thinking which the workman does is in regard to his work. The higher wages which scientific management involves will bring to the workman opportunities outside of his work which he cannot get otherwise. It will give him money for the purchase of books, for the building of his home, for the education of his children and for increasing the refinements of life. Even if it were true that scientific management curtailed the workman's opportunity to exercise real originality in his work, his intellectual life would still be the gainer from its introduction.

The workman's principal objection to scientific management is that he likes to do things his own way, to work as he pleases and when he pleases. Scientific management is objectionable to him because it compels him to change his habits, which is an uncomfortable process. If a workman were trained under scientific management from the beginning of his apprenticeship, and after several years were put to work in an ordinary shop, the change in habit would be just as disagreeable to him. He would object strenuously to being saddled with additional responsibilities while at the same time his pay was substantially reduced. The slipshod methods of his fellow workmen and the general inefficiency of the shop would grate on his nerves, and be ten times more disagreeable to him than the change in habits which scientific management usually introduces.

We must recognize that men are prone to complain and that anything new, especially if it involves a change in habit, will be the butt of the complaint. If they could not complain about scientific management, they would complain about the length of hours or the temper of the boss or the tools furnished for their work.

Scientific Management involves a Change of Habit

The fact that scientific management involves a change in habit which is disagreeable to many men is not a serious argument against it. People who become accustomed to living in disorderly and dirty surroundings find themselves uncomfortable when obliged to clean up and put things in order. Habits of labor which are inefficient are just as objectionable from the standpoint of the social welfare as habits of life which are unsanitary. Coming generations will look scornfully upon those who are inefficient, just as the present generation looks scornfully upon those who are dirty.

The change of habits involved in the adoption of scientific management is, from the practical standpoint, the strongest objection that there is. The minute you can show a workman that it is to his financial advantage to adopt the methods of scientific management, that minute all objections but this will disappear, but this one is ingrained in his temperament and nervous system, and cannot be reached by logic. Habit is one of the easiest things to form and one of the hardest things to eradicate, but even habits and prejudices must disappear at the demand of social welfare.

A great many misguided souls will urge against scientific management the same arguments which are urged against all other advances of civilization, namely that it impoverishes the imagination, takes the poetry out of life, puts men to work at machine-like tasks, etc. The same arguments are leveled against all improvements. The sanitary dwelling is less picturesque than the thatched cottage; the mowing machine is not so poetical as the scythe; the division of labor which enables ten little minds in combination to accomplish ten times the task that was formerly done by the ten master craftsmen is said to deaden men's souls and to limit their horizon. It is the eternal battle of common sense and the good of the community against selfish sentiment which regards only its own mental pleasure and takes no account of the good of the swarming many that are benefited by industrial advancement.

No Provision for Unions or "Collective Bargaining"

Another and very valid objection which workmen urge against scientific management is that it makes no provision for unions or "collective bargaining" as our friends the sociologists prefer to term it. It is undeniable that unions are necessary for the welfare of workmen and that without organized effort it would be difficult for them to maintain satisfactory wages and conditions of employment in the face of the tendency of capital to combine into trusts and associations. If scientific management is incompatible with labor unions, workmen cannot afford to accept it, because when scientific management has been adopted and unions have been destroyed, the whole of the benefits will be appropriated by capital, and labor will receive nothing for its increased efficiency.

Notwithstanding that many of the leading exponents of scientific management are opposed to labor unions, and believe that individual bargaining is one of the essentials of scientific management, this is not true. We can still have agreements in regard to minimum wages, hours of labor, conditions of employment, and many other things which affect the welfare of the workmen. The unions, however, must stop short of making any requirements in regard to methods of work or quantity of output or maximum wages paid or premiums given, because such things are not proper subjects of discussion between the unions and the employer, and because any effort on the part of the unions to interfere in such matters will harm workmen even more than employers.

I believe that the reasons that the advocates of scientific management feel their work to be incompatible with unionism is that many of the unions have in times past interfered in matters which were not properly their concern, and by doing so have harmed the cause of labor. Whether scientific management is largely adopted or not, unions will some day cease to interfere in these matters, because it is contrary to their own interests to do so. Since proper demands on the part of unions do not interfere with the operation of scientific management, and since those demands which would interfere with its operation are contrary to the interests of labor, I cannot see that there is anything incompatible in having scientific management in a union shop, and I believe that any effort to destroy unions when introducing scientific management can only serve to delay the date of its introduction.

Even the most serious objections to scientific management on the part of workmen, however, fall to the ground in the face of the fact that when scientific management is adopted workmen receive from thirty to sixty per cent in increase in wages. Not only will there be an immediate increase in wages as a result of scientific management, but with the extensive introduction of scientific management, there will be a substantial decrease in the prices of all those commodities in the manufacture of which it is generally applied. It is usually found that it is impossible to combat the self-interest of a community for a considerable period of time, and as soon as it becomes apparent that the working class, in common with all members of society, receives substantial benefit from scientific management, the objections to it will disappear and those things which at first were regarded as serious drawbacks, will eventually be deemed to be mere trifles and in some cases be regarded as positive benefits.

Objections of the Public to Scientific Management

From the standpoint of the general public, objection can be made to scientific management if it can be shown that it is inefficient, that it injures the health of the workmen, that it lowers the quality of the product, or that it brings about undesirable social or economic changes. The public does not, however, need to worry about the question of efficiency, because if scientific management is not efficient, it will not be used by manufacturers. Scientific management will for a long time be under very severe scrutiny by workmen themselves and it is unlikely that any harm will come to the physical welfare of the workmen unless in very exceptional cases.

Scientific management does not usually lower the quality of the product. In certain cases quality may suffer, but in most cases quality will improve as a result of scientific management. Sometimes a decrease in the quality of the product is not a serious matter, while at other times it is. If it is, scientific management is prepared by proper inspection to insist on such quality as may be commercially desirable. Whenever the public is disposed to require a certain standard of quality, and is willing to pay for that quality, there need be no fear that the quality of output will suffer from the introduction of scientific management.

The principal objection to scientific management is that it will bring about very important social and economic changes with which our present laws are not capable of dealing. One of the effects of scientific management will undoubtedly be the destruction of the small manufacturer. Scientific management achieves its greatest success in comparatively large plants. Those firms which adopt scientific management and are able to secure successful administrators, will crowd their competitors to the wall, eventually absorbing their business and becoming monopolies. Since our present laws are obviously inadequate to deal with such a situation, it follows that we must have a little scientific management in the lawmaking department of our government if we are to avoid social and political evils from the growth of scientific management.

It may be pointed out in this connection, however, that men of the "public-be-damned" class do not take kindly to scientific management. Men who are successful in introducing scientific management are those who recognize their duties, and are prepared to act for the welfare of the community as well as of their workmen and themselves. And aside from this fact those monopolies which will be the outgrowth of scientific management will be less oppressive and objectionable than those which are the outgrowth of high finance, legislative favors, or the cornering of natural resources.

Another economic evil which may result from the adoption of scientific management is the mis-direction of effort which will mark the transitory period while conditions are becoming settled. The cause of this is that by the use of scientific management the output of an industry will be very greatly increased. Sometimes the increase will be so great that the community cannot absorb the entire output at the cost of manufacture. The result will be that certain lines of work will be overdone and we will be some time in finding a rational and proper outlet for the extra productive capacity made possible by improved management.

Social and Economic Effects of Scientific Management

Upon surveying the social effects of scientific management, one is impressed with the idea that scientific management will improve social conditions very greatly and that there are only two economic evils prevalent at the present time that will not be materially diminished by the direct or indirect effect of scientific management. The first of these is the misdirected application of capital which results in potential overproduction in certain lines of industry. The second is the diversion of capital from industry for private pleasure. As an example of the first evil, I may cite the textile industry where capital is invested to such an extent that the mills are capable of filling all demands for textile goods when working at only a fraction of their capacity. Examples of the second evil are unnecessary since they will suggest themselves to most of my readers.

Scientific management must, in the long run, depend for its success upon the habit of mind of those who administer it. We think of the scientist as being a man who is, above all things, intelligently honest, who is without passion or prejudice; who is open-minded and determined to arrive at the truth. The scientific habit of mind is the only one compatible with the administration of scientific management. The man in authority must divorce himself from prejudice, from preconceived notions and snap judgments, and from everything which will turn him aside from the truth. In adopting scientific management, he must recognize certain great principles; some of which are economic, some of which are psychological, some of which are ethical, and some of which are merely physical.

An industrial establishment is merely a part of a great economic system. Recognizing this, the employer will see that if the establishment does not minister to the needs of the community, it is useless. Not only must its product be valuable, but is work must be carried on in such a way as not to harm the community. Work which is carried on at the expense of a part of the community, in order to benefit the remainder, cannot be justified. By such work I mean work carried out under dangerous or unsanitary conditions, or where the wages paid are insufficient to maintain the community standard of living. It may be cheaper to carry on work in that manner, but the moral sense of the community will not in the long run permit of it, and scientific management recognizes the fact.

The interests of all men engaged in a given industry are identical. A certain school of thought is accustomed to regard the labor situation as a war, in which employer and employe are striving to obtain an advantage over each other, each striving to secure from the other the largest possible proportion of the total returns of the industry. Scientific management recognizes this to be an error, and knows that cooperation between employer and employe is essential. It recognizes not only that the employer must purchase the cooperation of the employe by high wages and fair treatment, but also that he must cooperate with the employe by assising him in every way to become as efficient and valuable as possible. Each must cooperate with and assist the other, and must purchase by fair dealing and generous attitude the cooperation of the other.

The greater the productivity of a community, the more prosperous the community will be. High wages and restricted production are incompatible, and only by achieving the highest efficiency can the greatest prosperity be reached. There may be, however, overproduction in certain lines of work, because too much capital or too many men may be engaged in that line. This does not mean that too many men are employed or too much capital is available. It merely means that men are employed in the wrong industries and that capital is invested in the wrong lines. Consequently, the application of scientific management to all establishments engaged in one particular industry, may result in throwing the industrial system out of balance by producing more of one kind of goods than is necessary.

Conclusion

Work well done under proper conditions is interesting and healthful when the worker is healthy and well nourished. Work under unsanitary conditions is unhealthful. A poorly-nourished workman is always overtaxed by relatively small tasks. Unsatisfactory surroundings and slovenly work results in nervous strain which breaks down the workman's health. Men differ mentally and physically in innumerable ways, and each workman must be studied in order to discover the most useful place in which to put him. He must be put in that place where his abilities will be utilized to the utmost.

A careful study of a piece of work by a man of scientific habit of mind, having at his command the knowledge of a large number of expert workmen, will result in the development of methods of doing work which are far superior to the methods usually employed. Workmen naturally perform their tasks in improper ways as a result of habit. In order to have them perform the tasks in a proper way they must have supervisors to see that they form correct habits of work, and they must be encouraged by extra pay to continue in these habits.

The cooperation of workmen must be secured by persuading them that the employer has abandoned the attitude of war and that he is willing to divide the results of his improvements with the men whose cooperation makes these improvements possible.

Finally, the benefits of scientific management are so many and so varied that not only employers and workmen but the community generally will participate in them. It is therefore proper not to object to scientific management but rather to study the ways in which we can eliminate the evils which may possibly come from its use, and take advantage of the benefits just as we take advantage of the benefits of railroads, printing presses and steam power, in spite of the manifold evils which some men thought they foresaw as a result of their introduction.

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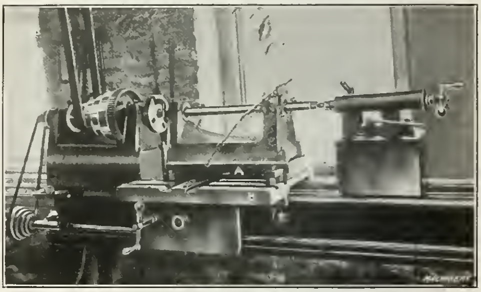
BORING AND FACING THE SPINDLE BEARINGS OF LATHE HEADSTOCKS

There are various methods used for boring and facing the spindle bearings of lathe headstocks. Some lathe manufacturers use boring machines, while others equip lathes with special fixtures for this purpose. The accompanying illustration shows the method used by the Rahn-Larmon Co., Cincinnati, Ohio, in boring and facing the bronze spindle bearings for a 20-inch engine lathe.

After the V-guides have been planed, the caps fitted, and the bearing boxes faced on the planer, the headstock is bolted to a special table *A* provided with ways to fit the V-guides in the headstock. This table, in turn, is clamped to a special carriage *B*, fitting the lathe shears and provided with a slot in its top face, which by means of a tongue on table *A* locates the bearings in the headstock in perfect alignment with the lathe centers.



Fixture used by the Rahn-Larmon Co., for boring and facing the Spindle Bearings of Lathe Headstocks

The boring is accomplished with a boring bar held on the centers, and driven by a dog. Both front and rear bearings are bored at one setting, two cutters being used. The front bearing is 3¼, and the rear, 2½ inches in diameter. The bronze bearings are next faced with a broad-faced fly-cutter, after which operation the bosses of the bearing caps are reduced to the same diameter as the bronze bearings with an L-shaped fly-cutter. All the operations enumerated, as well as clamping, etc., take about 40 minutes for each headstock.

D. T. H.

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Statistics relating to the automobile industry in the United States indicate that, at the present time, this industry is the third in importance of the various industries of the country. There were in April, 1912, 652,500 automobiles registered in the United States. The daily production of pleasure cars alone, during 1911, reached 700 a day. There are more than 25,000 commercial cars and trucks in use and it is estimated that 30,000 of these cars will be manufactured during 1912.

THE MOTOR TRUCK IN MANUFACTURING

ITS UTILITY, ADAPTABILITY, CAPACITY AND ECONOMY UNDER SUITABLE CONDITIONS

BY HAROLD WHITING SLAUSON*

There is probably no place where the motor truck is surrounded by more favorable conditions for efficient operation than in the average manufacturing business. Machines are used throughout for the production of the goods; why should not mechanical power be employed for the transportation of the raw and finished material? No matter how large or how small the plant may be, and regardless of the size, nature, or quantity of the product, a motor truck transportation, delivery, and hauling service *must* show a marked saving in time and money over the horse type, if the former is properly installed and operated under efficient conditions. As power-driven machines have reduced the cost of manufacturing goods, so will motor-propelled trucks lessen the hauling charges for those goods.

These may seem like sweeping statements, but they are attested to by thousands of successful truck installations in hundreds of different kinds of manufacturing businesses. The success of these proves the adaptability of the motor vehicle, for each of these manufacturing lines may require its trucks to operate under conditions absolutely different from any of the others. By means of special bodies and a wide selection of types and sizes of power plant, a variety of combinations can be obtained, the proper selection of which will allow almost any operating condition to be fulfilled. A few years ago the motor truck cost more to install and to operate than the horses and wagons required to perform the same amount of work, and this excess expenditure was charged to advertising; but the modern motor truck has been brought to the point where it can show an actual dollar-and-cents saving, and even on this one merit alone can the mechanical means of transportation compete with the horse. Figuring interest on the investment at 6 per cent, depreciation at 10 per cent, chauffeurs' wages higher than those paid to horse drivers, and insurance premiums and repairs at a larger amount than would ordinarily be required in practice, the properly-organized truck installation will show a saving of from ten to thirty per cent over the maintenance expenditure required by a horse system.

From an investigation of many installations made by one company, it was found that interest, insurance, garage expenses, and driver's wages constituted a daily fixed charge of $5.32 for a 5-ton truck. This charge, of course, continues whether the truck is in use or not, and remains constant regardless of the mileage covered. Operating expenses, such as those for tires, gasoline, lubricating oil, and allowance for repairs, overhauling, and depreciation amounted to 15½ cents a mile. For a 50-mile day, the total expense would amount to the fixed charge of $5.32, plus 50 times the 15½ cent per mile operating cost, or $13.07 per day.

This strikes the keynote of the secret of a successful truck installation. Inasmuch as the $5.32 represents a fixed charge that is not affected by the distance that the truck travels, it is evident that the cost per ton-mile will be reduced as the daily mileage is increased. A 5-ton truck traveling 50 miles a day has a ton-mile capacity of 250. Inasmuch as there is but little difference between the operating cost of a loaded truck and one running empty, it will be seen that the hauling expense per ton mile may be reduced to slightly over $0.05. This is on the assumption, however, that the truck will be run at full load at all times—a condition which, obviously, cannot be attained in the average installation. If the truck is run loaded in one direction and returns empty, the hauling cost per ton-mile will be doubled.

There are, consequently, four broad, general conditions to be met in order to secure the most efficient installation. The truck must be selected with due regard to its capacity; its work must be so laid out and routes so arranged that but a minimum amount of time will be spent in idleness, and its active hours must be employed in hauling loads approaching as nearly as possible to its rated capacity; its construction must be such that the necessity for repairs will be infrequent; and its design must be so simple that it may be handled and overhauled by the ordinary intelligent driver or machinist, thereby eliminating the expenses of high-priced help. The fulfillment of the first two of these conditions rests with the purchaser, with the co-operation of the manufacturer of the truck, while the last two depend upon the truck builder and designer—but with the necessary co-operation of the purchaser.

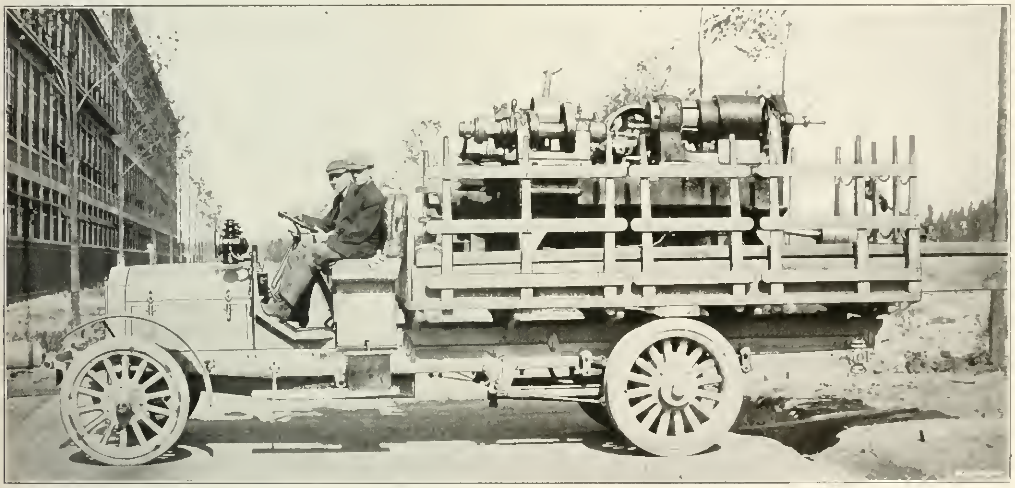

Fig. 1. Pierce-Arrow Auto Truck carrying Machinery to the Freight Depot

The selection of a truck with regard to its capacity is an important consideration, but one too often overlooked. A 5-ton truck should not be purchased to conduct a 2-ton hauling business, unless expansion in the near future is to be provided for. To haul two tons in this case will cost nearly as much as to haul five, and such an installation would probably show a loss. Of course, it rests with the purchaser as to whether the expansion of this end of his business will, in the future, call for larger trucks, or a greater number of small vehicles, but the installation departments of the truck factories will help him with this problem.

While it is necessary that the trucks should be run fully loaded as much of the time as possible, the fact must not be overlooked that loads in excess of the capacity of the machine will cause the ton-mile hauling cost to increase rapidly. In fact, it is probable that to this tendency on the part of owners and drivers may be attributed the majority of the failures of commercial vehicle installations. By a constant 25 per cent overload, the life of the tires may be reduced by two-thirds.

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Inasmuch as a high mileage is essential to efficient motor truck operation there should be as little delay as possible in loading and unloading, and trips and routes should be so arranged that the truck may be given an opportunity to take advantage of its speed and large territory-covering ability. But even though the area to be covered by the truck might, of necessity, be restricted to the factory yard, the use of special loading and unloading devices may easily overcome what would otherwise be serious obstacles to an efficient installation. If the factory is situated some distance from the freight yards, and the truck can be utilized to carry the finished products to the point of shipment and to bring back raw material on the return trip, conditions are nearly ideal, and such an installation should show a marked saving over any other arrangement. In fact, an installation that will allow the truck to travel loaded in both directions is so obviously destined to be successful that the only question to be considered is as to which of the many trucks on the market would be best adapted for the particular requirements of the business. Many manufacturing businesses employ one or more trucks to do "odd jobs" around the yard. As work of this type will consist, probably, in moving heavy machinery or other material, and in traveling under load from one building to another, trucks used for this purpose should show good returns on their investment.

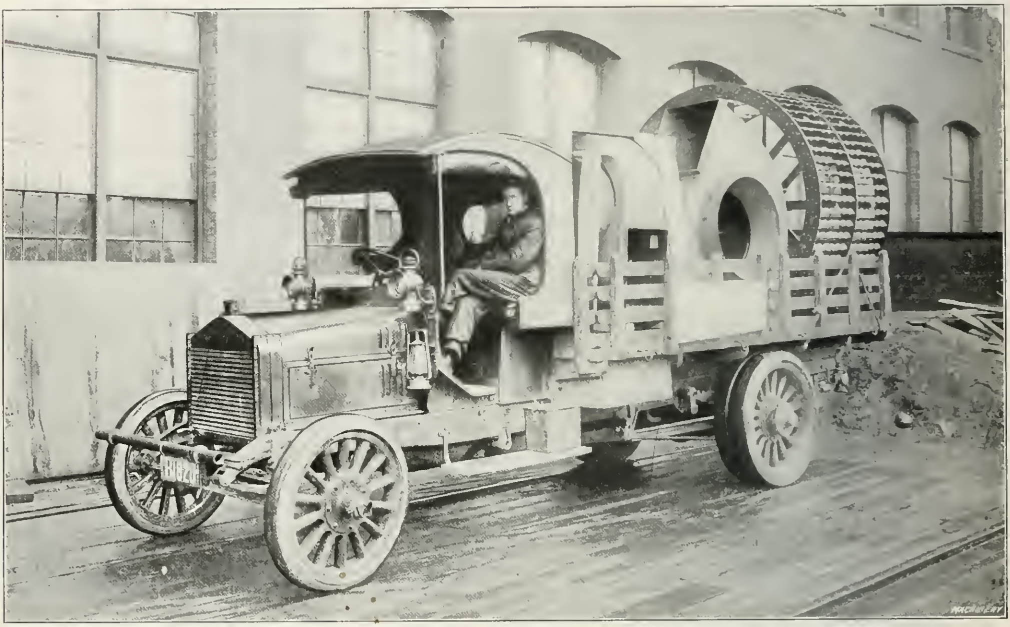

Fig. 2. Pierce-Arrow Five-ton Worm-driven Truck used by a Large Manufacturing Concern for carrying Heavy Castings and Large Parts of Machinery

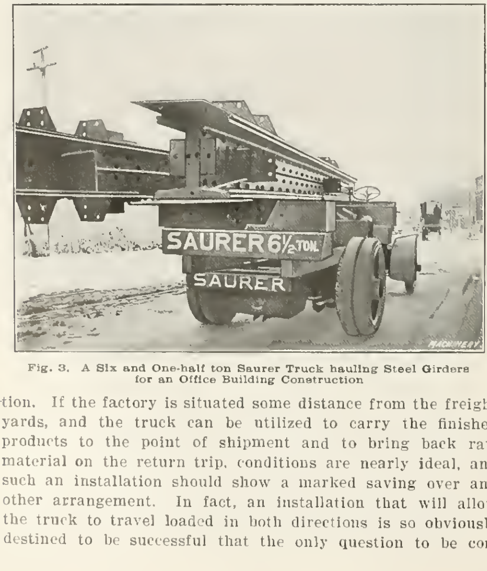

Fig. 3. A Six and One-half ton Saurer Truck hauling Steel Girders for an Office Building Construction

The very multitude of chassis sizes and types and body designs from which the purchaser may choose is striking evidence of the variety of purposes to which the motor truck may be put. Special bodies may be obtained to meet certain requirements, and these may be mounted on any size or type of chassis. It is probable that the average manufacturer will find the conventional stake body the type best suited to his needs. This may be mounted on a chassis of the ordinary length when heavy loads are to be carried, or on a chassis of extra-long wheelbase if its regular load is to be bulky or long.

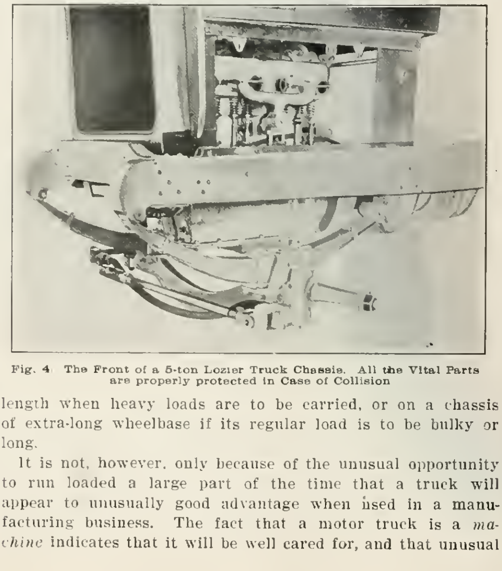

Fig. 4. The Front of a 5-ton Lozier Truck Chassis. All the Vital Parts are properly protected in Case of Collision

It is not, however, only because of the unusual opportunity to run loaded a large part of the time that a truck will appear to unusually good advantage when used in a manufacturing business. The fact that a motor truck is a *machine* indicates that it will be well cared for, and that unusual facilities will be already at hand for its overhauling and repair. Probably every tool that would be used in a complete garage and repair shop will be found in the average large factory. There will probably be a large force of men familiar with all kinds of machinery, and consequently the motor truck will not be the "strange creature" that would be the case were it replacing the horse transportation system of many another line of business. This enables the factory to retain its old drivers. Thus a complete garage and repair shop may be installed and equipped in the factory yard at but little additional expense, and the attendant saving in storage and overhauling charges will represent a large item. If the truck installation consists of but one vehicle, it may be advisable for a time, at least, to store the machine in a public garage, but even this will not bring the expense above that figured for a 5-ton truck in a preceeding paragraph, as this charge was included in the estimate.

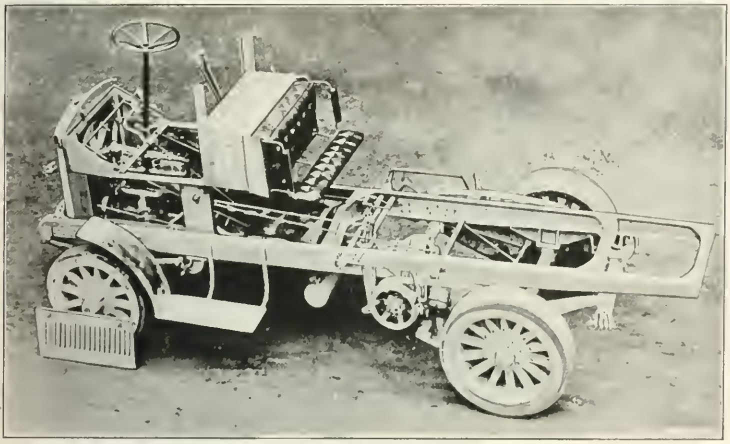

Fig. 5. Chassis of a Five-ton Lozier Truck showing the Accessibility of the Motor located under the Driver's Seat, which can be folded back

If the equipment consists of three or more trucks, it will undoubtedly prove advisable to equip a private garage and employ an expert whose sole duty shall consist in overhauling the vehicles and keeping them in perfect repair. In this case the drivers need only understand the control of the car, and are not required to be experts themselves. Consequently, a considerable saving may be made in chauffeurs' wages, and this forms the third advantage to be found in a motor truck installation in a manufacturing business.

The question of service is naturally an important consideration. No matter how well constructed a motor truck may be, it will require a certain amount of care and attention, and the engine must be overhauled occasionally. If several trucks are used, much of this work may be done at night, and if the power plants are thus kept continually in the top-notch of condition, there need be but little fear of interference with their work during the day. It was not long ago that, in large installations, one truck in every ten was used as a reserve machine. In other words, it was assumed that only 90 per cent of the trucks would be available for service. Today, through better management of the installation, as well as through improved design, the average percentage of idle trucks has been reduced to about two. Some builders have provided removable power plants that can be used to replace the engine that requires overhauling. These power plants are of the "unit" type and include, besides the motor, the clutch, transmission, and, in some cases, the radiator and all electrical equipment. These parts are all attached to the motor or its base and the entire power plant may be lifted out after the removal of two or three bolts. Thus, by the use of but one extra removable power plant, nine or ten trucks may be kept in practically continuous service, and yet each motor may be thoroughly overhauled as often as necessary.

The unit power plant, which includes the transmission mounted on an extension of the motor base, is not used on the majority of heavy trucks—although some of two, three, and even five-ton capacity will be found so designed. The average five-ton truck is chain-driven from two sprockets mounted at each end of a jack-shaft extending from the transmission case and located about in the middle of the frame. There is at least one notable exception to this design, however, in the form of a shaft-driven five-ton truck that employs a worm and gear for transferring the power from the propeller shaft to the floating rear axle. Practically all of the trucks having a capacity of over three tons use the twin, or dual, solid tires on the rear wheels. Such a wheel is provided with one set of spokes, but possesses two rims, thus giving the effect of an exceedingly wide tire. Instead of using one wide tire on each wheel, however, two narrower tires are mounted on the single felly.

The power plants of the larger trucks are similar to many of those used on the high-power touring cars. The ordinary 5- or 10-ton truck is generally driven by a 30- or 40-horsepower motor located in the forward portion of the chassis, either under a conventional bonnet or under the driver's seat. In the latter design, the seat tips back or to the side in order to render the motor easily accessible. The gear ratios of the truck are much higher than are those of the pleasure car employing a power plant of equal size, for the speed of a 5-ton truck should not exceed 12 miles an hour, while that of one of 10 tons capacity should be restricted to 7 or 8 miles an hour. Some 3-ton trucks are designed to attain a maximum speed of 15 miles an hour—and even higher—but the governors used on the majority of the motors restrict their speed to about 1200 revolutions per minute, and consequently the maximum speed of the truck will depend upon the gear ratios employed. On one truck, the governor is attached to the driving shaft, so that the speed of the car itself, rather than that of the motor, will be restricted.

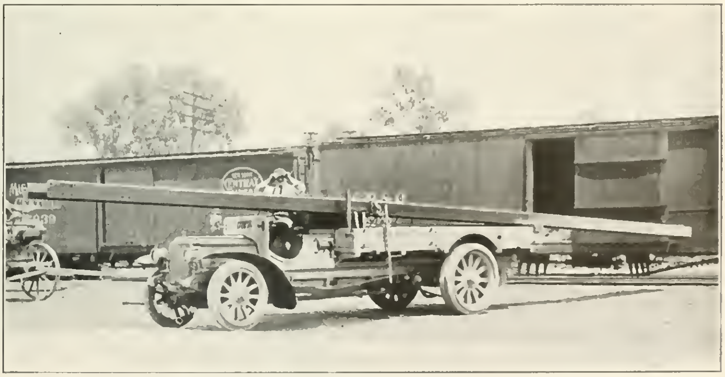

Fig. 6. Six and One-half ton Saurer Truck hauling Long Steel Girders

It is evident that many designers have kept in mind the desire of truck owners to employ former horse drivers—or other men unskilled in handling a power vehicle—instead of expert chauffeurs, for the modern motor truck is of exceedingly "foolproof" construction. In fact, continued overloading constitutes about the only means—aside from downright vandalism—by which the average motor truck can be injured. By means of heat-treated and other special steels in the motor, transmission, and other parts of the frame and running gear subject to unusual strain or wear, the present-day truck can successfully withstand a remarkable amount of abuse; but there are right and wrong ways of handling even the most invulnerable truck, and many designers have bent their efforts toward eliminating all possible sources of abuse. In some, the spark control lever has been removed and a fixed point of ignition used in its stead, so that the driver cannot run the motor at slow speeds and with closed throttle when the spark is advanced. On other trucks, an automatic spark advance and retard has been installed by means of which the speed at which the motor is operated regulates the point of ignition. In still another design, a spark lever has been used, but instead of placing this on the steering wheel—as is usually the case—it has been located on the dash where it cannot be reached as easily by the driver as can the throttle. It is assumed that there will be less temptation to "monkey" with the spark if the lever is not so conveniently located.

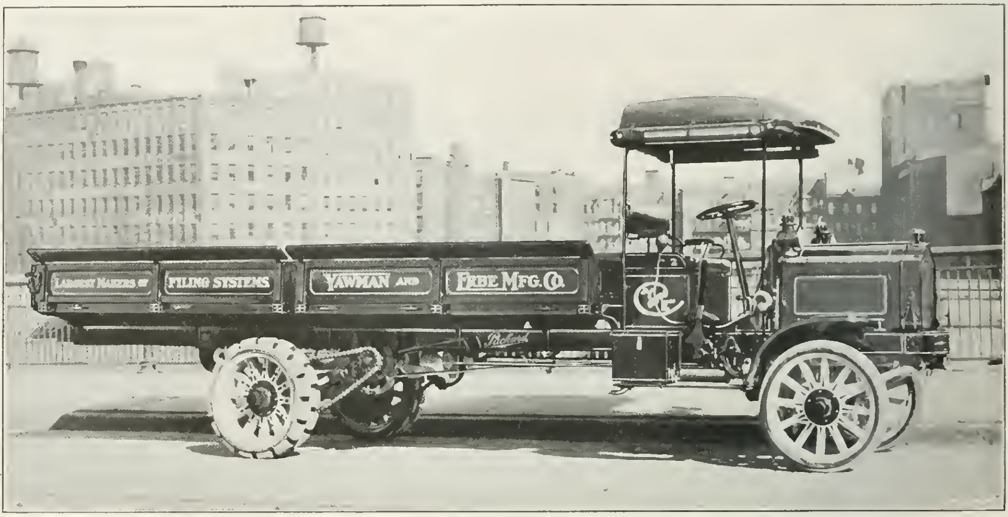

Fig. 7. Packard Truck with Long Overhanging Body at the Rear, facilitating Loading at a Platform. This Truck does the Work of Four Teams of Horses at an Average Cost of $9.92 per Day, or at a Saving of about $10.00

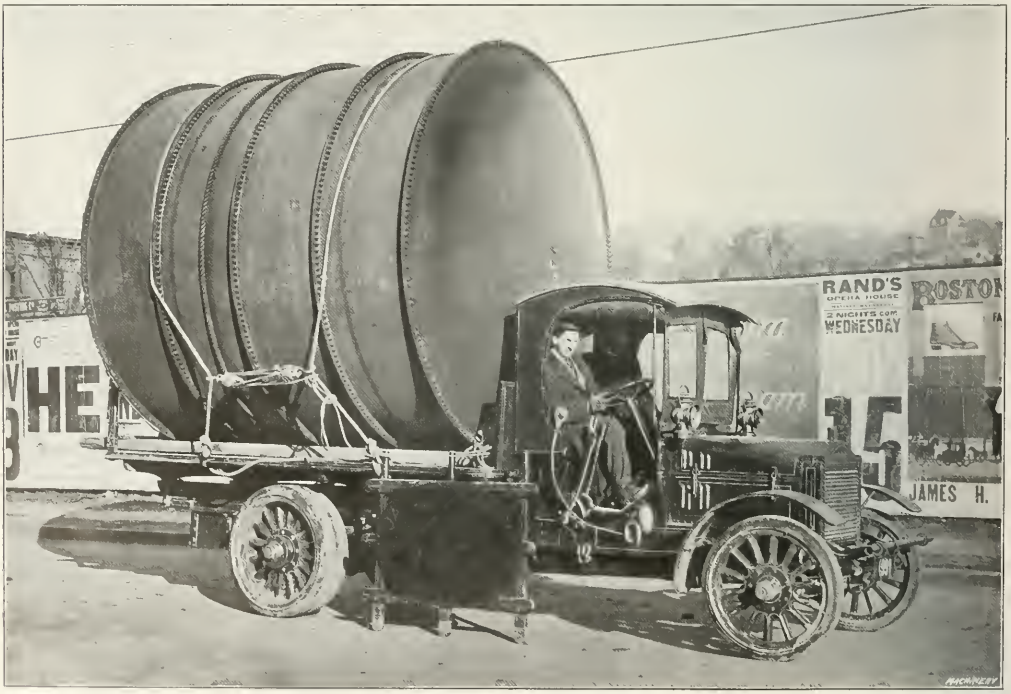

Fig. 8. A Good Example of the Load that can be put on a 5-ton Truck

Although some of the heavy trucks are provided with planetary transmission, the majority employ the sliding type with either the selective or progressive method of shifting—the latter being in the majority. Modern transmission gears are so accurately cut and are made of special steels of so high a grade that it seems well-nigh impossible to "strip" them. As an added precaution, however, some trucks are provided with special devices which render abuse in this direction impossible. On one such device, the gears are in mesh at all times and each is provided with an individual clutch. The gear control lever is used to engage the various clutches, and thus the different speeds are obtained without any actual sliding or clashing of the gears, and the changes may be made without releasing the main clutch. Other designs employ a notched quadrant which prevents the movement of the gear-shifting lever until the main clutch is disengaged. Still a third system allows the gear-shifting lever to be moved, but the gears themselves are not slid into position until the clutch is released. This action is obtained by means of a bar cam which brings the tension of a spring into play against the gear to be moved. A back-cut on the jaws of the positive clutch with which each gear is provided, however, prevents the movement of any of them while the jack-shaft is revolving, and as this jack-shaft will continue to turn as long as the main driving clutch is engaged, the gears cannot be changed until conditions are proper for the shifting.

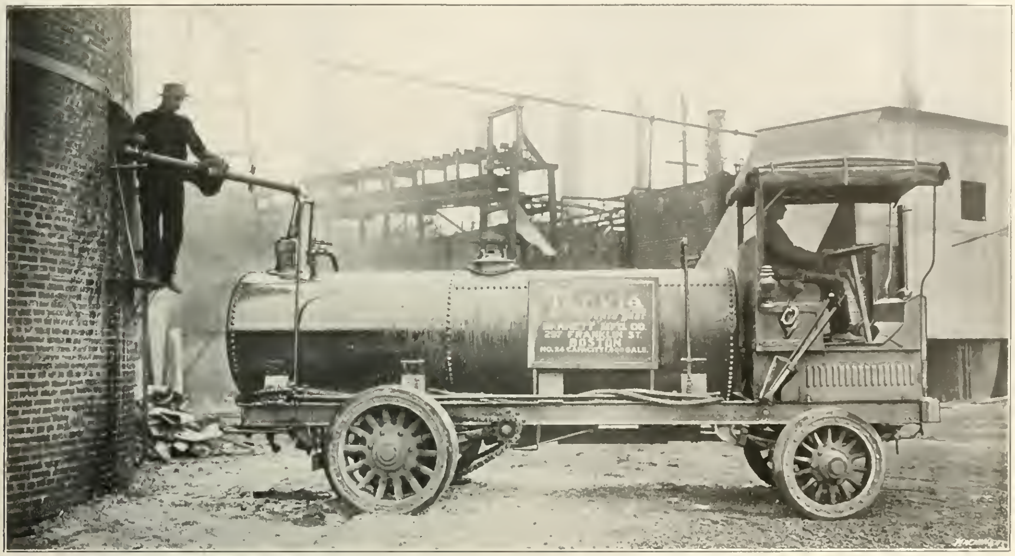

Fig. 9. Alco Tank Truck used for Spraying Dust-laying Oil on Roads

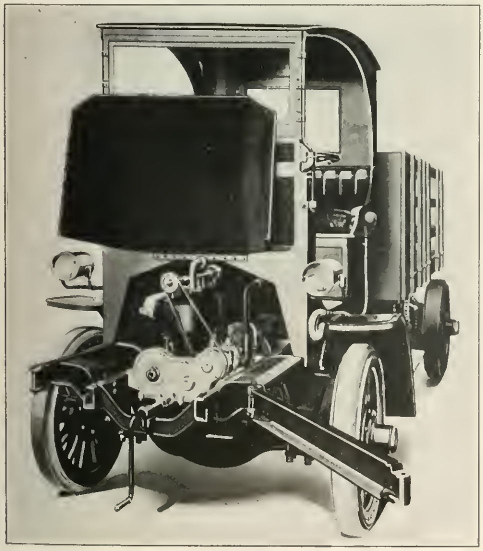

Fig. 10. Removable Power Plant of a Grabowsky Auto Truck ready to be slid out of the Chassis

From 60 to 80 per cent of the load on the modern motor truck is carried over the rear wheels. This insures effective traction and enables the truck to negotiate slippery roads and steep hills with comparative ease. Designers are realizing that, because of its surroundings and the nature of its work, the average motor truck will be subjected to many a hard knock from exterior sources, in addition to those it may receive at the hands of a careless driver. Consequently all vulnerable parts are protected as far as possible from contact with any obstacle which the heavier portions of the truck might strike. For example, a heavy cross-member may be riveted to the forward portion of the frame to serve as a guard for the more delicate radiator, and all of the motor, transmission, and protruding shafts or studs may rest within the confines of the frame proper. On some trucks, the motor sub-frame and radiator are mounted on separate springs to relieve these parts of the shocks and jars of travel that will not be absorbed by the heaviest body springs.

In fact, the modern truck is so well designed and constructed, and there is such a variety of body and chassis types and sizes from which to choose, that the blame for an unsuccessful installation may generally be laid to the purchaser of the truck and his system, rather than to the builder. There are, of course, many problems to be met and changes to consider, but each problem can be solved and all difficulties overcome especially well in a manufacturing business.

* * *

The corrosion of nickel, chromium, and nickel-chromium steels has been investigated by Messrs. J. Newton Friend, J. Lloyd Bentley, and Walter West, of Darlington, England, and the results of the investigation have been placed on record in a paper read before the Iron and Steel Institute of Great Britain. One of the interesting conclusions arrived at is that in certain neutral corroding media, such as salt water, the resistance to corrosion rises with the percentage of chromium. Hence, the employment of chromium steels in the construction of ships seems to be fully justified on this ground alone. Nickel steels appear to be resistant both to acid and neutral corroding media, in proportion to the percentage of nickel.

DESIGN OF A HYDRAULIC INTENSIFIER

A SYSTEMATIC METHOD OF CALCULATING THE DIMENSIONS OF THE DIFFERENT DETAILS

BY J. B. VARELA*

The object of this article is to explain in a simple and direct manner the calculations necessary for designing a hydraulic intensifier that shall fulfill certain specified requirements, and be of correct design, as nearly as possible, from the view-point of the engineer. The specifications that will govern the design may be briefly stated as follows: Required, a hydraulic intensifier to raise the pressure from 1500 pounds per square inch to 4500 pounds per square inch, having a capacity of 10 cubic feet on the low-pressure side. The choice of the materials, as well as of the proper working unit stresses, is left to the judgment of the designer.

In order to ascertain the diameters of the rams and the corresponding lengths of the stroke, it is advisable to tabulate the various possible diameters together with their corresponding lengths of stroke, and then select the most suitable dimensions as dictated by practical considerations.

Large Ram			Small Ram	
Diameter	Area	Stroke	Diameter	Area
21	346.36	49.8	12	113.1
17	226.98	76.1	10	78.54
16	201.06	86.0	9	63.62

The high-pressure cylinder acts as the low-pressure ram, as shown in Fig. 1. This arrangement is the most economical in the use of materials, as well as in the space occupied by the apparatus.

The sizes tabulated indicate fairly good proportions. We will select the third set of possible dimensions and calculate how they balance. The area of the low-pressure ram multiplied by the pressure acting on it must equal the product of the area of the high-pressure ram by the pressure acting upon it plus the excess load required to overcome the friction of the machine. Thus:

$201.06 \times 1500 = 301{,}590$ pounds, the load on the low-pressure ram,

$63.62 \times 4500 = 286{,}290$ pounds, the load on the high-pressure ram.

15,300 pounds, the excess load on the low-pressure ram. This difference is necessary, as noted above, in order to overcome the frictional forces that oppose the motion of the rams.

The volume of the low-pressure cylinder is assumed to be equal to the volume displaced by the low-pressure ram, that is $201.06 \times 86 = 17{,}291$ cubic inches, which is slightly in excess of the required volume. The actual volume of the low-pressure cylinder greatly exceeds this figure, as will be seen from Fig. 1. The length of the stroke is 86 inches, which is not abnormal.

The friction of the packing may be calculated by the following formula:

$$F = \mu P D$$

in which F represents the force of friction; P, the internal pressure in pounds per square inch; D, the diameter of ram in inches; and μ a coefficient, the value of which depends on the kind of packing used. (Although U-leather packing offers the least frictional resistance, we will use hemp packing in our design owing to the fact that it is easy to replace, cheap to maintain, and that leakage can be readily avoided.) The value of μ for hemp packing may be taken as 0.20. Hence the force of friction against the stationary ram is: $F = 0.2 \times 4500 \times 9 = 8100$ pounds; and for the movable ram: $F = 0.2 \times 1500 \times 16 = 4800$ pounds; making a total of about 12,900 pounds.

The inside diameter of the low-pressure cylinder is 18½ inches and the internal pressure 1500 pounds per square inch. Using Lamé's formula, we have:

$$D = d\sqrt{\frac{S + P}{S - P}}$$

in which D represents the outside diameter of the cylinder; d, the inside diameter; S, the working unit tensile stress, taken as 8000 pounds per square inch; and P, the internal pressure, also in pounds per square inch. Hence:

$$D = 18.5\sqrt{\frac{8000 + 1500}{8000 - 1500}} = 22.37\text{, say } 22\tfrac{3}{8} \text{ inches.}$$

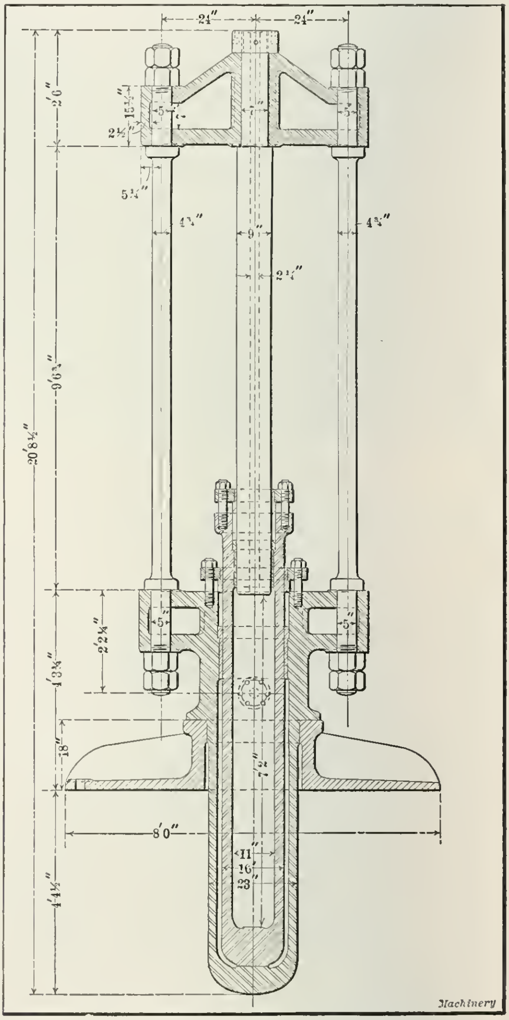

Fig. 1. General Assembly View of Hydraulic Intensifier

Therefore, the thickness of the cylinder wall is:

$$\frac{22.375 - 18.5}{2} = 1\ 15/16 \text{ inch.}$$

Using Peterson's formula as a check on the above calculations, we have:

$$t = \frac{p\,r}{S - 2/3\,p}$$

in which t represents the required thickness; p, the internal pressure in pounds per square inch; r, the internal radius of the cylinder in inches; and S, the working unit tensile stress in pounds per square inch. Therefore:

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$$t = \frac{1500 \times 9.25}{8000 - 2/3 \times 1500} = 1.98, \text{ say 2 inches.}$$

These results are in close agreement with each other. Owing to the fact that the water under pressure percolates somewhat into the pores of the casting, thereby reducing the actual effective thickness of the cylinder walls to resist the pressure, and because of the difficulties that may arise when casting the cylinder if its walls are made too thin, it is advisable to make the thickness of the walls slightly in excess of the calculated value. Another reason for increasing the thickness of the walls is on account of the fact that the cylinder will be subjected to a test pressure double the normal working pressure, while the maximum tangential unit stress S should not exceed, under the test, 15,000 pounds per square inch.

Substituting these new values in Peterson's formula:

$$t = \frac{3000 \times 9.25}{15{,}000 - \dfrac{2 \times 3000}{3}} = 2.135, \text{ say } 2\tfrac{1}{4} \text{ inches,}$$

which makes the outside diameter of the cylinder 23 inches.

The outside diameter of the movable ram is fixed at 16 inches, and from Fig. 1 it can be seen that the inside diameter is made 11 inches. This ram is subjected to an internal pressure of 4500 pounds per square inch, and also to an external pressure of 1500 pounds per square inch. We may, therefore, assume for simplicity that the actual pressure is the difference between the two, and since the thickness is fixed, we can determine the value of the tangential unit stress S acting upon the inner surface of the bore.

From Lamé's formula we have:

$$S = \frac{(D^2 + d^2)\ P}{D^2 - d^2}$$

$$S = \frac{(16^2 + 11^2)\ (4500 - 1500)}{16^2 - 11^2} = 8377, \text{ say 8400 pounds per}$$

square inch, which is a safe stress.

The test pressure will be applied simultaneously to the inner and outer surfaces of the ram. The tangential unit stress S then becomes, according to Lamé's formula, 16,750 pounds per square inch, exceeding the maximum value previously fixed. Strictly speaking, however, these stresses are the apparent tangential unit stresses acting at the inner surface of the bore. If we take into account the longitudinal elongation of the cylinder, the true tangential unit stress T, upon the inner surface of the bore, is found by the following formula:

$$T = \frac{(r_1^2 + 4\,r_2^2)\ p_1 - 6\,r_2^2\,p_2}{3\,(r_2^2 - r_1^2)} \qquad (1)$$

in which r_1 and r_2 are the inner and outer radii of the ram, respectively; and p_1 and p_2, the corresponding inner and outer pressures. Substituting the known values in this formula, we have:

$$T = \frac{(30.25 + 4 \times 64)\ 4500 - 6 \times 64 \times 1500}{3\ (64 - 30.25)} = 7030 \text{ pounds}$$

per square inch.

When the test pressures are applied, the values of p_1 and p_2 become 9000 pounds and 3000 pounds per square inch, respectively, and the corresponding value of T found by Formula (1) is about 14,060 pounds per square inch, which is well within the maximum value assigned for S.

A possible, but not probable, contingency may arise when the movable ram is subjected to the full internal pressure of 4500 pounds per square inch, while the external pressure is zero. In this case the value of S as obtained from Lamé's formula is:

$$S = \frac{(256 + 121)\ 4500}{256 - 121} = 12{,}565 \text{ pounds per square inch, which}$$

is a safe stress.

The total pressure acting on the small or stationary ram is $63.62 \times 4500 = 286{,}300$ pounds, nearly. Let us assume that this load is carried by two tie-rods placed as shown in Fig. 1. Let A represent the area at the root of the thread of one of the tie-rods, and assume the working unit tensile stress to be 10,000 pounds per square inch for mild steel. Then:

$$2\,A \times 10{,}000 = 286{,}300, \text{ whence } A = \frac{286{,}300}{2 \times 10{,}000} = 14.32 \text{ square}$$

inches.

From a table of bolts it is seen that the diameter of bolt having the area at the root of its threads next larger in value to 14.32 square inches is a 5-inch bolt. We, therefore, make the diameter of that portion of the tie-rod that fits in the casting 5 inches. Since the diameter at the root of thread is 4.48 inches, we will make the diameter of the body of the tie-rod 4¾ inches.

The next step is to design the top casting. This piece is a simple beam carrying a concentrated load at the center. It is a rather difficult matter to calculate the required dimensions directly from the formula, and consequently we will assume the most suitable dimensions and check them for strength. For a simple beam with a concentrated load at the center of the span the maximum bending moment occurs at the point of application of the load, and its value is:

$$M = Pl \div 4$$

in which M represents the bending moment, P the load, and l the length of the span.

The load P equals 286,300 pounds, or 143.15 tons; the length of the span is 48 inches. Consequently

$$M = \frac{143.15 \times 48}{4} = 1718 \text{ ton-inches.}$$

The unit tensile stress acting on the outer fiber at the center of the beam is found by the formula:

$$\frac{M}{S} = \frac{I}{c}$$

in which M represents the bending moment found above; I, the rectangular moment of inertia of this section; and c the distance from the neutral axis to the outer fiber. The cross-section of the top casting at the center is as shown in Fig. 2, which is equivalent, as far as the rectangular moment of inertia is concerned, to that shown in Fig. 3. The moment of inertia about the neutral axis A-A is:

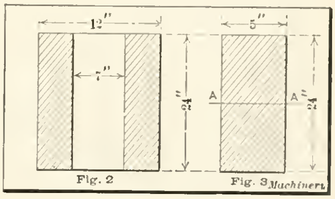

Fig. 2. Section of Top Casting at Center Fig. 3. Equivalent Section of Top Casting

$$I = \frac{5 \times 24^3}{12} = 5760, \text{ and } c = 12 \text{ inches.}$$

$$\text{Hence, } S = \frac{1718 \times 12}{5760} = 3.58 \text{ tons per square inch,}$$

which for a steel casting is well within the limits of safety. When the test load is applied, this unit stress becomes equal to about 14,200 pounds per square inch, which is also well within the maximum value previously fixed.

The ends of the casting are in shear, the value of which is $286{,}300 \div 2$ pounds. The area resisting this shearing stress is 81.75 square inches. Hence the shearing unit stress is:

$$286{,}300 \div (2 \times 81.75) = 1750 \text{ pounds per square inch, about.}$$

Practical considerations, in addition to the stresses produced by the external forces, were the controlling factors in proportioning this piece.

The next step is to check the studs that compress the glands. We will assume the extreme case of the glands being subjected to the full pressure on their lower surface. For the low-pressure gland, the total pressure acting on its lower surface is about 42,500 pounds. This load is borne by ten 2-inch studs. The area at the root of the thread of a 2-inch bolt having 6 threads per inch is approximately 2.5 square inches, thus giving a working unit stress of about 1700 pounds per square inch. This is a very low value, but it must be borne in mind that the gland may be unevenly screwed down, due to the comparatively large diameter of the bolt circle, thus inducing greater stresses in some bolts than in others.

The total pressure acting on the lower surface of the high-pressure gland is about 74,200 pounds. This load is carried by eight 2-inch studs having 6 threads per inch, and consequently the working unit stress is about 3700 pounds per square inch. Owing to the fact that the bolt circle is smaller in diameter than in the previous case, the danger of an unevenly screwed down gland is not so great, and for that reason we are stressing these bolts twice as much as those in the low-pressure gland.

* * *

BAR TURNER FOR "LIBBY" TURRET LATHE

A box-type of turning tool having some interesting mechanical features embodied in its construction is shown in Figs. 1 and 2. This turning tool is used on the "Libby" turret lathe, manufactured by the International Machine Tool Co., Indianapolis, Ind., and is used for turning bar stock. It has a capacity for turning bars from ¾ inch up to and including 3¼ inches in diameter. It is clamped by four bolts to the face of the turret, the boss or shoulder *A*, Fig. 2, fitting in the bored hole in the turret, and thus aligning the tool. It carries a single high-speed turning tool *B* of 1 by ⅝ inch section. A cut 1 inch deep—the full width of the tool—can be taken in machine steel without any perceptible chatter.

The main frame or body *C* is a steel casting, cored to clear the largest bar—3¼ inches—and provided with openings to allow the chips to drop out. The front face of the frame is machined to receive two blocks *D* which carry the hardened and ground roller supports *E*, the latter being free to rotate on hardened and ground studs held in the blocks. These blocks *D* are provided with T-bases which fit in corresponding grooves in the frame and in the two blocks *F*, the latter being held to the frame by two bolts as shown. The roller supports are adjusted by collar screws *G*, which are screwed into the frame, the collar fitting in a slot cut in the base of the block. The studs on which rollers *E* rotate are provided with oil grooves and proper means for lubrication.

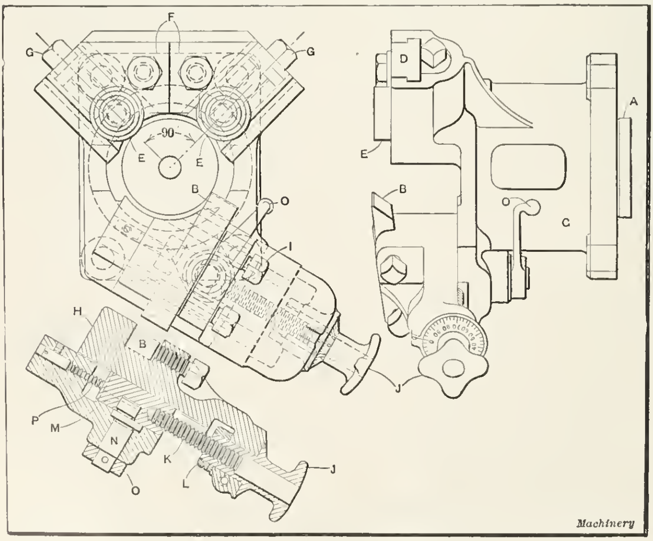

Fig. 2. Construction of the Bar Turner shown in Fig. 1, showing how the Turning Tool is withdrawn from the Work when retreating

The tool-slide *H* fits over a dovetailed guide machined on the front face of the frame, and is provided with an adjustable gib. A groove is cut in the tool-slide to receive the turning tool *B*, the latter being clamped rigidly in position by two set-screws. The 2½-inch adjustment of the slide *H* for the diameter of the work is effected by means of a knob *J* and screw *K*. The knob is provided with a collar having 100 graduations, and as screw *K* has 10 threads per inch, each graduation equals a movement of the slide *H* of 0.001 inch. The overhanging arm of the slide is bored to receive the reduced end of the knob and is split and provided with an adjusting screw to compensate for wear. A collar *L* screwed onto the end of the knob and locked by a headless screw is used to take up the end play resulting from the frequent adjusting and the thrust of the tool.

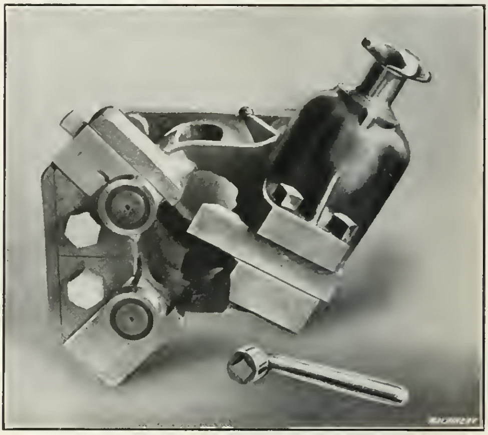

Fig. 1. Box-type of Turning Tool for the "Libby" Turret Lathe

The ordinary box-tool commonly used on turret lathes and screw machines is drawn straight back over the work after taking a cut; consequently, if a heavy cut has been taken—causing the tool to spring away from the work—the tool will make a spiral mark when returning. This objectionable feature is obviated in the particular tool illustrated in an interesting manner. The forward end of screw *K* is pinned to a block *M* which fits in a slot cut in the frame *C*. This block is actuated by an eccentric stud *N*, the latter being operated by a handle *O* held on it by a pin. When the cut has been finished, the operator pulls out handle *O*, rotating the eccentric, which, in turn, withdraws block *M* from stop *P*. Then as screw *K* is fastened to block *M*, thus connecting it with slide *H*, it follows that the slide carrying the turning tool must also recede. When handle *O* is pushed in, block *M* is located in the exact position by stop-screw *P*, which is locked with a headless screw, thus setting the turning tool again to the correct diameter.

Another commendable feature in the construction of this tool is the location of the turning tool relative to the supports and the body of the holder. The turning tool is set tangentially to the work and is also so placed that it can be located in advance of the supports or face of the holder. This construction allows the tool to cut close to a large shoulder—much larger than the width of the frame—without any portion of the holder coming in contact with the work. This feature makes this turret tool especially valuable for turning large work. The wrench shown in the foreground in Fig. 1 is used for tightening the set-screws on the turning tool.

D. T. H.

* * *

On January 1, 1912, there were 70,000 power driven vehicles in use in Germany, about 63,000 of which were passenger cars and about 7000 trucks. Of the passenger cars about 23,000 were private pleasure cars and 30,000 were used for business purposes. There were also 5200 motor cabs and omnibuses in use.

MUSEUMS OF SAFETY AND THEIR ACTIVITIES[*]

A BRIEF HISTORY OF THE MOVEMENT FOR THE PREVENTION OF INDUSTRIAL ACCIDENTS

BY MANCIUS S. HUTTON[†][‡]

It is not so many years ago that labor was considered one of the cheapest of commodities and the employer of labor simply hired a new man in place of one incapacitated through injury at his work. He did not take the time to study how accidents could be prevented, nor did he spend money in placing safeguards about the works; but he was willing to spend the same or more money in fighting, in the courts, the claims for damages which the injured employe tried to obtain. The old common law liability of employers was very lenient at first towards the firms in whose shops accidents happened, but latterly the juries have been awarding larger sums to the sufferer. Within the last four years, however, the relations between the employer and his workmen have been changing in many places by the former's recognition of his responsibility for his work people, and he has been trying to safeguard the dangerous places around his factory. He has also been forced somewhat to do this by the casualty insurance companies in order to obtain a lower premium from these companies.

Present Activity in Passing Laws to safeguard the Industrial Worker

In nearly all the states, at the present time, laws in regard to safeguards have been made more stringent. In some of the states, commissions have been appointed to investigate and report to the legislature on the whole question of accident and sickness prevention, with the object of enacting laws which would tend to reduce the number of industrial accidents by compelling the introduction and use of safeguards. These laws, however, should not be made so exacting as to bankrupt the small employer.

When enacting workmen's compensation laws in the various states, which in no case were made compulsory, the law makers so changed the common liability law that it became to the advantage of the employer to accept the terms of the compensation law rather than to go to the courts under the liability law. This was done by taking away from the law the two defences under which the employer had the best chance of winning the suit. These defences are known as the "assumption of risk" and the "fellow servant rule." The former of these is that an employe who contracts to work for an employer assumes the hazard of the occupation. The latter one is that an employer cannot be held responsible for an injury to the workman which was caused by another employe engaged in the same work.

The recognition on the part of the employer of his responsibility toward his work people, the passing of more stringent factory laws, and the enacting of compensation laws, all have brought the employer to the realization that the question of safety and sanitation in his factory is a very vital one. He is now, therefore, studying these questions and others which are related to them. It is obvious that it would be to the employer's advantage to find all the material and information on safety devices brought together in one place for study. This is the genesis of the idea of museums of safety.

Foreign Museums of Safety

The first museum of safety was opened to the public at Amsterdam, Holland, in 1893. This museum, at the start, was a very small affair and was entirely supported by private subscriptions, but it soon outgrew its first quarters. In 1910 the city gave a site for a new and larger building, while the parliament appropriated $22,500 for the building. The running expenses will, as hitherto, be borne by private subscriptions. This museum was opened eight years before the country passed a workmen's compensation law.

There are at present sixteen museums of safety, of which fourteen are in Europe, one in the United States, and one in Canada. In the following table is given the location of these, together with the year of their opening and the year in which the compensation law in that country was first enacted.

City	Country	Year of Museum Opening	Year of Enactment of Compensation Law
Amsterdam	Netherlands	1893	1901
Berlin	Germany	1903	1884
Budapest	Hungary	1908	1907
Copenhagen	Denmark	1910	1898
Dresden	Germany	1911	1884
Gratz	Austria	1911	1887
Helsingfors	Finland	1910	1895
Milan	Italy	1906	1898
Montreal	Canada	1909	1909
Moscow	Russia	1908	1903
Munich	Germany	1906	1884
New York	United States	1907	1906
Paris	France	1905	1898
Stockholm	Sweden	1908	1901
Vienna	Austria	1909	1887
Zürich	Switzerland	1902	has none

The year given for the New York museum is that of the first exhibition of safety devices. It was not until three years later that a permanent museum was opened. The year given in the fourth column is that of the first Federal Compensation Law in the United States.

The following countries which have passed compensation laws have no public museum of safety:

Country	Year of Enactment of Compensation Law
Norway	1894
Spain	1900
Belgium	1903
Great Britain	1907

From the table it will be seen that Germany has three museums at the present time and Austria two. It is an interesting commentary on this movement that while Switzerland has never passed a compensation law, yet it was the second country to have a public museum of safety and sanitation located at Zürich; and Germany, which was the first country to have such a law, did not open its first museum at Berlin until nineteen years after the law went into effect. This latter museum is one of the largest and most up-to-date in the world. Its actual location is at Charlottenburg, a suburb of the city. The building occupies one-sixth of an acre and contains, besides the exhibition hall, the administration offices and a lecture hall which can accommodate two hundred people. The exhibition hall covers an area of 64,000 square feet.

In the summer of 1911 there was held in Dresden the first International Exhibition of Hygiene. This exhibition was opened to the public in April and closed in October. From the time of its opening to the first of September it has been estimated that four million people visited it. Nearly every country was represented, even those of South America, by either a pavilion or a section in a building. The United States was the only large country which was not officially represented. It was an educational campaign put in practical form by means of models and charts, so that the lesson could be easily understood and would not easily be forgotten. The preparations for the exhibition required over four years. After it had been closed there was a popular demand on the part of the German people that the models and charts which had taken so long and so much painstaking care to prepare should not be destroyed, but should be kept in a museum. Thus it was that Dresden's name was added to those cities which have a permanent museum.

One reason why the German museums are ahead of others in regard to their buildings and exhibits is the encouragement and financial backing which the government gives them. In the case of all the foreign museums, with the exception of that in Vienna, the government or the city in which they are located have given some financial help. Some of the foreign museums occupy only part of a building, as is the case of the one in Paris, which is located in the Vaucasson Gallery of the National Conservatory of Arts and Trades.

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[*] The following articles on this and kindred subjects have previously been published in MACHINERY: "American Museum of Safety Award of Medals," February, 1912; "The Prevention of Industrial Accidents," November, 1911, engineering edition, and the articles there referred to.

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To the average American these foreign museums are of no practical benefit, as few can visit them and the literature which they publish is not within the reach of everyone unless translated. The reason for mentioning them has been to show the large number located in the principal centers of Europe.

The American Museum of Safety

The idea of having a museum of safety devices in America was conceived by the present director of the Museum in 1900, on his return from abroad where he had seen, in Paris, a partial exhibit from the Amsterdam museum. The next seven years were spent in educational work by means of lectures throughout nearly all the states. The next step forward was the holding of an International Exhibition of Safety Devices in New York City which lasted two weeks. This was held at the Museum of Natural History in February, 1907. It exhibited practical safeguards in the way of models, photographs and actual devices manufactured by American firms; it also had actual devices, photographs and charts of methods which were in use abroad. These latter were obtained from the foreign museums. After this exhibit was over it was decided to hold another the next year, which should be open for a longer period. The exhibition of 1908 was held at 231-241 West 39th St., New York City, and extended over a period of two months (April-May); it contained exhibits from eighty different American firms, while the foreign museums were again represented by documents, photographs and charts. There were only a few models of foreign devices shown at this exhibition. The next year was spent in lecture work and in visiting factories in which safety devices were being used. In November, 1910, the first permanent Museum of Safety and Sanitation in America opened its doors and invited the public to come and visit it. It is located on the sixth floor of the United Engineering Building, 29 West 39th St., New York City, and occupies two rooms. It is open every day, except Sundays and holidays, between the hours of 9 A. M. and 5 P. M.

There are four methods in which a museum of this kind can have its work brought to the attention of the public:

1. By the collecting and displaying in a museum of the actual safety devices themselves, or, if too large or cumbersome, of models of them. The devices should be constructed so that they can be operated in the same way as in actual practice. If either the device or model cannot be shown, then the device should be illustrated by photographs, blueprints or charts.
2. By the assembling of a library of all the literature pertaining to the subjects which have to do with the question of improving the workmen's condition. The library should be fully catalogued and contain foreign books and pamphlets as well as American literature.
3. By means of lectures illustrated with lantern slides of the best safety devices. These lectures are delivered at the principal industrial centers and before employers, workmen, societies, associations, state and city officials, and others interested.
4. By the publication of literature on various subjects relating to the workmen's welfare, such as illustrated books, pamphlets and leaflets; besides promoting the movement through articles published in the daily papers and the technical press; and the making of special reports and publishing of same.

The first and second methods are by far the most advantageous as regards the studying of safety devices and industrial hygiene, but they are limited to those persons who live in or near the city in which the museum is located. Those outside this narrow area would not gain any advantage from it. The third method has a larger scope, but is limited by the fact that it is only possible to lecture a limited number of times in any year in any one large industrial center. The publication of illustrated books, pamphlets and leaflets which can be mailed to anyone, places the last method far ahead, as regards the number of persons which it reaches, of all the other methods combined.

It may be of interest to those not familiar with the service which such a museum can render, to make some extended references to the activities of the American Museum of Safety. It applies all four methods given above. In its exhibition hall it now has over two hundred full-sized apparatus and models, besides having at least three thousand mounted photographs from both foreign and American practice. The exhibits, including the photographs, are divided into three sections, each of which is under the jurisdiction of a committee; more sections will be added from time to time, as space and exhibits warrant. The three sections at present are: iron and steel; fire prevention; and industrial hygiene and sanitation. There is also a general section which includes exhibits which do not come properly under the other three. The chairmen of these section committees are men who are authorities on their special subject.

The exhibits are put in the museum by the manufacturer or inventor himself. Among the conditions for exhibiting are the following:

1. No exhibit is allowed to be displayed which has not been approved of by the Board of Approval of Exhibits.
2. There will be no charge for space in the exhibit hall.
3. The installation of an exhibit is at the exhibitor's expense.
4. Exhibits are accepted with the understanding that they are not to be removed within twelve months except with the consent of both the Director and the Chairman of the Board of Approval.
5. Exhibits are not accepted which are not purchasable in any market or commercially available in the industries as a means to prevent accidents.
6. Untried inventions are not accepted.
7. The museum assumes no responsibility for any damage by fire or loss by theft.

These conditions are nearly the same in all the museums.

A few of the more important firms which are exhibiting in this museum at the present time are: The United States Steel Corporation, and several independent steel companies, Brown & Sharpe Mfg. Co., Mergenthaler Linotype Co., National Cash Register Co., Norton Co., Patent Scaffolding Co., Pennsylvania Railroad Co., Prudential Insurance Co., Standard Oil Co., Travelers Insurance Co. and many others.

The American Museum has been visited since its opening by the presidents, general managers and committees of safety of different companies, state factory inspectors, casualty insurance inspectors, engineers, workmen and students. The museum provides a demonstrator who shows and explains all the devices.

The library of the museum contains bulletins, reports, catalogues, books, charts and articles taken from different publications. When this library was started there was very little literature on these subjects in the English language, while the foreign publications were more numerous, especially those in German. Accident prevention is now a very live subject in America, the result of which is that special articles and books are increasing in numbers. Many of the foreign publications are not easily obtainable anywhere else in the United States for reference or study. This library is growing very fast and is an important adjunct to the museum.

In lecturing before associations, workmen, superintendents, foremen, inspectors and others, the museum has had a splendid chance to do educational work. At the present time there are four members of the museum who are doing this lecture work. Each of them has from one to two hundred colored slides of practical safety devices. During the last year the director of the museum has had the opportunity of lecturing before the superintendents, foremen, and workmen of several of the large steel companies, the New Jersey Zinc Co. and the Pennsylvania Railroad Co. The number of people who have been reached by these lectures averaged between three to twenty-one hundred at each lecture. The total number of lectures delivered during the year has been in the neighborhood of fifty.

From the time of the museum's first inception to the present time, there have been published a number of pamphlets and books to promote the work of the museum, as well as to educate the public to the waste of life in the industries. The museum has had the cordial cooperation of the daily papers and the technical press in the work which it is carrying on. The museum, at the present time, is engaged in publishing

"Safety Manuals" and leaflets, of which two manuals and three leaflets have already been published. Other manuals and leaflets are in preparation and will be issued from time to time during the course of the year. The museum has embarked on a new method of valuable help to the employer which is the inspection of plants and the reporting of the kind of safeguards recommended. The museum is always glad to answer any legitimate question in regard to accident prevention.

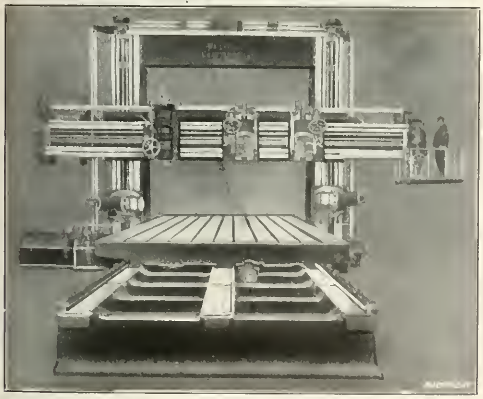
The museum awards annually three gold medals, the first of which is known as the "Scientific American Medal of the American Museum of Safety," and is given to "such individual or corporation as has produced and exhibited in the American Museum of Safety within a recent period of years any perfected device of utility which in the judgment of the Jury of Award of said museum best conserves human life and limb in the processes of productive industry." This medal has been awarded three times. The second medal is the "Travelers Insurance Company Medal of the American Museum of Safety," which is awarded to the "American employer or other corporation which in the judgment of the Jury of Awards of the museum has done most or achieved greatly, during a recent period of years, in the conservation of the lives and limbs of their workmen by means of safety devices for machines and processes." This medal has been awarded twice. The last medal is the Louis Livingston Seaman Medal of the museum to be given for progress and achievement in the promotion of hygiene and sanitation and the mitigation of the evils of occupational disease. This was awarded for the first time in 1911.

The Legislature of the State of New York passed in May, 1911, a bill incorporating the American Museum of Safety. The museum is a non-commercial enterprise, and it does not take orders for any of the devices it happens to exhibit. It has so far received no financial support from city, state or national government, but is maintained entirely through membership subscriptions. In this respect it differs from the foreign museums, which, as explained before, obtain at least some governmental support. It is to be hoped that the industrial community will realize the public service which the museum is rendering and will seek to cooperate in its work as a public duty.

* * *

A LARGE GERMAN PLANER

The accompanying illustration shows a planer built by the firm of Wagner & Co., Dortmund, Germany. This machine is intended for work on turbine housings and is built for F. Schichau in Elbing. The extreme length of work that can be done is about 34 feet 5 inches, and the extreme width, 16 feet 5 inches, the limit in height being 13 feet 1 inch. The main drive is from a 60-horsepower motor. The machine is provided with a milling head in addition to the four planer heads. Auxiliary motors are used for the various feeds.



A Large Planer which takes in Work approximately 34 by 16 by 13 feet

PLANING STEEL RACKS FOR FROG AND SWITCH PLANERS

The rack used on the frog and switch planers manufactured by the Cincinnati Planer Co., Cincinnati, Ohio, is made of a steel forging instead of from cast iron, on account of the heavy duty that this type of planer is called upon to perform. The rack is made in sections, these being fastened securely by bolts and dowels to the under side of the planer table. To cut the rack teeth, the sections of the rack are clamped to the planer table, as shown in Fig. 1, the rack teeth being formed with cutting tools held in the tool-head.

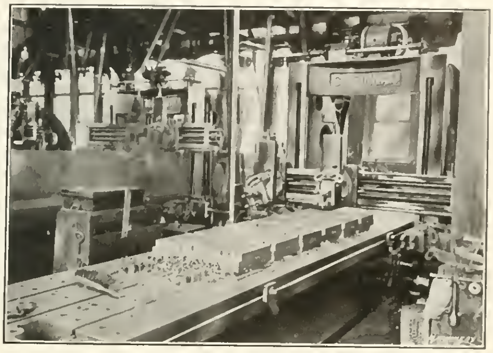


Fig. 1. Planing Teeth in Steel Racks for Frog and Switch Planers

The rack sections shown clamped to the planer table in Fig. 1 are made from 40-point carbon steel forgings, and the teeth, which are 1½ diametral pitch, are cut from the solid block. Naturally, this operation requires considerable time, and calls for a special type of planer tool equipment. The successive tools used are shown in Fig. 2. Here *A* is the first roughing tool—similar in shape to a wide parting tool—with a nose 5/8 inch wide. This tool is used to rough out the teeth, taking a cut 0.040 inch deep per stroke, at a cutting speed of 40 feet per minute. After all of the teeth have been roughed out to within about 1/8 inch of the proper depth, tool *B*, having a stepped face is used to rough out the angular sides of the teeth. Next, tool *C* is put in the tool-holder, and all the teeth are finished to within about 1/64 inch of the proper depth.

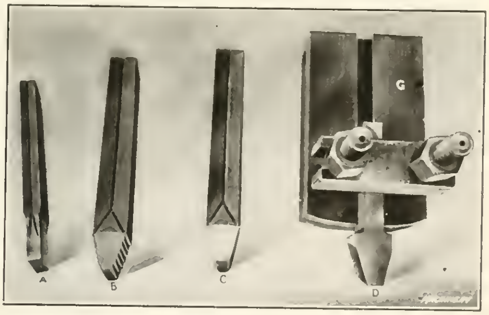


Fig. 2. Successive Tools used in Cutting the Steel Rack Teeth in the Rack for a Cincinnati Frog and Switch Planer

The final shape is given to the teeth by the rack-tooth cutter *D*. This is held by a strap, bolts and nuts in a slot in the special block *G*, the latter fitting snugly in the clapper-box. Holding the finishing tool in this manner insures that the teeth will be accurately formed on the sides, and also maintains the proper face angle. The spacing of the teeth, of course, is accomplished by means of the micrometer collar on the rail-screw.

D. T. H.

* * *

The total steam power used in the United States is about 27,000,000 horsepower. It is estimated that 35,000,000 horsepower could be made available from the waterfalls. Of this about 5,000,000 horsepower has been developed.

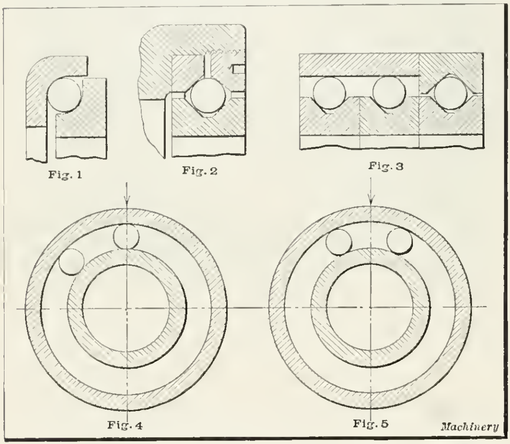
BALL AND ROLLER JOURNAL BEARINGS*

THEIR DEVELOPMENT FROM EARLY TYPES AND CONSIDERATIONS IN THEIR DESIGN

BY ROBERT H. GRANT†

In a previous article, appearing in the August number of MACHINERY, the writer reviewed the history and development of ball and roller thrust bearings. In this article ball and roller journal bearings will be treated.

The first type of ball bearing used was that known as the cup and cone type, a section of which is shown in Fig. 1. The design of these bearings has been varied considerably, some designers having advocated a two-point bearing, and others a three-point bearing; some have believed in the use of large balls, and others in balls of a smaller size, etc. At the present time it is of little importance, however, as later types of bearings have taken its place.



Figs. 1, 2 and 3. Early Types of Ball Thrust Bearings. Figs. 4 and 5. Action of Ball Journal Bearings when Distance between Bearing Points is too Great

The next type of bearing was the grooved ball shaft bearing, a section of which is shown in Fig. 2. This bearing had three hardened steel races, and was fitted to a housing or hub. The plain outer race was driven into place and the threaded race was a good fit in the housing, so that the two would be in alignment with each other. The inner race or cone was a sliding fit on the shaft, so as to allow it to adjust itself to the outer races. This bearing was satisfactory for light loads and high speeds, but had to be very accurately ground and fitted; otherwise there would be a three-point bearing instead of a four-point, which would soon cause wear. On account of the expense of manufacture and mounting, this bearing has been very little used. The adjustable feature also caused a great deal of trouble due to the fact that inexperienced users would adjust the bearings improperly; hence, types were developed in the early years of bicycle manufacture which could not be adjusted.

The next bearing developed was a modification of the grooved ball shaft bearing, as shown in Fig. 3. The first bearing in the series is a regular grooved ball thrust bearing which takes the end thrust, while the other ball bearings take the journal load, thus distributing it over the whole length of the journal bearing. This bearing was applied to a railway car as early as 1888 and is now quite extensively used on electric cars.

While many other bearings have been developed and tried, the regular annular ball bearing has been adopted by nearly all manufacturers as the standard. These bearings are now being made of the same inside and outside diameters and thicknesses by all makers. The various makes differ only in the material, workmanship, size of ball, and design of cage. The material mostly used for the ball races is an alloy steel made in the form of tubing. One steel much used for this purpose, as made by the Becker Steel Co., of New York, is composed of carbon, 1 per cent; chromium, 1.25 per cent; manganese, 0.35 per cent; phosphorus and sulphur, not to exceed 0.025 per cent; and silicon, 0.25 per cent. In German bearings a chromium content between 1.50 to 1.60 per cent is used. It is claimed that this alloy steel gives still better results. Alloy steels of this type will stand a high surface pressure, which is necessary on account of the fact that the ball has practically only a point bearing in the race.

The cage, the design of which varies considerably with different manufacturers, should be made of a light, strong material and should prevent the balls from coming in contact with each other, and at the same time give them perfect freedom of action. The diameter of the balls to be used must, of course, be determined largely by the load that is to be carried; the ball must have sufficient diameter to stand the strain. It is evident that the closer the points of contact are to each other when the load comes onto the balls, the better will the bearing run. If the balls are small there will be a greater number of points of contact, and the bearing will work more freely, but the size of the ball must be kept within safe limits to prevent it from breaking.

The ball cage is of vital importance, as it reduces the friction between the balls, preventing them from rubbing against each other, but it should be so made that the bearings can be almost entirely filled with balls. In Figs. 4 and 5 are shown two diagrammatical sketches to illustrate the importance of having the bearing nearly filled with balls and the bearing points as close to each other as possible. When the load is directly over one ball, as shown in Fig. 4, this ball will carry the greater part of the load. When the load comes between the balls, as in Fig. 5, the ball just coming into action will necessarily take more of the load than the ball which is leaving the line of action. It will carry this increased load until it reaches the center and for some distance beyond. Thus it can be seen that if three or four balls are at the same time near the line of action, the load of the bearing is more evenly distributed over the balls. This condition can only be obtained by making the cage so that the balls practically fill the annular space of the bearing.

Types of Ball Bearing Cages

The first cages used were designed with so great a distance between the balls that the bearing could carry only a very light load. In recent constructions it has been found possible to make ball bearings with a cage where 96 per cent of the space between the races is filled with the balls. The balls are introduced through filling slots, the size of which is a little less than the diameter of the ball, so that the latter are forced in between the two races under pressure. The shallow filling slots are not as deep as the ball races and are inclined at an angle to these. The early cages, such as shown in Fig. 6, were made from brass castings and were very clumsy and heavy. Later sheet-steel cages came into use, but the best cages, at the present time, are pressed up from sheet bronze or brass, in two parts, and are then riveted or fastened together after the bearing has been assembled.

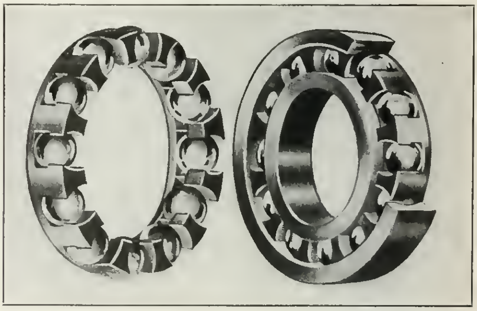


Fig. 6. Early Type of Ball Cage for Journal Bearings

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*See "Ball and Roller Thrust Bearings," MACHINERY, August, 1912.

†Address: 912 Oakland Ave., Ann Arbor, Mich.

Double Row Annular Bearings

On account of the thrust to which annular bearings are sometimes subjected, the regular type was found unsatisfactory for certain work, and the double-row annular bearing was introduced. The first double-row annular bearing made in this country was designed and put on the market by the writer in 1890. The first design of this bearing is shown in Fig. 7. This bearing was not ground, but simply polished, and proved very satisfactory in a great many cases. It was, however, somewhat ahead of its time, and did not become as popular as the single-row bearing. The first double-row bearings of this type were made from soft steel and casehardened. Later they were made from regular tool steel and finally from an alloy steel.

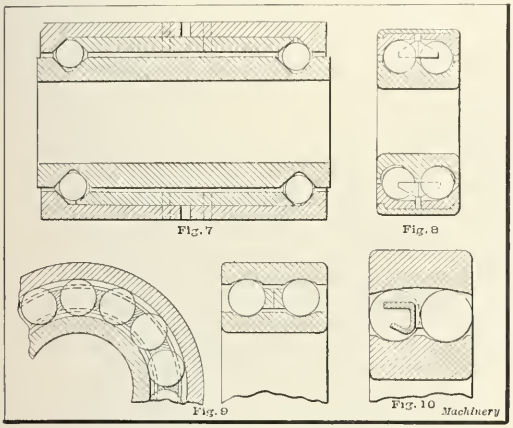
Fig. 7 Fig. 8 Fig. 9 Fig. 10

Figs. 7 to 10. Various Types of Double Row Ball Journal Bearings

A type of double-row annular bearing made by the New Departure Mfg. Co., Bristol, Conn., is shown in Fig. 8. This bearing is composed of a cone with two grooves, two cups, and a shell. One cup is first forced into the shell, then the bearing is assembled and the second cup forced into place, after which the shell is spun over at the ends. When this bearing was first made, the cage was solid, and, therefore, caused considerable trouble, as it was practically impossible to get both races of exactly the same diameter. This caused the balls on one side to run at a different speed from those on the other, resulting in damage to the cage. This difficulty was overcome by making the separator in two parts, thus allowing each row of balls to run independently of the other.

Another type of double-row annular ball bearing is that brought out by Fichtel & Sachs, as illustrated in Fig. 9; this is practically composed of two single-row annular bearings. The cage used in this case is especially advantageous, as it permits the balls to occupy about 96 per cent of the annular space. The balls are introduced after the cage has been put into the bearing.

The double-row annular ball bearings manufactured by the S. K. F. Ball Bearing Co., Fig. 10, have a distinctive feature of self-alignment. Although this bearing has a retainer made of one piece, it is so constructed that both rows of balls take an equal amount of the load at all times.

Review of Manufacturing Methods

In the manufacture of annular ball bearings the methods have changed very rapidly. The bearings were first made by turning the races from a solid bar, which was a very expensive process, as about 75 per cent of the stock was wasted. In Fig. 11 is shown the method which the writer adopted in the early stages of the ball bearing manufacture, in order to economize on material as well as to cheapen the cost of production. The operations were performed on a Cleveland automatic screw machine and consisted in first drilling and reaming the central hole; then, with a hollow mill having a pilot to guide it, the space between the races was cut out. A grooving tool formed the recesses for the balls, after which the pieces were cut off. As the larger sizes of bearings came into use, forgings were adopted for the races for these sizes. The method first employed for finishing these forgings was to use a hand screw machine; later the semi-automatic machine was adopted for this work.

The latest and best method for making the ball races is to make them from tubing. On account of the processes through which the tubing has passed, the metal is very dense and close grained, so that the bearings made from this material have an excellent bearing surface.

After the races have been machined it is necessary that they should be heat-treated. The treatment consists in heating the bearing very slowly to or near the recalescent point and then allowing it to cool slowly. This treatment is given to the ball races in order to prevent them from warping out of shape in the hardening process. After being hardened they are subjected to an artificial seasoning; without this operation they would not keep their shape.

The simplest method employed for the seasoning is to use a wheel about 6 feet in diameter, mounted on the top of a tank containing boiling water. The wheel is slowly revolved, and to it are attached wire baskets which hold the races. These come into contact with the boiling water for a short time, after which they cool off slowly during the remainder of the revolution of the wheel. The races are subjected to this treatment for about twelve hours, and in this way a result which ordinarily requires two months for its accomplishment is rapidly obtained.

The next operation is to rough-grind the bearing, after which it is allowed to rest for several days before being finish-ground. When finish-grinding the bearing, it is completely finished all over except on the outside diameter, which is left until after the bearing has been assembled, in order to insure perfect concentricity. The machines and methods used in the manufacture of ball bearings will be taken up in detail in a future article.

Roller Journal Bearings

In the making of roller journal bearings, the most difficult problems are to insure the alignment of rollers and to take care of the thrust at the end of the roller. Most of the improvements on these bearings have been to provide rings or collars to hold the rollers in position, as well as to take the thrust. One of the first roller bearings to be manufactured was made by the Ball Bearing Co. of Boston, Mass. This bearing had thin annular disks or washers at the ends, with flat brass stay-rods connecting them. The sides of these stay-rods were concave and held the rollers in place. The rollers were made in short lengths with nothing to prevent them from wearing out through the end of the cage, which they very often did when the sleeve, casing or roller was not ground perfectly straight.

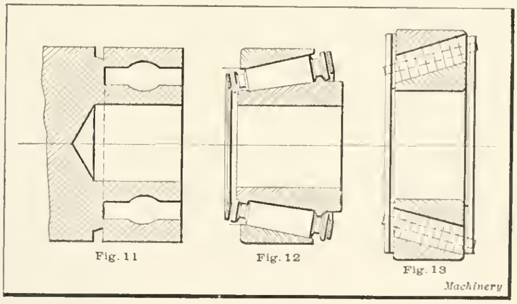
Fig. 11 Fig. 12 Fig. 13

Fig. 11. Method of Turning Ball Races from Bar Stock. Figs. 12 and 13. Taper Roller Journal and Thrust Bearings

The Standard Roller Bearing Co. of Philadelphia, Pa., then brought out another roller bearing in which the cage was made by drilling holes into the ends of sleeves, the metal in which was thinner than the diameter of the roller to be used. Two such sleeves were used for each bearing (one at each end), the two sleeves being held together by stay-rods. A ball was placed at the bottom of the drilled hole, against the end of the roller, in order to minimize the friction. This construction, of course, overcame the difficulty of having the roller wear through the cage end, but the rollers were not kept in perfect alignment, as the holes in the cages had to have some play in order to have the bearing run smoothly.

Other bearings have been developed which overcome the difficulties mentioned. Among these are the Zahn bearing where the roller is provided with a groove around it which fits either a projecting ring solidly held in the bearing, or shoulders on the races which are supposed to keep the roller in perfect alignment, and, at the same time, take the thrust. Another bearing known as the Johnson bearing, which is shown in Fig. 14, is provided to take the end thrust as well as the annular load and to overcome the difficulties due to lack of alignment in the rollers. In this bearing the stay-rods which hold the cage together are provided with two balls inserted in them which hold the rollers in alignment. The ends of the cage are grooved and a hardened steel washer is inserted. The balls which take the end thrust bear upon this washer. The roller is also provided with a ball at each end to eliminate friction. This bearing has some good features, but it is very intricate and must be made with great care. It is also rather expensive unless used where the end thrust, as well as the radial load, is to be carried.

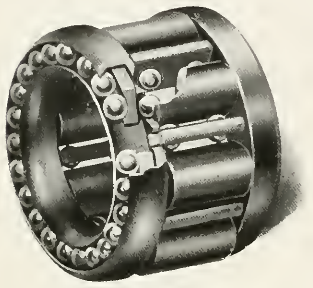

Fig. 14. The Johnson Bearing for taking Both Radial Load and End Thrust

Taper Roller Journal Bearings

Taper roller journal bearings have certain advantages, but they also introduce certain conditions which are difficult to overcome, the same as do taper roller thrust bearings. The first bearings of this kind were made by the Grant Axle & Wheel Co., of Springfield, Ohio. This bearing took the thrust on the cone and had holes in the rollers with stay-rods through them to form the cage. This style of bearing is supposed to take the thrust as well as the radial load. When taking the thrust on the ends of the roller, however, there is a tendency to twist the roller and to get it out of alignment with the axis of the shaft, and if the rollers are not all of exactly the same size, the larger rollers that take the thrust will soon chip off and wear out.

The Timkin Roller Bearing Co., of Canton, Ohio, soon followed the Grant Axle & Wheel Co. in making a bearing in which the thrust was taken exactly as in the Zahn bearing previously mentioned, where the roller is grooved and fits ridges in the race. To still further develop this bearing, two grooves were provided in the roller and two ridges on the inner ball race, as shown in Fig. 12. The latest type of straight roller taper bearing is that shown in Fig. 13. Here the rollers are made up of short straight sections, the same as in a plain roller thrust bearing. The use of straight rollers in this bearing causes slippage of the rollers. On account of the difference between the surface speed at the large and small diameters of the cone, there is a great deal of slippage which, although it increases the friction, at the same time takes the thrust of the bearing.

* * *

WORM AND HELICAL GEARS AS APPLIED TO REAR AXLE DRIVES*

European practice extending over a period of fifteen years has given ample evidence of the eminent success of the worm and helical type of gearing, and the author feels confident in saying that in the near future a large percentage of the cars in the United States will be equipped with this drive. The principal reason for the adoption of the helical form of tooth appears to be its peculiar quality of silence, regardless of speed or load. With the best methods of design and assembly, great durability, strength and efficiency are obtained.

It is impracticable in an article of this character to cover all the details satisfactorily. However, the author believes that on all styles of cars in the United States to-day the worm gear could be used successfully for rear axle purposes.

The successful worm gear should embody the following qualifications:

1. Cheapness of construction.
2. Strength for resisting shocks.
3. Hardened and smooth surfaces for durability.
4. Material of a suitable composition to reduce friction.
5. Simplicity of construction and mounting.
6. Perfect bearing conditions.
7. Noiselessness at any speed or load.
8. Reversibility.
9. Lightness in weight.
10. High efficiency in power transmission.

Granting that there is some argument against the worm in regard to trucks as to the dead axle proposition, this could be overcome by using a worm gear on each end of the axle, the same as sprocket wheels, having a double worm gear drive in place of the cumbersome chain drive. If at first slightly more expensive than the chain and sprocket drive, less repairs will more than make up the difference. Care should be taken to have accurate bearings, both radial and end-thrust.

RESULTS OF EFFICIENCY TESTS ON ORDINARY TYPE WORM-GEAR FOR AUTOMOBILE REAR AXLE DRIVE FOR ELECTRIC VEHICLES AND LIGHT POWER CARS

Number of Test	Temperature of Worm-gear, Degrees F.	Twist of Shaft in Degrees	R. P. M. of Worm	R. P. M. of Worm-gear	Input, Transmission Dynamometer, Horsepower	Output, Brake Horsepower	Efficiency, Per Cent
1	74	$1\frac{1}{4}$	1393	143	1.64	1.01	61.6
2	82	2	1423	146	2.65	2.11	79.6
3	86	$2\frac{3}{4}$	1416	145	3.41	3.11	91.3
4	86	$3\frac{9}{16}$	1416	145	4.46	4.15	93
5	90	$4\frac{7}{16}$	1370	140.5	5.48	5.03	92
6	94	$5\frac{7}{16}$	1389	142.5	6.72	6.12	91.2

Worm-gear: Phosphor-bronze, 39 teeth.
Worm: Casehardened steel worm, solid on shaft, quadruple thread.

Considerable discussion has arisen in regard to the relative merits of the straight and Hindley types of worm gearing. In my opinion both can be used successfully, although each has its own advantages and disadvantages. For most purposes, particularly where considerable power is to be transmitted, the Hindley type has the advantage, but with ordinary machinery it is somewhat more difficult to obtain the same degree of accuracy as can be obtained in the case of the straight type.

From tests made there is no question but that there is a larger bearing surface on the Hindley type of worm than on the straight. Therefore this type of gearing will for the same pitch present a bearing of greater durability, and heat less than the straight type, particularly under heavy load. The straight type may have less trouble with end-thrust bearings. The worm can move in its position longitudinally with the worm axis and therefore does not require as close an adjustment of the end-thrust bearings. With first-class bearings the Hindley type has the advantage, as a smaller and lighter gear can be used, thus reducing the expense.

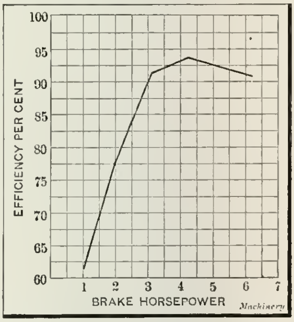

Diagram showing Relation between Brake Horsepower and Efficiency, based on Results of Tests

Some efficiency tests on an ordinary type worm and worm-gear for automobile rear axle drive, for electrical vehicles and light-power cars, were undertaken by the author. A transmission dynamometer, similar in some respects to the apparatus used at the Massachusetts Institute of Technology by Prof. Riley, was constructed. The prony brake was adopted for an absorption dynamometer, and a long shaft of small diameter was arranged to obtain the torsion of the shaft in degrees by an electrical indicator apparatus for a transmission dynamometer. The results of the tests are given in the accompanying table. The diagram shown gives a curve plotted from the results obtained in the tests and recorded in the table.

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* Abstract of paper by Mr. Frank Burgess, read before the Society of Automobile Engineers at the Detroit meeting, June 27-29, 1912.

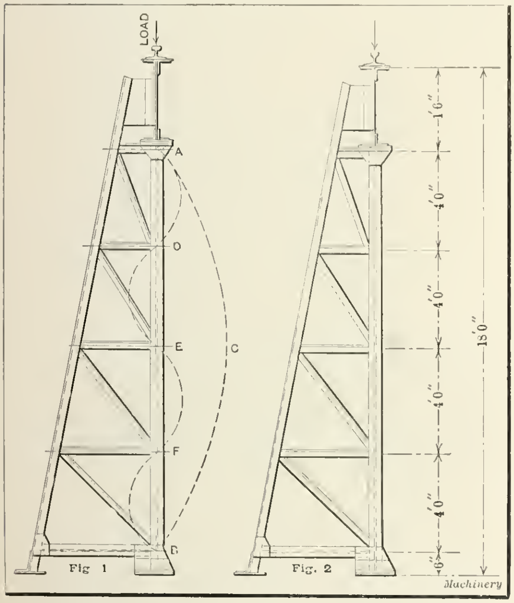
STRESSES IN AN A-FRAME FOR A CRANE RUNWAY

AN ANALYSIS OF THE PRIMARY STRESSES AND A DISCUSSION OF THE STRESSES IN THE LATTICE BARS

BY HARRY GWINNER

Fig. 1 is an outline of an A-frame or trussed column for a crane runway. The following information has been requested in connection with it: "A discussion of the stresses in the members; a graphical analysis of the stresses; and an investigation into the influence that the other members have upon the perpendicular main member when choosing a section, as in the case of a column."

This frame will be treated as being subjected at different times to a different set of forces, which actually occurs in practice. In Fig. 1 the frame is shown as being subjected to a direct load along the axis of the main member *AB*. Under this load there is no tendency for the frame to rotate about the foot of the column *AB* (provided there is no eccentric stress in the column), and while the trussing does not receive any primary or direct stresses from this load, it does receive secondary stresses when the column begins to deflect under the load, or when the inevitable shortening begins to take place—that is, when the points *A* and *B* approach each other.



Figs. 1 and 2. Analysis of Stresses in A-frame for Crane Runways

The object of the trussing is to prevent buckling in the column at the points of attachment of the trussing, and will compel the member *AB* to assume the compound curve line, threading in and out of the column through the points of attachment *ADEFB* instead of bending along the single curve *ACB*, when deflection begins to take place. Thus the member *AB* may be treated as a column or strut of one-quarter of the length of *AB* (since the trussing as shown in the figure divides the length into four portions), so far as bending in the plane of the trussing is concerned.

To test the column to note the effect of the trussing or bracing, assume in Fig. 2 a direct load of 150,000 pounds, and the dimensions as shown. Assume a 15-inch by 42-pound I-beam for the column, and use the straight line column formula:

$$P = 16{,}000 - 70\frac{l}{r}$$

where

P = permissible unit stress,

l = length of column,

r = radius of gyration.

Then we have for the permissible unit stress per square inch for the four-foot sections:

$$16{,}000 - 70\frac{4 \times 12}{1.08} = 12{,}890 \text{ pounds,}$$

1.08 being the least radius of gyration about the line 1—1, Fig. 3.

The permissible unit stress for the full length portion, taking the radius of gyration about axis 2—2, is:

$$16{,}000 - 70\frac{18 \times 12}{5.95} = 13{,}460 \text{ pounds}$$

Thus it will be seen that the trussing breaks the continuity of the column on the weaker side, and, hence, strengthens it materially.

Stresses in Truss Members

The stresses in the truss members are secondary ones, similar to those induced in the lattice bars of a built-up column. Some years ago the writer took up the matter of stresses in lattice bars with Prof. Mansfield Merriman—the author of the well-known work on "Mechanics of Materials"—who, at that time gave the information that no rational formula had been deduced for accurately computing the stresses. In an article on "Tests of Built-up Steel and Iron Compression Pieces," in the *Transactions of the American Society of Civil Engineers*, Vol. LXV, 1909, the results of the experiments undertaken showed that there is no simple mathematical law governing the distribution of the stresses in a latticed column, and in Bulletin No. 44, issued by the University of Illinois Engineering Experiment Station, on "An Investigation of Built-up Columns Under Load," a portion of the summary of the tests says: "It seems futile to attempt to determine the stresses which may be expected in column lacing for central loading by analysis based on theoretical consideration or on data now available."

Hence, it is theoretically impossible to assign any definite values to the horizontal reactions, or the tendency to buckle at the connections of the trussing to the column. However, the following method is sufficiently accurate to determine the stresses for the purpose of proportioning the trussing. Using the formula $16{,}000 - 70\frac{l}{r}$ to get the permissible unit stress on the column, and with the assumption that the column is very short, 16,000 pounds per square inch will be used. The expression $70\frac{l}{r}$ may, therefore, be taken as the measure of the stress per square inch due to bending in the column under a direct load.

If l is in feet, this expression becomes $70 \times 12\frac{l}{r} = 840\frac{l}{r}$. Designating this stress per square inch as S, we have $S = 840\frac{l}{r}$. Then, by assuming a load put on the side of the column to produce this stress, we can more easily ascertain the stresses. Hence, place the column as shown in Fig. 4, loading it with a uniform load of w pounds per linear foot, and treat it as a beam. Then the beam will tend to deflect as shown by the dotted curve xzy. If the column is treated as being pin-connected at A and B in Fig. 1, it will have a tendency to assume the curve ACB shown in Fig. 1, which is very similar to he curve xzy in Fig. 4. Under his assumption, we may treat the bending in the column as if it were caused by the uniform load in Fig. 4.

Now, $\frac{wl^2}{8}$ is the bending moment in foot-pounds, or $\frac{12wl^2}{8}$ is the bending moment in inch-pounds. Then,

---

* Dean of Mechanical Engineering and Superintendent of Shops, Maryland Agricultural College, College Park, Maryland.

$$\frac{\text{Bending moment}}{\text{Section modulus}} = \frac{M}{Z} = S_1$$

Therefore, $$\frac{12}{8} \times \frac{wl^2}{Z} = S_1.$$

Let I = moment of inertia,
C = distance from center of gravity to extreme fiber,
A = area of section,
r = radius of gyration.

Then,

$Z = \frac{I}{C} = \frac{Ar^2}{C}$, and, from the previous equation,

$$S_1 = \frac{12wl^2}{8} \times \frac{C}{Ar^2} = \frac{3wl^2C}{2Ar^2}$$

Therefore, as S and S_1 are approximately the same, $\frac{840l}{r} = \frac{3wl^2C}{2Ar^2}$ and solving for w, we have:

$$w = \frac{560Ar}{lC}, \text{ or total load} = \frac{560Ar}{C}$$

Therefore, R in Fig. 4 is $= \frac{560Ar}{Cl} \times \frac{l}{2} = \frac{280}{C}Ar.$

Having found R, treat the frame as for finding the stresses in a latticed truss, and as indicated in Fig. 5.

The writer recently requested sme information on trussed columns from two expert detailers and designers on columns employed by a bridge company with whom he was at one time employed. They both agreed that the most suitable way to handle such problems was to assume a deflection of two or three inches at the center of the column (after designing the column to take care of the direct load), and then to ascertain the amount of load which, when the column was treated as a beam, would produce this amount of deflection. The stresses at the different points along the beam (column), are proportional to the ordinates of the curve as shown in Fig. 4.

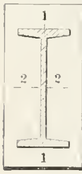


Fig. 3

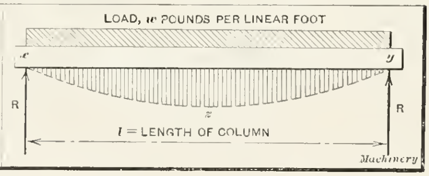


Fig. 4. Column treated as Beam

Under this assumed deflection, the lengths of these ordinates can be measured on the supposition that this deflection, or elastic line, is a sinusoid, the equation of which is

$$Y = \Delta \sin x \sqrt{\frac{P}{EI}}$$

as given in Johnson's "Modern Framed Structures" under column formulas. This method is rather crude, but it has the advantage of giving something upon which to work.

The New Jersey Steel and Iron Co. has incorporated in its specifications the following clause: "The lattice bars shall be so spaced that each channel between the lattice connections shall be stronger than the column considered as a whole, and their size shall not be less than would be obtained by treating the column as a lattice girder supported at the ends and loaded at the middle with a load equal to 3 per cent of the total compression on the column. Mr. Pritchard, who was the engineer of this firm at one time, says the 3 per cent rule was first published in 1891 in the *Lehigh Quarterly*, and that it was adopted as a result of experience.

It is the opinion of the writer that the secondary stresses due to the direct load, as mentioned in the foregoing paragraphs, are very small, and that the theoretical sections required to take care of them are so small that these sections are impracticable, and that any structural shapes which are large enough for the rivets will be greatly in excess of any theoretical sections required.

In general, the practice is to entirely neglect these secondary stresses in crane frames and to design the trussing of such frames for horizontal loads. These horizontal loads are produced when the brakes are applied to the trolley traveling at right angles to the crane girders. The coefficient of sliding friction of the wheels on the rails is found to be about 0.2, and the maximum horizontal load possible, therefore, will occur when the brakes are so suddenly applied to the moving trolley carrying its maximum load, as to cause it to slide on the rails. Therefore, to proportion the trussing, assume 0.2 of the maximum vertical load plus 0.2 of the weight of the trolley applied horizontally at the rails of the runway girders, and design the A-frame as a cantilever for half this load, as it is assumed that the bridge girders of the crane transmit the other half to the opposite A-frame. The column *AB* (Fig. 1) is therefore designed to take the combined stress due to the direct vertical load and this horizontal load.

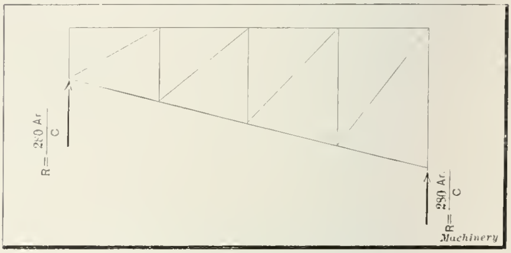


Fig. 5. Frame treated as Latticed Truss

The A-frame is often used out-of-doors, and is therefore subjected to wind pressure, and often additional stresses are induced by the swaying of the live load carried by the crane or by an inclined pull caused by the load being out of plumb when the crane starts to lift it. All of these stresses must be considered and the design treated accordingly.

In the request for information that prompted this article, nothing was said relative to the stresses induced by forces in a plane at right angles to the plane of the trussing. If the moment of inertia of the cross-section of the column is not sufficiently strong to take care of these forces, side bracing should be used. The calculation of this bracing is made in a manner similar to that of the portal or intermediate bracing in a bridge.

* * *

COURT DECISION ON EMPLOYERS' LIABILITY

A recent unanimous decision of the Illinois Supreme Court in the suit of Milford Streeter of Aurora, Ill., against the Western Wheeled Scraper Works, establishes a new basis for the relation between employers and employes as regards accidents and accident prevention, this new basis being a consequence of the new state employers' liability law of Illinois, which is similar to those enacted in several of the other states. The court, affirming the decisions of two lower courts, holds that the old law, under which an employe could not recover if he knowingly worked on defective or unsafe machinery, is now a dead letter. The wording of the conclusion of the court's decision is as follows:

> "The law does not leave to the employer's judgment the reasonableness of inclosing or protecting dangerous machinery, or permit him to expose to increased and unlawful dangers such of his employes as may be driven by force of circumstances to continue in his employ rather than leave it and take chances of obtaining employment elsewhere under lawful conditions. The guarding of the machinery mentioned in the statute is a duty required of the master for the protection of his workmen, and he owes the specific duty to each person in his employ. To omit it is a misdemeanor, subjecting him to a criminal prosecution."

* * *

The oldest metallic objects to which archaeologists have assigned a probable date are those found at Nagada in Egypt. These consist of some pieces of gold, a bead, a button and fine wire of nearly pure copper, which are supposed to be at least 6300 years old. Nearly all the ancient gold that has been examined contains silver enough to give it a light color.

SELECTING THE NUMBER OF TEETH FOR GEARS AND SPROCKETS*

BY G. M. BARTLETT†

The tables in the accompanying Data Sheet Supplement contain the decimal equivalents of all fractions with denominators up to 60. In machine design it is frequently necessary to determine gears and sprockets with low numbers of teeth to give approximately such ratios as can be expressed exactly only with very high numbers of teeth. For example, in a certain machine employing a chain drive, it is required to have the speeds of the driving and driven sprockets as near as possible to 1149 and 473 revolutions per minute. It is stipulated, however, that the number of teeth in the larger sprocket must not exceed 60. Dividing 473 by 1149, we find that the ratio is 0.4117. By referring to the table of fractional equivalents given in the accompanying Data Sheet Supplement, the nearest fractional value to this ratio, with a denominator less than 60, is found to be 7/17. Hence, the number of teeth in the two sprockets can be 14 and 34, or 21 and 51. This will give speeds of 1149 and 473.118 which introduces a comparatively small error. In the absence of such tables, the method of obtaining the approximate fraction 7/17 would be rather cumbersome, as will be seen from the following:

```
473 | 1149 | 2
       946
      ----
       203 | 473 | 2
             406
             ---
              67 | 203 | 3
                   201
                   ---
                     2 | 67 | 33
                         66
                         --
                          1 |  2 | 2
                               2
                               -
```

This is the operation by which the greatest common divisor is sometimes found. Next, place the partial quotients obtained in a row as below. Beneath the first number, write its reciprocal ½. Beneath the second number write a fraction, the numerator of which is the second number itself, and the denominator of which is the product of the first and second numbers plus 1. For the numerator of the next fraction, multiply the partial quotient (3) by the numerator of the second fraction (2), and add the numerator of the preceding fraction (1). The result is 7. For the denominator, multiply the partial quotient (3) by the denominator of the fraction just found (5), and add the denominator of the preceding fraction. The result is 17. Proceed in the same way for the succeeding fractional values, the method used being that of continuous fractions.

$$\begin{array}{ccccc} 2 & 2 & 3 & 33 & 2 \\ \frac{1}{2} & \frac{2}{5} & \frac{7}{17} & \frac{233}{566} & \frac{473}{1149} \end{array}$$

These fractions approach the value of 473/1149 as we proceed towards the right, but as we cannot use more than 60 teeth in the sprocket, the fraction 233/566 cannot be used. Hence, we must use the fraction 7/17, or, if this fraction does not give a sufficiently close approximation, we must use some fraction between 2/5 and 7/17 that might come closer to the required ratio and which has a denominator less than 60. Between the values of 2/5 and 7/17 there are, then, the following fractions: 23/57, 21/52, 19/47, 17/42, 15/37, 13/32, 24/59, 11/27, 20/49, 9/22, 16/39, and 23/56. Whether or not any of these gives a closer approximation, can only be found by trial. In the present case, of course, the matter would be easily determined, as 7/17 comes so very close to the required ratio.

As another example, suppose it is desired to feed stock to a punch press through rolls of 4-inch diameter, the rolls being turned by a ratchet and pawl at the end of each stroke of the punch. The feed is to be as near as possible to 2¼ inches, and the number of teeth in the ratchet to be as low as possible. To find the answer to this problem with the aid of the tables in the Data Sheet Supplement, we proceed as follows: The feed for one revolution of the rolls is $4\pi = 12.5664$. To feed 2¼ inches, the rolls must make $2.25 \div 12.5664 = 0.1790$ of a revolution. Referring to the table, the nearest fraction to this ratio is 5/28; hence we choose a ratchet of 28 teeth, feeding five teeth at a stroke. The feed will be 2.244 inches instead of 2.25 inches, an error of only 0.006 inch. If we should choose the next higher fraction to the ratio 0.1790, which is 7/39, the ratchet will have 39 teeth, and the feed of seven teeth in this ratchet will be equivalent to a feed of 2.256 inches, which also involves an error of 0.006 inch.

If a plate cam is to be cut on a lathe, and it is necessary to feed the tool 0.53 inch for each revolution of the cam, and the lathe is so constructed that it takes 10.35 revolutions of the lead-screw to feed the tool 0.53 inch, the change gears must be so selected that there will be a velocity ratio of 1 to 10.35 between the work-spindle and the lead-screw. Two pairs of gears will be required. Assume the ratio of the intermediate gears arbitrarily as 1 to 3; it remains to find a combination with a ratio as near as possible equal to

$$3 \times \frac{1}{10.35} = 0.2899$$

Referring to the Data Sheet Supplement, the nearest fractions to a ratio of 0.2899 are 11/38 and 9/31. As change gears with multiples of these numbers of teeth are usually not available, we take the nearest available fraction, which is 7/24, giving gears with 28 and 96 teeth, respectively. The ratio 1/3 can be obtained by using gears with 24 and 72 teeth, and the value of the train of four gears, hence, is:

$$\frac{96 \times 72}{28 \times 24} = 10.286$$

which gives a feed of 0.527 inch per revolution instead of 0.530 inch, an error of only 0.003 inch.

Problems in cutting racks for gears of a given diametral pitch, or in cutting screw threads of unusual leads may be considerably simplified by the use of this table.

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* With Data Sheet Supplement.

† Chief Engineer, Diamond Chain & Mfg. Co., Indianapolis, Ind.

* * *

IMPROVEMENTS IN GAS ENGINE DESIGN

BY GEORGE M. STROMBECK

In gas engine design, as well as other matters, experience is the court of last appeal. When any particular practice has stood the test of years, it is not safe, except through knowledge gained by unusually wide practical experience, to condemn it, as there may be reasons for its existence that outweigh the theoretical objections to it. This is especially true in an industry where competition is so keen as in the gas engine business. While much of Prof. Hirshfeld's criticism of gas engine design in the July number of MACHINERY is justified, he attacks a number of things which the writer, after five years' shop experience, believes to be sound practice.

In regard to overhanging cylinders, it is doubtful if anyone would justify the construction in Fig. 1 of the previous article, but the modification hinted at in Fig. 2 and further developed in the accompanying illustration has much to commend it: first, the entire length of the cylinder on all sides is free to expand, and, second, the metal is uniform at all places; these are both the best possible conditions under which a cylinder can retain its shape, thus permitting lighter rings with consequent reduction in engine friction and wear. From a manufacturing point of view the construction is simpler than that shown in Fig. 4 (former article), because all the work can be done at one setting and in a lathe, making it easy to obtain true work. In reference to Fig. 4, every shop man knows that this design involves at least two settings for machining, and this increases the cost. Furthermore, there is a chance of getting the guides out of line with the bore; moreover, some parts of the cylinder section are heavier than others, and as the ribs are bolted to the frame there is a possibility of undue stresses not present with the overhanging cylinder. The makers of a very widely known and successful engine have manufactured over twenty thousand with an overhanging cylinder during the last dozen years, and have had no trouble whatever from them. In fact, they are so pleased with their performance that they are continuing this feature in a new line now being brought out.

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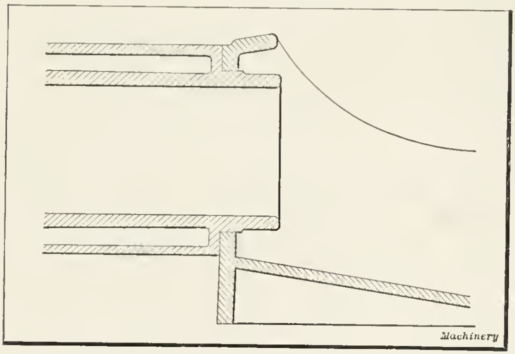
* Chief draftsman, Root & Vandervoort Engine Co., Moline, Ill.

Another point in design which the writer believes has more to justify it than to condemn it is the direct connection between the water jacket in the cylinder and in the head, Fig. 9. That solution of a problem which is direct, and, all things considered, saves most time, must be conceded to be the best engineering practice. Reasonable care in the machining of the ends of the cylinder and head will produce a surface that readily holds a gasket. The only time when trouble would be experienced would be when a part of the circumference is subjected to a much higher temperature than the rest, and when this is the case it would probably be difficult to make a tight joint even though the water jacket were not cut through. If only a part of the extra work necessary to provide other means of cleaning the jacket is applied to making the joint between the head and cylinder right, the trouble with the jackets will not be enough to deserve mention. Any other method would first of all deprive the foundry of a most positive means of holding and venting the jacket core, with a resulting higher loss of castings (with same care and labor). The cleaning out of the core sand and, later, removing of scale would be much more difficult and far less certain if pockets or hand holes were used. There is a remarkable agreement among manufacturers in this point of design, which would not be the case had their experience proved to them that the present methods were wrong.



Method of Attaching and Supporting Gas Engine Cylinder

A minor point in design is the oil groove around the base. While this, no doubt, serves to collect some oil which would otherwise reach the floor, it is doubtful whether the advantages gained offset the foundry difficulties. To be of service, such a groove must be continuous, which can only be done by bringing it outside of the bosses for the anchor bolts. If this is done, larger flasks and the handling of more sand is necessary; but more objectionable than this is the fact that the sand forming the grooves is poorly supported, requiring careful securing. Even then it may wash away in pouring the casting. These objections have been sufficient to cause the removal of such a drain from such engines as were at first designed with it.

The splash collar on the crankshaft, Fig. 15, is, in theory, a fine thing, but its cost is disproportionate to its advantages. While it looks innocent enough, such a little knife edge would add a very large percentage to the cost of grinding the shafts, which is the present practice. With a straight shaft the operation is simple; with a splash collar more or less complication would be introduced, and much greater care in handling the finished product would be required. The splash collar is a refinement which a very large majority of users of small and medium sized engines would not want to pay for.

The use of malleable iron for connecting-rods is, according to experience, anything but an objectionable practice. The maximum return for minimum effort, that is, the cost, must determine this as well as all other problems in engineering manufacture. In small sizes, steel drop-forgings are the solution. In larger sizes, this is out of the question, and the designer must choose between the turned rod and a cast one. If he wishes the benefit of the economical I-section, the material must either be steel casting or malleable iron. The art of casting steel is not as advanced as that of casting malleable iron; hence, there is more uniformity with the latter.

William Kent, in the latest revised edition of his "Pocketbook," says, on page 430, of malleable iron: "For the repeated stresses of severe service the malleable casting ranks ahead of steel, and only where a high tensile strength is essential must it be replaced by that material." On page 431 he says: "The effect of annealing is to oxidize and remove the carbon from the surface of the casting, to remove it to a greater or less degree below the surface, and to convert the remaining carbon from the combined form into the amorphous form called a 'temper carbon' by Professor Ledebur, the German metallurgist. * * * In the American practice the annealing process is rather a heat-treatment than an oxidizing process." On the following page Mr. Kent says: "It was formerly the general belief that the strength of malleable iron was largely in the white skin always found on this material, but it has been demonstrated that the removal of the skin does not proportionately lessen the strength of the casting."

The above statements agree exactly with the writer's experience with malleable iron connecting-rods. Barring accidents, there has been no trouble with such rods. The effect of inertia on the rod, to be sure, makes it a beam under a continuous load, but this load does not act when the rod is under its greatest stress, nor is it at any time very large in engines of the size that are usually fitted with malleable-iron rods. Hugo Güldner, in his excellent book on gas engine design, gives the maximum bending moment M_b in the plane of the motion of the rod, caused by the inertia, as follows:

$M_b = 0.000002\ n^2 r A g L^2$, where
$n =$ revolutions per minute,
$r =$ radius of crank in inches,
$A =$ area of mean section of rod in square inches,
$g =$ weight of one cubic inch of the material of the rod in pounds,
$L =$ length of rod in inches.

Applying this to an actual case will show the relative unimportance of this bending stress. An engine making 350 revolutions per minute has a connecting-rod 27 inches long. The mean section is I-shaped and has an area of 1.65 square inches, and a moment of inertia of 1.09. The bore is 6½ inches, and the stroke is 11 inches. Substituting in the formula:

$M_b = 0.000002 \times 350 \times 350 \times 5.5 \times 1.65 \times 0.26 \times 27 \times 27 = 421$ inch-pounds.

The rod section is 2¼ inches deep. The fiber stress is then, according to the usual formula:

$$S = \frac{M}{I/C} = \frac{421}{1.09 \div 1.125} = 435 \text{ pounds per square inch.}$$

When it is remembered that this stress does not occur until after the maximum force of the explosion has been exerted, it is plain that it needs but little consideration, and that the use of malleable iron in the connecting-rod is not objectionable.

Concerning the low-tension ignition system, it would seem singular that manufacturers should adhere to it so strongly if there were not much in its favor. Equally singular would it seem that all leading manufacturers of magnetos are now developing low-speed, low-tension magnetos for make-and-break service, if they did not believe in this system. The sooting up and fouling of spark plugs even with automobiles is proverbial. If this is the case in an engine which explodes regularly every cycle, what is to be expected in a hit-and-miss engine on a light load, where the explosions are far apart, giving plenty of time for lubricating oil and soot to foul the plug? With the make-and-break ignition, the motion of the igniter prevents this. The practice of the manufacturers is the result of the experience of numerous experts, continually in the field, who have had full opportunity to compare both systems under all conditions.

MANUFACTURING THE VIXEN FILE*

METHODS USED IN PRODUCING A CIRCULAR CUT FILE

BY CHESTER L. LUCAS†

Since the days when primitive man used the file for sharpening his implements of field and war, the file has been one of the most common tools. As in many other commonplace things, however, no one seemed to see room for improvement until, in 1900, Alexis Vernaz, of Yverdon, Switzerland, was trying to devise a hand tool for cutting a lot of exceptionally hard castings. The Vixen file was the result of his efforts. His whereabouts is not known at present, but there is an Elliott Cresson medal waiting for him that was awarded by the Franklin Institute in 1909 for making the first radical improvement in files for generations. The essential points of the Vixen file are well described by a sentence from the patent specifications: "A file provided with teeth cut in the form of arcs, having their bases located rearwardly with respect to the cutting edge of the teeth."

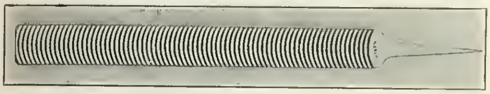


Fig. 1. The Vixen File

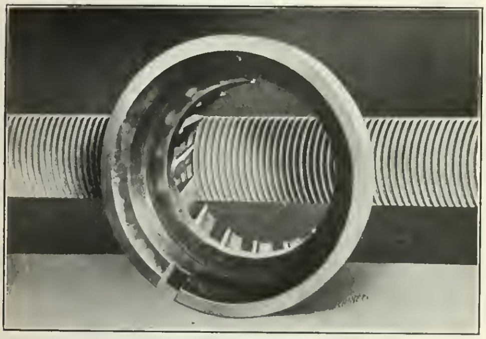


Fig. 2. How the Teeth are cut on Vixen Files

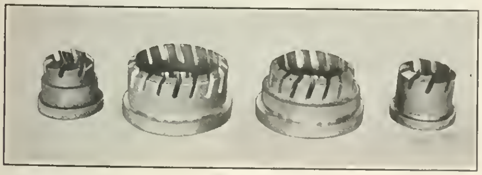


Fig. 3. Four of the Cutters

Fig. 1 illustrates a Vixen file, in which it will be seen that the radical difference between it and the ordinary file lies in the shape of the teeth. The object of curving the teeth is to provide a shearing cut, and by reason of this shearing cut the file is self-clearing. The determination of the radii of the arcs of the cutting teeth of the various sizes of files was the result of experiments which indicate that the best cutting tooth is obtained by using a radius approximately the width of file being made. Teeth cut on smaller radii in proportion to the width of the file make it impossible to guide the file correctly, and teeth of much larger radii do not cut nor clear as easily. The teeth of Vixen files are milled with hollow cylindrical cutters. Several of these cutters are shown in Fig. 3. Of necessity, the cutter is slightly inclined to the face of the file while cutting the teeth, in order that the side of the cylindrical cutter not being used may clear the parts of the file not being cut. This condition is graphically shown in Fig. 2. The amount of this inclination varies from 2 to 4 degrees, depending on the different depths of cut. By thus inclining the cutter to the work and securing a rake to the teeth, an added quality is given to the tooth, enabling it to cut rapidly. The inclination of the axis of the cutter results in cutting the teeth slightly deeper at the center than at the edges, therefore, the face of the finished file is slightly lower in the center, the amount, however, is so small that it is practically imperceptible.

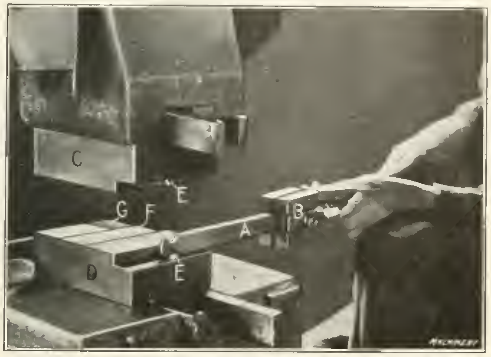


Fig. 4. Forging the Tang

Steel for Vixen Files

The steel from which Vixen files are made is a Swedish chrome steel and is ordered on specification calling for chemical analysis as follows:

Carbon	1.20 to 1.35 per cent (1.25 per cent desired)
Chromium	0.40 to 0.60 per cent (0.50 per cent desired)
Manganese	not to exceed 0.40 per cent
Silicon	not to exceed 0.30 per cent
Phosphorus	not to exceed 0.03 per cent
Sulphur	not to exceed 0.03 per cent

The hardness, according to the Brinell hardness scale, should be from 130 to 170, a hardness of 150 being desired.

Operations in Making the File

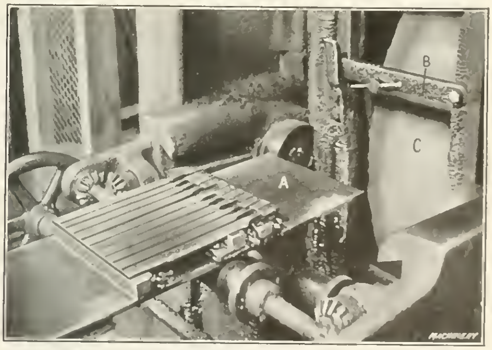


Fig. 5. Grinding the Sides

The first operation in the making of the file consists in the shearing of the bar stock to length. This is an ordinary operation and is performed upon a shearing press of the usual type. From the shearing press the short lengths of steel go to the tanging hammer where the tangs of the files are forged in the manner illustrated in Fig. 4. The dies, and the beginning of the tanging operation are here illustrated. A helper hands the file blank, one end of which has been heated to a forging heat, to the operator of the hammer in which the tangs are forged. The blank *A* is held in special tongs *B*. The first part of the tanging operation consists in "nicking" the end of the file blank between the two half rounded projections *E* at the front of the dies *C* and *D*, leaving the file blank in the condition shown. After this blow the operator shifts the file blank to the middle section *F* of the dies which have beveled faces corresponding with the taper of the tang. By rapidly turning the blank after each blow, the metal beyond the nicked portion of the blank is drawn out to approximately the shape of the finished tang, after which one or two blows are struck on the finishing faces *G* of the die to complete the tang. It is an almost incredible fact that the tang of an 8-inch file is forged in from ten to fifteen seconds from the time it is taken from the fire.

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* For further information on file making, see the following articles in MACHINERY: "File Making at a Sheffield Works," April, 1911, engineering edition; "Toolmakers' Files," January, 1911; "Vernaz Circular Cut File," October, 1909; "Making Swiss Files in America," September and October, 1907. See also MACHINERY'S Reference Book No. 48, "Files and Filing."

† Associate Editor of MACHINERY.

Following the tanging operation, the trademark impression is stamped upon the shank of the file, after which the blanks are annealed by being heated in large quantities in iron boxes and allowed to cool very gradually. The annealing operation decarbonizes the exterior surface of the steel, and before cutting the teeth it is important that this inferior surface of the stock be faced off. This operation, called stripping, is common in making files of all kinds, the metal being removed on large broad-faced grindstones, six feet in diameter. The files are held by the tangs on the plate shown at *A* in the illustration Fig. 5, which is dropped into position against the wheel and clamped by bar *B*, after which the holding plate and files are reciprocated in a vertical line against the face of the wheel *C*, at the same time being flooded with water and fed gradually against the wheel. By this means, 1/64 inch is removed from each side of the file-blanks, leaving them perfectly flat and ready for the cutting of the teeth.

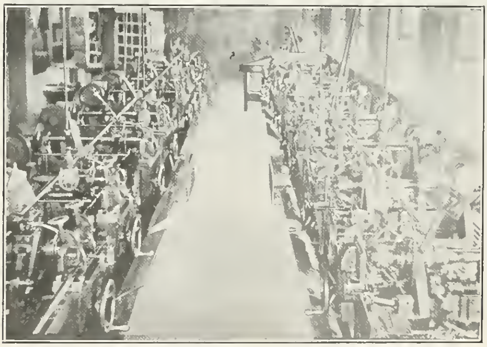

Fig. 6. Two Groups of the Tooth-milling Machines

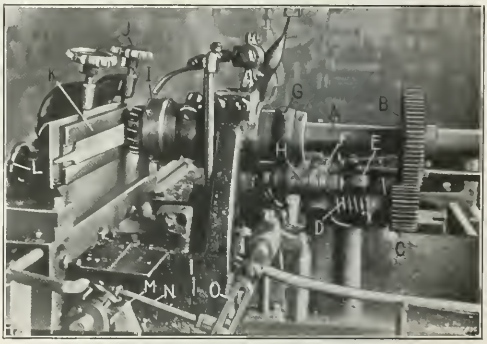

Fig. 7. Details of Machine for Milling Teeth

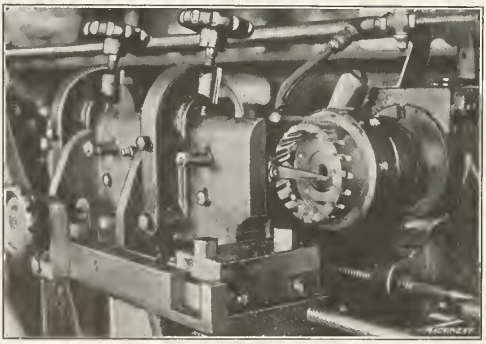

Fig. 8. Close Range View of Cutting Head

Fig. 9. Preparing the Files for heating in the Lead Bath

Cutting the Teeth

The most interesting operation in connection with the making of the Vixen file is the cutting of the teeth. The machines for cutting the teeth are operated in groups of eight, being driven from lineshafting at the rear of the rows of machines. Two of these groups of machines are shown in Fig. 6. The machine consists essentially of a spindle which carries the cylindrical cutter and a table which supports the file blank in a plane at right angles to that of the cutter spindle. As the cutter revolves, it is fed forward to the file blank, withdrawn, the file holding table moved forward the distance of one tooth and the cutter spindle brought forward again. Thus, the teeth are cut one at a time and the machine is automatically stopped after the last cut. Referring to Fig. 7, the cutter spindle, its method of feeding and the cross feed of the work table, may be seen. The cutter spindle shown at *A* is driven by bevel gearing from the extreme right-hand end of the machine. By means of gear *B* in mesh with gear *C* operating on a worm-shaft, the worm *D* engages a worm-wheel, not shown, which causes cam *E* to turn against yoke *F*. Yoke *F* is attached to collar *G*, and thus as the high part of the cam is reached, the cutter is fed forward to its deepest position with respect to the file and, of course, returned when the low part of the cam is reached. The double spring box *H* constitutes a means for insuring the feeding of the cutter to the proper depth of the tooth in each instance; the springs within the barrels overcoming any tendency for uneven feeding of the spindle caused by chips lodging upon the cam or from other sources.

The cutters themselves are made of Rex high-speed steel. Four of these cutters are shown in Fig. 3, and, as may be seen, they are milled very deep between the teeth, which allows them to clear themselves of chips rapidly and provides for many sharpenings before they are worn out. The cutting faces are ground to an included angle of 60 degrees and the cutter is held to the end of the spindle by a flanged sleeve *I*, shown in Fig. 7, which is tightened by a spanner wrench holding the cutter securely in place. The illustration Fig. 7 also shows the method in which the files are held for cutting, consisting of the two clamping screws *J* which operate against jaw *K* of the vise. For varying the depth of the tooth, handwheel *L* is used, thereby bringing the work table nearer to or farther from the cutter. The number of teeth cut per inch varies from 6 2/3 to 16, and for spacing the teeth there is a ratchet and pawl upon the end of the feed shaft. This pawl, shown at *M* in the illustration Fig. 7, is operated by a lever *N* which, in turn, is reciprocated by the arm *O*. Another view of this machine is shown in Fig. 8 which more clearly shows the cutter and its relation to the file blank.

The widths of the files vary from ⅞ inch to 1¾ inch.

There are, on each side, from 90 to 250 teeth, varying, of course, with the pitch and length of the file. It takes twenty-five minutes to cut the teeth in one side of an ordinary 12-inch Vixen file, as compared with one minute for cutting the teeth on one side of an ordinary commercial 12-inch file. Hence it is apparent that the manufacturing cost of a Vixen file is comparatively high.

Hardening

Previous to heating the files for hardening, they are treated with a charcoal and oil preparation to prevent the lead used in the heating from clinging to the teeth and thus interfering with the hardening. The files are brushed with this solution and placed against racks of steam pipes as shown in Fig. 9, to bake the coating on before the files are placed in the lead pot.

The molten lead in which the files are heated is kept at a temperature of 1400 degrees, its condition being indicated by a Bristol pyrometer. Several files are kept heating in the lead pot, being immersed to the tangs. A bar across the top of the lead pot holds the files beneath the surface of the molten lead so that they may be heated slowly and evenly. A file is taken from the lead pot by the hardener, and before being quenched in the brine solution in which the files are hardened, the red hot file is rapidly straightened across lead blocks with a wooden faced hammer. This operation, which is shown in Fig. 11, is necessary on account of the strains set up in the steel by the milling of the teeth. After straightening, which takes but a few seconds, the file is plunged straight down into the brine and moved rapidly up and down until the "singing" has nearly ceased. The file is then quickly removed, sighted, and again straightened after the manner shown in Fig. 10. For this purpose the file is clasped in an iron holder, *A*, after sighting, and placed with the high side down against the wooden bar *B*, the tip end of the file being caught under bar *C*. Pressure is then applied to straighten the file and cold water splashed upon the upper side to bring the file back to a straight condition. This operation of straightening requires a great deal of judgment, for, if the file is kept in the hardening tank a few seconds too long, it will break when pressure is applied for straightening, and on the other hand if removed too quickly, the temper of the file will be impaired.

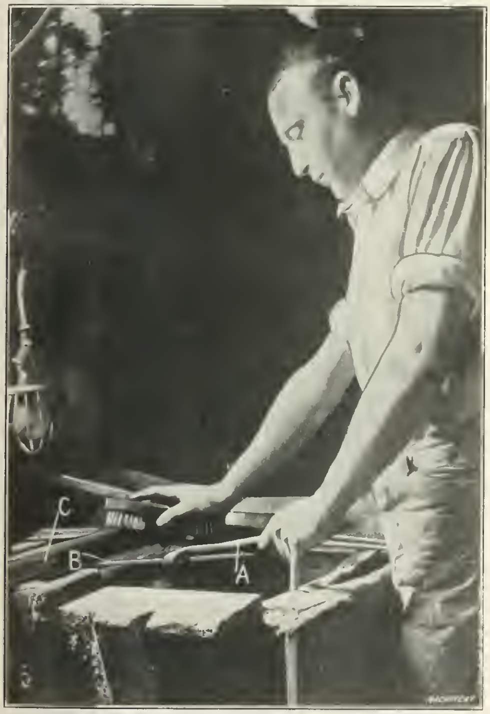

Fig. 10. The Cold-straightening Operation

Sharpening the Files

From the hardening department the files go directly to the sharpening machines. Unlike the sharpening of most tools, files are sharpened by being passed over jets of steam which is mixed with a cutting paste made with a fine mineral abrasive powder. The sharpening machine shown in Fig. 13 is equipped with three nozzles which are shown being used in the operation of sharpening Vixen files. The base of the machine contains the sharpening paste which is led to the nozzles of the steam pipes and thus is propelled against the sides of the file when it is moved backward and forward over the nozzle. A spool, shown just above the nozzle, is used to keep the file at the proper distance from the nozzle. In addition to removing all dirt and scale from the files, this operation sharpens the file by cutting away a slight amount from all parts of the file which it strikes. The files are held by the tangs and in passing over the nozzles, the abrasive material strikes the teeth from the back. If the operation were reversed and the files fed in from the points, the sharpness of the teeth would be removed and the files dulled instead of sharpened. For testing the sharpening, "provers"

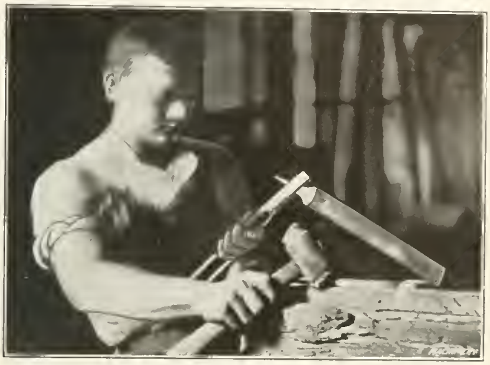

Fig. 11. Straightening Hot Files

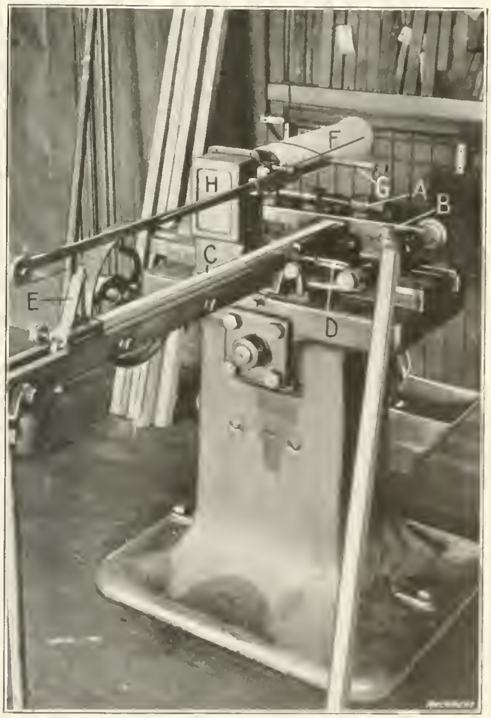

Fig. 12. Herbert File Testing Machine

are used. These provers consist of short pieces of soft steel which are drawn over the file by hand. Even to those unaccustomed to this work, the prover indicates the fact that the file has been really sharpened, and to the sharpener the prover reveals any sections of the file which are not quite up to standard sharpness. Lime is added to the special sharpening compound to prevent the files from rusting after they leave the sharpening machine. The final operation consists in cleaning out the file under a jet of live steam, and after oiling, the files are ready for use.

Testing Files on the Herbert File Testing Machine

A Herbert file testing machine, shown in Fig. 12, the working parts of which are shown in detail in Fig. 14, forms the only practical method of testing the cutting and enduring qualities of the file. This machine was described in detail in MACHINERY, December, 1907, and is also described in MACHINERY'S Reference Book No. 48, "Files and Filing." Briefly stated, the machine consists of a reciprocating file holder *A* in which the file *B* is held, backed up by suitable supports. The file is reciprocated across the end of the square test bar *C* at the rate of 50 strokes per minute. On the return stroke, the bar is withdrawn slightly by means of arm *D*. The forward feeding of the bar is accomplished by means of a 30-pound weight which is attached to the bar at the front of the machine by a chain running over a pulley. The rate of forward travel of the bar is recorded on the chart *F*, by the pencil held in the holder *G*. By means of clockwork within the case *H*, the chart cylinder is turned slowly, with the result that a curve is traced upon the chart which indicates the cutting efficiency of the file tested.

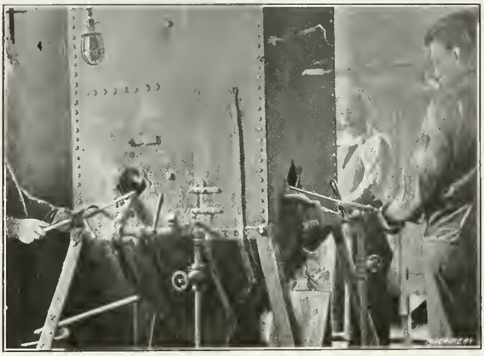
Fig. 13. Sharpening the Files

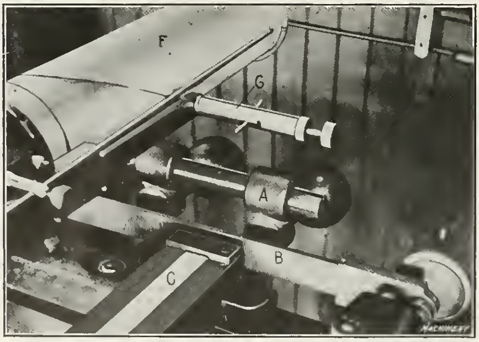

Fig. 14. Details of the File Testing Machine

Credit is due to Mr. W. D. Craft, manager, and Mr. C. M. Zubler, superintendent of the Vixen Tool Co., Philadelphia, Pa., for courtesies shown the writer in the preparation of this article.

* * *

Muzzling the gears may not stop them from biting, but it promises to muffle the bark.

MAKING THE FOSTER SAFETY SET-SCREW

BY CHESTER L LUCAS

In the new factory of the New Haven Machine Screw Co., New Haven, Conn., which appears in Fig. 1, a considerable part of the work consists in the making of the Foster safety set-screw. The factory is of reinforced concrete, and in designing the building, special attention was given to the lighting system; as may be seen, almost all of the wall space is taken up by windows. Fig. 2 shows a view of the automatic turret lathe department in which the blanks for the set-screws are made. Low carbon steel is used in making the set-screws. The turret lathes used are of the multi-spindle type, operating on four bars of steel at once, and when the blanks are dropped from these machines they are in the condition shown at *A*, Fig. 3, having the point roughly shaped, the opposite end rounded, and the stock drilled from the central hole.

Fig. 1. Home of the Foster Safety Set-screw

In the second operation the hole is broached to a hexagonal shape.[†] This operation is performed in a punch press, using the attachments shown in Fig. 4. Referring to this illustration, *A* is a dial revolving on a stud *B* which is fitted to the bed of the press. Around the edge of this dial, bushed holes are spaced to receive the set-screw blanks being broached. The dial is turned, bringing each of these holes successively under the broaching punch *C* by means of an indexing arrangement at the side of the press. This indexing arrangement consists of a lever *D* fulcrumed on the stud *E* and operated from the main shaft of the press. At the lower end of the lever, motion is transmitted to an arm *F* which reciprocates the indexing pawl *G* at each return stroke of the press ram. In broaching, the operator places the blanks in the holes in the revolving dial, and as they are indexed to the position under the punch, they are broached. Upon reach-

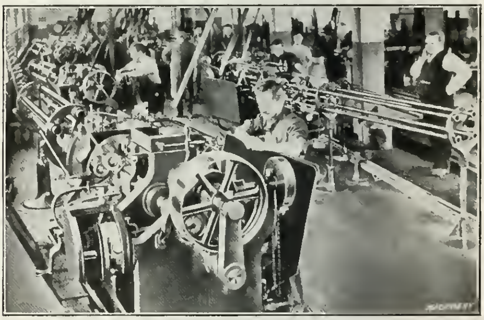
Fig. 2. The Automatic Turret Lathe Department

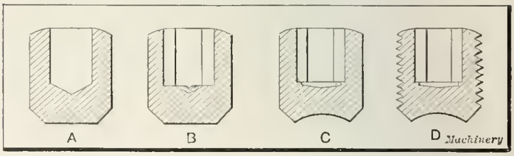

Fig. 3. The Four Steps followed in Making the Set-screws

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[*] Associate Editor of MACHINERY.

[†] A method of progressively broaching square holes in socket wrenches was described in the March, 1902, number.

ing the position directly under finger *I*, they are ejected from the dial by being pushed out by this finger at the down stroke of the press. By referring to *B*, in Fig. 3, which shows the result of this broaching operation, it will be noticed that the metal removed from the six corners of this hole is pushed into the conical end of the hole. In order to clear out these chips and make a neater looking hole, the set-screws are re-drilled in the machine shown in Fig. 5. This machine works upon the blank from both ends, the blank being held by means of jaws *A* and *B*, of which jaw *A* is movable and is clamped upon the work by the foot pressure of the operator. In re-drilling it is only necessary to remove enough metal to clear out the chips and leave the bottom of the hole clean. While re-drilling the blank set-screws from the one end, a forming tool is countersinking and shaping the point of the set-screw, and when taken from this machine the set-screw has assumed the shape shown at *C* in Fig. 3, and is ready for threading.

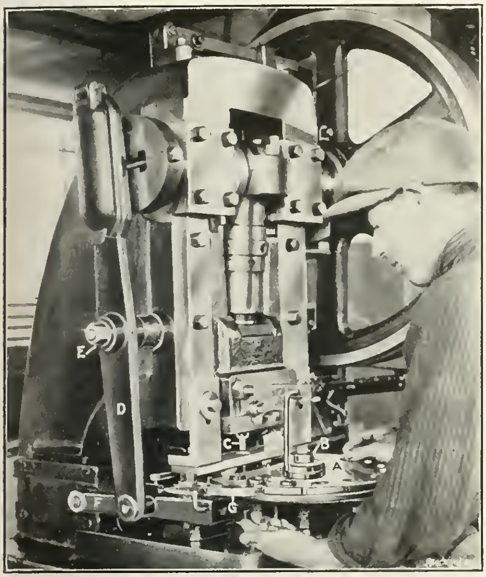

Fig. 4. Broaching the Holes

The threading of Foster safety set-screws is performed on Geometric threading machines, and the details of the threading operation appear in Fig. 6. The machines are equipped with Geometric self-opening dies, and, for threading, the blank set-screw is held upon a short hexagonal arbor, the carriage is run up by hand, and the blank led into the dies. The set-screws are then casehardened by a special process after which they are ready for shipment, the finished set-screw appearing as shown at *D* in Fig. 3.

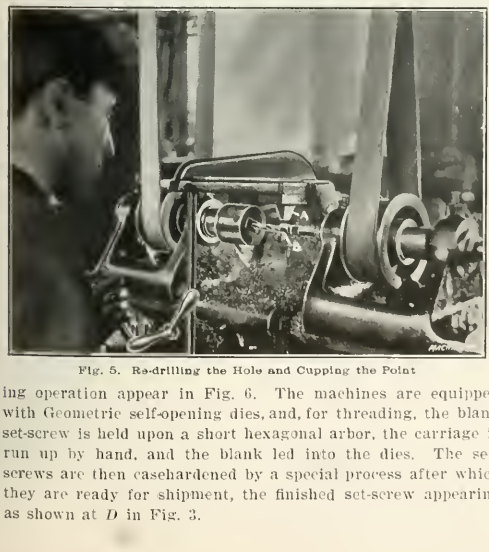

Fig. 5. Re-drilling the Hole and Cupping the Point

GENERATORS FOR THE KEOKUK POWER PLANT

The General Electric Co., Schenectady, N. Y., is building a number of very large electric generators for the hydro-electric power plant at Keokuk, Iowa, where ultimately 300,000 horsepower will be developed from the water power of the Mississippi River. This hydro-electric development has been made possible by the building of the greatest power dam ever constructed. The dam is built entirely from concrete. It has a total length of 9096 feet and rises 50 feet above the average river bed. The initial electric installation consists of fifteen alternators connected to the same number of vertical hydraulic reaction turbines of the single runner type. Each turbine and generator form an independent unit. The turbines are mounted on vertical shafts 25 inches in diameter, and will operate at a speed of 57.7 revolutions per minute, the normal capacity being 10,000 horsepower. The generators are installed on the top of the wheel pits directly over the turbines and will generate a three-phase alternating current at 11,000 volts. Transformers will be installed for stepping up the voltage of the current which is to be distributed over the high-tension transmission lines to 110,000 volts. The power will be distributed within a zone of 150 miles radius. Owing to the slow speed of the generators, their dimensions are very large. They are 32 feet in diameter and 12 feet high, the total weight being over 300 tons. One of the cities to avail itself of the power developed is St. Louis, located 135 miles from Keokuk. The street railway and electric light companies in that city have already contracted for 60,000 horsepower.

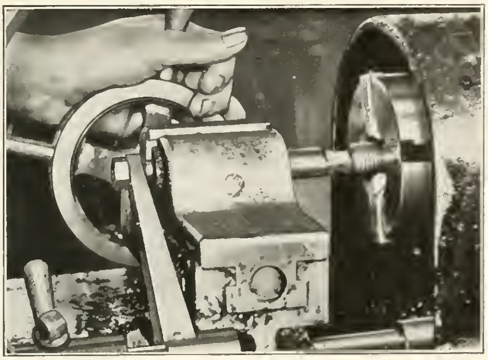

Fig. 6. Threading the Screws

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TEST ON SECTIONAL FIREBOX BOILERS

An interesting demonstration of a new type of boiler was recently made at Coatesville, Pa., under the direction of Dr. W. F. M. Goss, dean of the College of Engineering, at the University of Illinois. Two full sized locomotive boilers, designed for high-speed passenger service, were each subjected to severe low water tests. Both boilers were identical in size and design except that one was provided with a Jacobs-Shupert sectional firebox built by the Jacobs-Shupert Firebox Co., while the other had an ordinary radial stay firebox. The observations were taken from a safe location 200 feet away from the boilers. After the boilers were in normal operation, the feed water supply was shut off, the crown sheet and other portions of the heating surface being still subjected to the heat of the fire. The boiler having the Jacobs-Shupert sectional firebox was tested under these severe conditions for 55 minutes without failure, notwithstanding the fact that the level of the water fell to a point more than 25 inches below the crown sheet. The ordinary stay boiler exploded after the test had continued for 23 minutes, the water level having fallen to 14½ inches below the crown sheet. The crown sheet and the stays which hold it in place, having become highly heated, pulled away from each other and released the pressure in the boiler. The damage to the boiler was such as to make entire reconstruction necessary.

EFFICIENCY OF WORM GEARING FOR AUTOMOBILE TRANSMISSION*

RECORDS OF A NUMBER OF TESTS MADE ON VARIOUS TYPES OF WORM GEARING

The investigations recorded in the following were made at the plant of the Brown & Sharpe Mfg. Co., Providence, R. I., for the purpose of determining the efficiency of three types of worm gearing for use in an automobile transmission system, and the heating effect due to continuous running. The power for these tests was obtained from a 50 H. P. induction motor, running at approximately 870 R. P. M. at full load. Between the motor and the worm-gear case was placed an automobile transmission-gear case to enable tests to be made at two lower speeds. Between this and the worm-gear case was placed a transmission dynamometer designed by the author. (See MACHINERY, June, 1909, engineering edition, for description of this device.) An Alden brake was used to absorb and measure the power transmitted by the gears under test. The apparatus is shown in Fig. 1 as arranged for testing worm gears; *A* is the motor, *B* the automobile transmission-gear case, *C* the transmission dynamometer, *D* the case containing the worm gear under test, *E* the Alden brake, and *F* the platform scale which measured the load on the Alden brake.

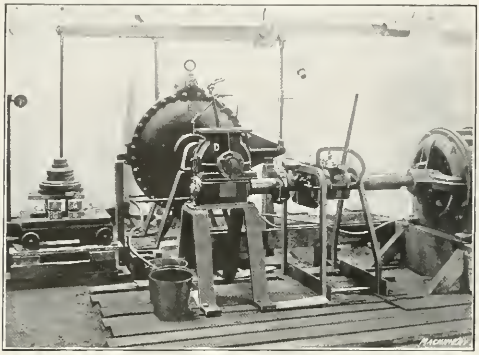

Fig. 1. Arrangement Used for Testing Efficiency of Worm and Gear Drives

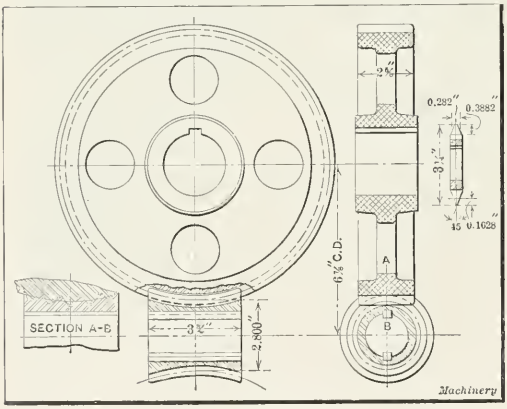

Fig. 2. Worm-gear Drive No. 1

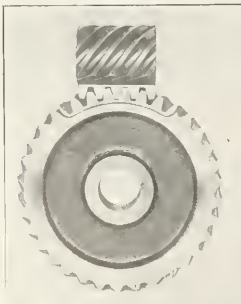
Fig. 3. Section through Teeth, Drive No. 2

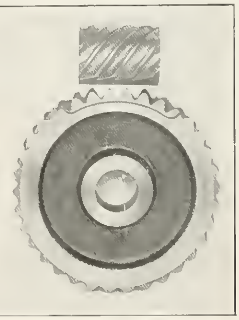
Fig. 4. Section through Teeth, Drive No. 3

The apparatus was so arranged that as the load was imposed, the weight on the platform scale was removed, and all vibration of the scale-beam was eliminated by interposing springs *S* between the blocks *G* which sustained the weight on the scale, and also by suspending by a wire from the weight at the end of the scale beam a plate which dipped into a pail of oil, thus acting as an efficient dashpot. It was found possible by careful manipulation to maintain a steady and easily read load on both the transmission and absorption instruments.

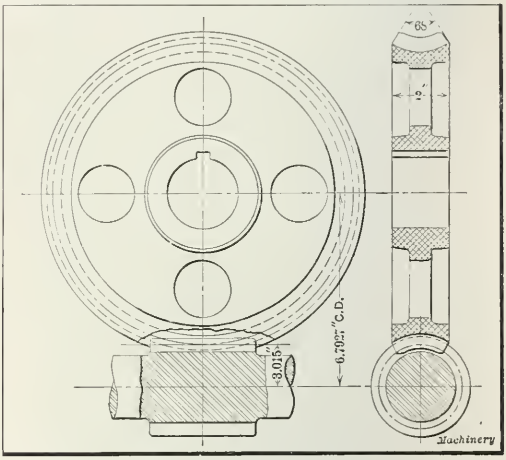

Fig. 5. Worm-gear Drive No. 3

With this arrangement of the transmission dynamometer and brake, runs were made at various loads, and the torques corresponding to horsepowers per 100 R. P. M. marked on the dial of the transmission instrument, corresponding to similar loads as indicated on the brake. It is evident that by this method of comparison the two instruments must check each other exactly. A thermometer placed in the oil-well at the back of the worm-gear case *D* indicated the temperature of the oil, and another thermometer placed on the wall near the apparatus indicated the room temperature. The oil employed to lubricate the gears was one intended for use with superheated steam, having a specific gravity of 26 Baumé, a flash point of 625 degrees F., and a viscosity at 212 degrees F. of from 260 to 265. The case contained about five quarts of the oil.

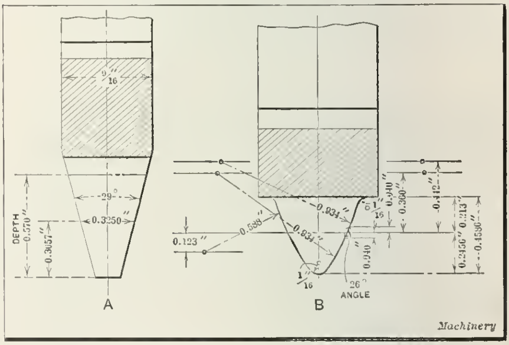

Fig. 6. A, Cutter for Gear No. 2; B, Cutter for Gear No. 3

In all the trials the worm was located underneath the gear.

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*Abstract of a paper by Prof. Wm. H. Kenerson, of Providence, R. I., presented before the American Society of Mechanical Engineers.

Fig. 7 shows a section through the gear case. As indicated, both shafts are mounted on ball bearings and end-thrust ball bearings take care of the thrust on the worm and worm-wheel. All the worms were made of machine steel, casehardened, and the worm-wheels of phosphor-bronze.

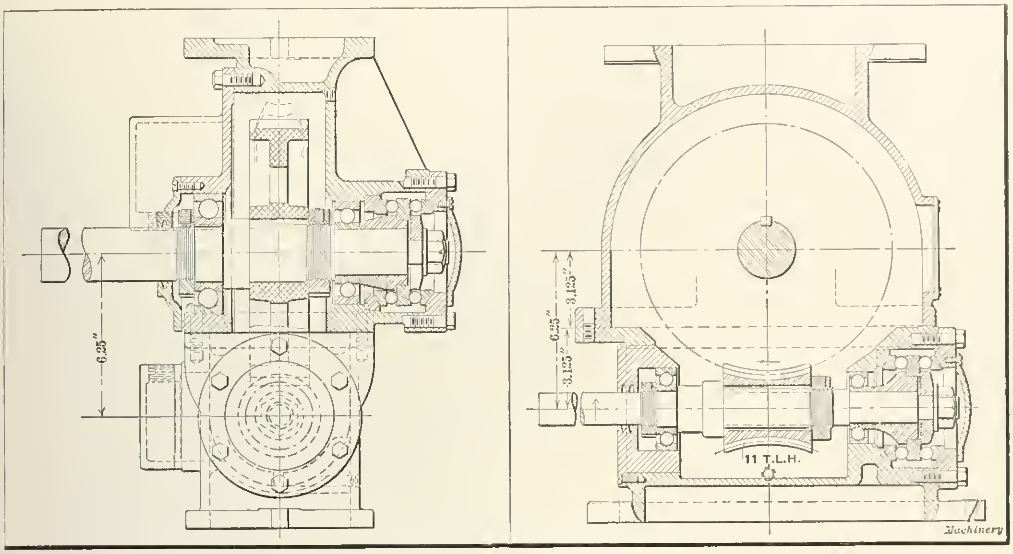


Fig. 7. Section through Gear Case used for Testing Worm-gear Drives

The first worm and wheel tested are shown in Fig. 8, and are similar to those used for driving the spindle on the Brown and Sharpe automatic spur gear machines. This pair of gears is an unusual case of the worm and worm-wheel. The smaller gear is hobbed with a hob of the size of the larger gear, thus making possible adjustment of the larger gear, which would not otherwise be the case. While in appearance this gear resembles a Hindley worm, it is not of this type. The smaller gear will be called the worm and the larger, the worm-wheel, in the following description. Fig. 2 gives the dimensions of the worm and gear shown in Fig. 8. The specifications for this pair of worm and worm-wheel are as follows: worm-wheel, phosphor-bronze; No. of teeth, 43 left hand; pitch diameter, 10.95; outside diameter, 11.28; circular pitch, 0.800; angle of teeth with axis, 45 degrees; normal circular pitch, 0.5657; pitch of cutter, 5.553; addendum, 0.1628 (not standard); thickness of tooth, 0.282; whole depth, 0.3882; included angle of cutter, 45 degrees. The worm-wheel was cut with the cutter shown, and the shape of the teeth on a section through the worm and worm-wheel, parallel to the axis of the worm, is also shown.

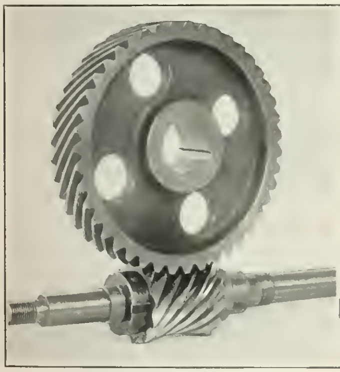


Fig. 8. Worm-gear Drive No. 1

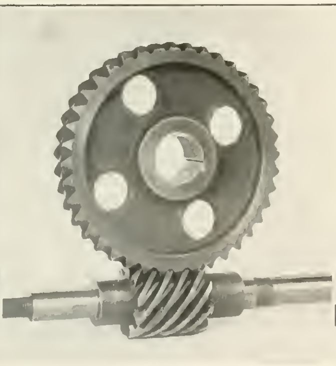


Fig. 9. Worm-gear Drive No. 2

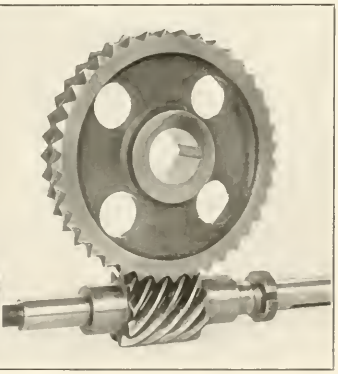


Fig. 10. Worm-gear Drive No 3

TABLE I. EFFICIENCY TEST OF NO. 2 WORM-GEAR WHEN ON DIRECT SPEED

R.P.M. Motor	R.P.M. Worm	R.P.M. Worm-gear	Speed of Worm in Feet per Min.	Initial Load	Reading on Scale	Load on Brake 315-foot Radius	Brake H.P. per 100 R.P.M.	Total Brake H.P.	Total Transmission Dynamometer H.P.	Efficiency of Worm-gears	Transmission Dynamometer Reading				Temperature at End of Test		Time		Duration, Minutes
											1	2	3	Av.	Oil	Room	Start	Finish	
875	875	196.9	690.7	104	55	49	24.5	48.24	49.26	97.9	5.6	5.65	5.65	5.63	268	65	10:14	10:20	6
873	873	196.4	689.1	104	60	44	22.0	43.22	44.35	97.5	5.1	5.05	5.1	5.08	273	65	10.20	10:25	5
880	880	198.0	694.6	104	65	39	19.5	38.61	40.92	94.4	4.7	4.65	4.6	4 65	276	66	10.25	10:30	5
880	880	198.0	694.6	104	70	34	17.0	33.66	36.26	92 8	4.15	4.1	4.1	4.12	275	66	10.30	10:33	3
883	883	198.7	697.0	104	75	29	14.5	28.81	31.17	92.4	3.55	3.55	3.5	3.53	273	66	10.33	10:37	4

The general appearance of pairs Nos. 2 and 3 are shown in Figs. 9 and 10, and the dimensions in Fig. 5. The difference between gears Nos. 2 and 3 is principally one of shape of the worm threads. This difference is clearly brought out in the sections of the worm and wheel shown in Figs. 3 and 4. The specifications for the No. 3 worm and worm-wheel are as follows: Worm-wheel, phosphor-bronze; number of teeth, 40; pitch diameter, 10.5704; throat diameter, 10.9964; circular pitch, 0.8302; angle of teeth with axis, 38 degrees 16 minutes; normal circular pitch, 0.6518; pitch of cutter, 4.8196; addendum, 0.213; thickness of tooth, 0.3568; whole depth, 0.4586. Worm: Aurora steel, casehardened; number of teeth, 9; pitch diameter, 3.015; outside diameter, 3.441; circular pitch, 1.0524; angle of teeth with axis, 51 degrees 44 minutes; thickness of tooth, 0.295; lead, 7.4719; ratio of wheel to worm, 40 to 9.

TABLE II. AVERAGE EFFICIENCIES OF WORM AND GEAR NO. 1

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-Wheel	Input	Output	Oil	Room	
First Speed	254.2	65.03	26.18	24.06	206	73	91.9
	254.6	65.13	24.75	22.47	217	73	90.8
	254.5	65.11	22.98	20.81	225	73	90.5
	255.1	65.25	21.17	19.25	228	73	90.9
	255.3	65.30	19.56	17.63	232	73	90.1
	255.7	65.41	17.76	16.02	233	71	90.2
	255.9	65.48	16.00	14.41	233	74	90.1
	256.3	65.60	14.31	12.79	233	74	89.4
	256.5	65.62	12.37	11.15	231	74	90.2
	256.8	65.69	10.55	9.53	229	74	90.2
Second Speed	545.2	139.5	43.48	41.16	178	73	94.8
	546.9	139.9	40.54	37.78	207	70	93.0
	547.8	140.1	36.88	34.33	214	70	93.2
	548.8	140.4	33.47	30.89	217	70	92.3
	550.2	140.7	29.76	27.41	218	70	92.3
	550.5	140.8	26.01	23.94	218	71	91.3
	551.1	141.0	22.22	20.45	217	71	92.0
Direct	859.5	219.8	66.43	64.86	178	69	97.0
	864.5	221.1	62.80	50.71	201	70	94.9
	871.0	222.8	59.23	54.60	214	70	92.2
	874.5	223.7	54.22	49.22	224	70	90.8
	878.0	224.6	48.60	43.80	230	70	90.1
	882.0	225.6	42.25	38.36	233	70	90.8
	884.0	226.1	36.24	32.79	237	71	90.5

The shape of the teeth on the worm in Fig. 3 was produced with a cutter, the included angle of which was 29 degrees, and the depth of tooth 0.570 inch. This depth was based on the axial pitch, whereas the usual method on multiple worms is to base the depth on the normal pitch. The object in using this cutter was to obtain as many teeth as possible in contact at one time and also a shape that could be ground with a straight-sided emery wheel. The teeth of the worm in Fig. 4 were cut with a cutter shaped as shown at *B* in Fig. 6, which is an arbitrary shape made to produce the greatest effective breadth possible.

TABLE III AVERAGE EFFICIENCIES OF WORM AND GEAR NO. 2

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-wheel	Input	Output	Oil	Room	
First Speed	254.7	57.32	19.26	18.34	164	69	95.3
	254.7	57.32	17.99	16.91	160	69	94.1
	251.5	57.25	16.73	15.46	162	68	92.5
	254.3	57.22	15.08	14.02	142	69	93.1
	255.1	57.39	13.52	12.63	159	69	93.5
	251.9	57.35	12.14	11.18	160	69	92.2
	254.8	57.34	10.69	9.75	160	69	91.4
Second Speed	541.2	122.4	36.95	36.11	178	70	97.7
	545.0	122.6	34.61	33.10	184	70	95.6
	546.7	123.0	32.09	30.14	188	70	93.9
	548.4	123.4	28.90	27.15	187	70	93.9
	549.0	123.5	25.80	24.08	186	71	93.3
	549.6	123.7	22.59	21.03	163	70	93.1
	551.0	124.0	19.12	17.98	163	70	94.0
Direct	873.5	196.5	49.35	48.14	265	66	97.5
	875.0	196.9	44.50	43.30	256	65	97.3
	878.0	197.5	40.40	38.50	260	66	95.2
	881.0	198.2	36.40	33.70	261	66	92.4
	883.4	198.8	30.73	28.84	262	66	93.8

In conducting the trials, the load was maintained at the desired point by one observer who adjusted the brake. Readings were then taken on the transmission instrument by two independent observers. The speed of the motor was observed in each case, and from this, knowing the gear ratio, all the other speeds were easily computed. Temperatures were taken immediately following each series of observations. For purposes of comparison, a series of trials was also run on a pair of bevel gears. The specifications for this bevel gear and pinion are as follows: Driving pinion, 5 per cent nickel steel, casehardened; pitch, 5; number of teeth, 14; angle of edge, 15 degrees 4 minutes; angle of face, 71 degrees 5 minutes; outside diameter, 3.3359. Driving gear, 5 per cent nickel steel, casehardened; pitch, 5; number of teeth, 52; angle of edge, 74 degrees 56 minutes; angle of face, 13 degrees 47 minutes; outside diameter, 10.4627.

TABLE IV. AVERAGE EFFICIENCIES OF WORM AND GEAR NO 3

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Worm	Worm-wheel	Input	Output	Oil	Room	
First Speed	254.1	57.19	18.75	18.30	136	79	95.5
	254.8	57.33	16.54	15.48	144	79	93.1
	255.0	57.38	13.75	12.62	149	79	91.8
	255.4	57.47	10.80	9.77	150	79	90.5
	255.6	57.52	7.38	6.90	149	79	93.6
Second Speed	543.2	122.2	38.59	36.06	204	77	93.4
	543.8	122.4	35.36	33.04	215	77	92.4
	544.8	122.6	33.12	30.03	219	77	90 7
	545.8	122.8	29.82	27.02	221	77	90.6
	546.5	123.0	26.70	23.98	222	78	89.8
	547.2	123.2	23.56	20.95	222	78	88.9
	548.3	123.4	20.02	17.89	221	78	89.4
Direct	866.0	194.8	49.95	47.72	215	77	95.5
	868.2	195.3	45.68	42.98	223	77	94.1
	870.8	195.9	41.20	38.20	228	77	92.7
	874.0	196.7	36.88	33.45	230	77	90.6
	876.0	197.1	31.45	28.60	230	78	90.9
	878.8	197.7	26.45	23.73	229	78	89.7

TABLE V. AVERAGE EFFICIENCIES OF BEVEL GEARS

Speed	R. P. M.		H. P.		Temperature, Degrees F.		Efficiency
	Pinion	Gear	Input	Output	Oil	Room	
First Speed	254.2	68.43	20.92	20.19	....	70	96.6
	254.5	68.51	17.50	16 78	....	70	95.9
	256.1	68.95	14.54	13.44	....	69	92.4
	256.5	69.05	10.95	10.01	....	70	91.4
Second Speed	541.8	145.0	39.64	39.37	....	67	99.3
	544.1	146.4	33.43	32.22	....	67	96.4
	545.7	146.9	26.25	24.98	....	67	95.2
	548.5	147.6	18.75	17.72	....	67	94.5
Direct	872.0	234.7	52.05	51.63	....	70	99.2
	878.6	236.6	42.09	40.22	....	70	95.5
	884.4	238.2	30.40	28.58	132	79	94.0

Table I is a record of one set of observations, typical of the series. Tables II, III, IV and V summarize the results of all the trials, and the curves of Fig. 11 show the average efficiency of the different gears at the various loads and speeds. In conjunction with the efficiency trials, a series of runs was made to determine the heating effect due to continuous running. In these trials, which were in effect endurance tests, a constant load was transmitted through the gearing, and the temperature of the oil in the gear case and the temperature of the room noted at frequent intervals. From these observations it was found that at the beginning of the run the oil temperature rose rapidly and somewhat irregularly. As the run continued, however, the rise became much more gradual and regular. In the runs where the smaller amounts of power were transmitted a point was reached where the temperature remained constant. This indicated that radiation was sufficient to carry away the heat due to power lost through friction in the gearing, or in other words, that the gears would run indefinitely at that load. The heat curves of the No. 1 worm and gear are shown in Fig. 12.

The higher loads indicated were abnormal for the gears under consideration, and would not occur in any use to which the gears would normally be put. The fact that these trials continued for from 60 to 80 minutes without failure indicates that the structure is both strong and enduring and that, should such temperatures be reached for any accidental reason, the gears would not be destroyed. The result of the trials was of particular interest because of the very high efficiency and carrying capacity of the gears tested.

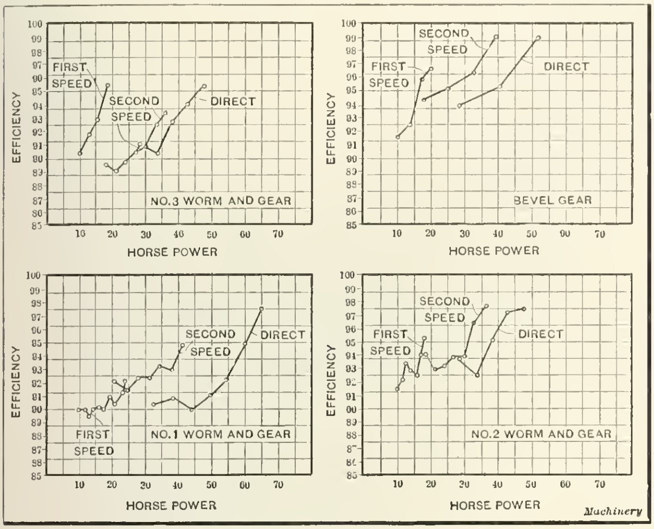


Fig. 11. Efficiency Curves at Various Loads and Speeds

Every possible precaution was taken to secure accuracy in the results, and the high degree of accuracy obtained is due largely to the skill and care of Mr. B. F. Waterman of the Brown & Sharpe Mfg. Co., under whose personal supervision the apparatus was erected and all the trials were conducted.

* * *

A new development in pneumatic tires of a revolutionary nature promises to make considerable improvement in what now is the weakest member of the automobile. The ordinary pneumatic tire is inflated with air, compressed to a pressure of about eighty pounds per square inch. In the new tire the condition of air pressure is reversed, the air being pumped out, leaving the internal pressure at about eight pounds absolute. The external pressure, of course, tends to collapse the walls, which are so shaped that the internal cross-section assumed is a flattened ellipse with the long axis vertical. Load on the tire tends to separate the sides and press them outward against the external or atmospheric pressure. Thus the tire rides on external air pressure instead of internal pressure, as in the common type.

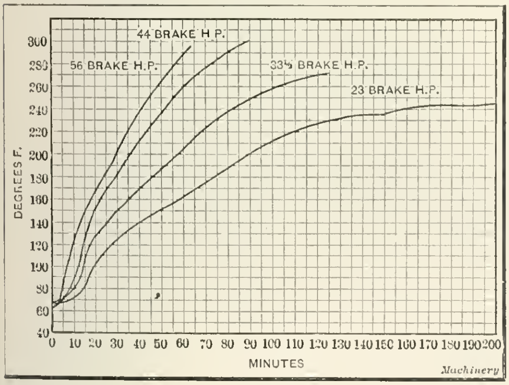


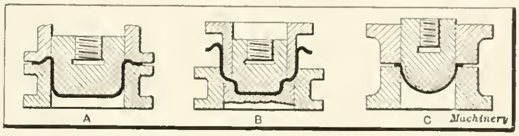
Fig. 12. Heat Curves for No. 1 Worm and Gear

PREVENTION OF WRINKLES IN DRAWN WORK

The formation of wrinkles in drawing operations is a source of great trouble, and there are many pieces of drawn work which could be performed in a single operation were it not for the wrinkles that would inevitably appear. In drawing operations, the tendency to wrinkle starts with the first contact of the punch upon the metal.

The usual method of preventing wrinkles is to provide the punch with a blank-holder which is operated by springs of sufficient tension to allow the metal to be pulled from beneath it for drawing, but maintaining pressure enough to keep the metal free from wrinkles. At *A*, in the accompanying illustration, reproduced from the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, appears a section of a simple drawing die in which it will be noticed that the die is provided with a raised ridge around its opening, the blank-holder having a corresponding depression. Consequently, the sheet metal being drawn is pulled over this ridge, and as the space between the blank-holder and the top of the ridge is purposely made slightly less than the thickness of the metal, it will be seen that as the stock passes through this opening any wrinkles are "ironed out." At *B*, the shell from the dies at *A* is shown undergoing a second operation.

For strength and protection in hardening, as well as to facilitate the drawing operation, the ridge is provided with a fillet where it joins the flat surface of the die. It is obvious that the addition of this ridge to the drawing die occasions a little extra work in the diemaking, but this work is offset by the fact that the blank-holder and upper surface of the drawing die do not have to be ground perfectly smooth and parallel, as is ordinarily required. The size of the ridge around the die should be in proportion to the diameter of the shell. A shell 4 inches in diameter is most easily drawn with a die having a ridge of 7/16 inch radius. For a shell of 8 inches diameter the radius of the ridge should be ½ inch. For a shell 12 inches in diameter the radius of the ridge should be 5/8 inch. For a shell 16 inches in diameter the radius of the ridge should be ¾ inch, and a shell 20 inches in diameter would require a ridge having a radius of 1 inch.



A Method of Drawing Sheet Metal by Means of which Wrinkling of the Stock is avoided

It is obvious that the completed shell will have a ridge left at the edge. On work which is to be wired or for work on which the edge is to be turned over, this additional ridge is no detriment as it can be made use of directly. Moreover, if a succeeding operation is to follow, deepening the shell slightly, this ridge will provide the surplus metal required. This point is illustrated at *C*. In other cases, the extra metal left at the edge may be removed when the shell is trimmed. It is claimed that this improvement in drawing dies is being employed with success. By its use, wrinkles are absolutely prevented, and, moreover, the drawing operation puts less stress upon the metal.

* * *

The J. N. Lapointe Co., Marlboro, Mass., maker of broaching machinery, recommends the use of the following compounds when broaching steel: 2½ pounds of soda-ash; 3 gallons of mineral lard oil; and 50 gallons of water. Mix the soda-ash and the lard oil with 10 gallons of water, and add the other 40 gallons afterward.

LETTERS ON PRACTICAL SUBJECTS

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CENTERING DROP-FORGED CRANKSHAFTS

The usual method of centering drop-forged crankshafts for the lathe, *viz.*, by marking off on centers and surface plate is very slow when a great number of crankshafts are to be centered. The method described in the following is considered by the writer to be an improvement upon previous methods.

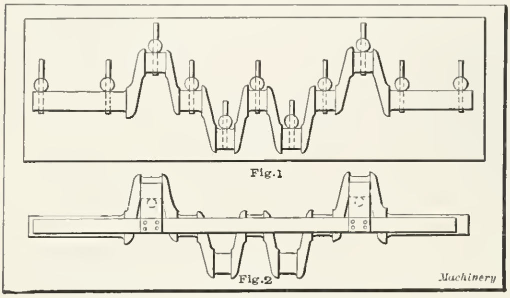


Fig. 1. Plate used for Correcting Warped Crankshafts. Fig. 2. Gage for Cutting off Crankshaft to Right Length

The drop-forgings are first tested for alignment, as they often warp slightly in hardening. This warping should be corrected by the aid of a plate fitted with pegs, as shown in Figs. 1 and 3. The pegs are a good fit in the holes in the plate and correspond to the correct outline of the crankshaft. Each peg has a piece of steel rod projecting through it at each side and resting on the surface of the plate. The drop-forging is placed on these projecting rods and is straightened until each journal and throw has a reasonably close contact with them, the variations allowed depending upon the amount of material left for machining in the drop-forging. The small steel rods keep the webs of the crank from touching the plate, while the vertical pegs give the correct alignment to the throws and journals in planes at right angles to the plate.

The ends are next sawed off to within ¼ inch of the finished length; a simple templet, as shown in Fig. 2, is used for marking this length correctly. The crank is now ready to have the centers put in. This is done on a sensitive drilling machine, the column of which is provided with a pivot carrying the centering jig shown in Fig. 4. This jig consists of a stiff cast base or bar, pivoted at the center, with a T-slot along its full length. At each end a bracket is mounted, the position of which is adjustable to suit the length of the crankshaft. These brackets are fitted with bushings to suit the diameter of the center drill. One end of the bushing is enlarged to form a cap for the end of the crankshaft. The hole in this cap should be larger in diameter than the diameter of the largest drop-forging likely to be used. The ends of the crankshaft are held in this cap by means of four set-screws.

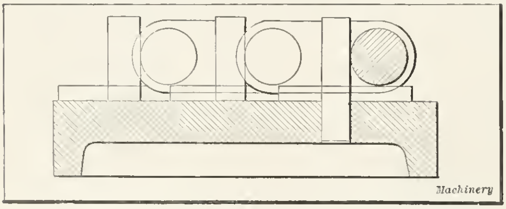


Fig. 3. Section of Plate and Crankshaft in Fig. 1 in Enlarged Scale

Setting gages are used as indicated in Fig. 4. These are bolted in the T-slot at the correct position for each throw and journal. These gages are made of thin spring-steel blades of suitable length, allowance being made for the material to be left for machining. They can be easily changed for different sizes of crankshafts and are cheap to make.

One end of the crankshaft is now placed in the cap at the bottom. The top bracket is raised to allow the crankshaft to enter into its cap, and then the crankshaft is secured in the caps by the set-screws. When clamped it is turned and tried against the steel blades, the set-screws being adjusted until the best average position is obtained. Then the center is drilled at one end, the jig swiveled around, and the center drilled at the other end. It would be a still further improvement to mount the jig horizontally and use a simple drill head at each end of the crankshaft. In this case, a swiveling jig would not be required and both centers could be drilled at the same time.

It will be found that in addition to having obtained a better and quicker method of centering than is afforded by the usual marking-off method, there will be fewer broken center drills, owing to the fact that the crank is held steadily and its weight is not taken by the weak point of the drill. G. R.

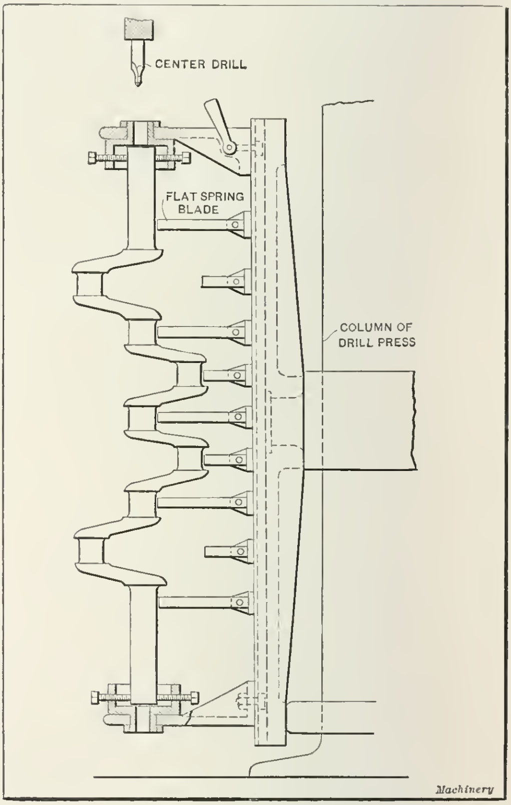
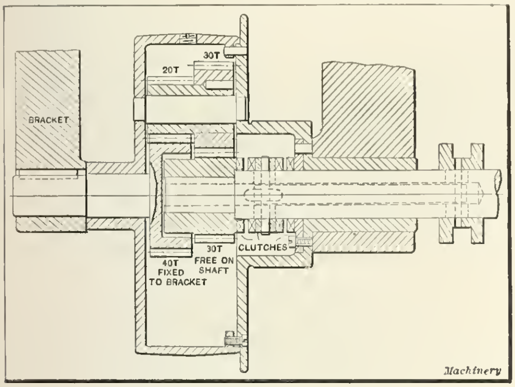


Fig. 4. Centering the Crankshaft in the Drill Press

PLANETARY GEARING—OIL-PUMP TROUBLES

A writer in the May number of MACHINERY mentions an instance of the successful employment of planetary or differential gearing as a speed reducing mechanism. That gearing of this type may be successful at low speeds such as cited (120 revolutions per minute) is, no doubt, possible, but when the speed rises to say 500 revolutions per minute, the experience of the present writer goes to show that it ought not to be employed. In one case a number of machines furnished by a high-class concern were driven in one direction by a direct drive. To obtain a reverse drive certain clutches were used to throw into action a train of epicyclic gears. All gears were regular spur gears, no internal gear being used. The accompanying illustration shows the arrangement of the gears. All the gears ran in oil, but, nevertheless, the noise, right from the beginning, was more than normal, and it increased the longer the machines were used. Finally an examination disclosed that the teeth of some of the gears had worn so badly that they had broken off; the wear was also very unequal. It was assumed that the gears were too weak, and, hence, they were replaced by carefully made hardened steel gears. These, however, were so noisy that it was finally decided to eliminate the planetary gearing and use a reverse countershaft.

There seems, at first, to be no good reason why planetary gearing should cause any more noise or wear than ordinary gearing, but that some reason exists is certain. The writer believes that the trouble is due to the fact that the resultant of the various forces is a constantly changing one, due to the varying positions of the planetary gears in their motion. Sometimes the forces will tend mainly to draw the centers closer together; at other times there will be forces tending to force them further apart. Hence, there is a constant sliding movement between the teeth of the meshing gears which accounts both for the excessive wear and the noise, particularly at high speeds. In some cases the trouble may be due to the pull of the belt and the pressure from the gears being in different planes, thus tending to tilt the gears, the amount of this tilting action varying according to the varying direction of the resultant force. As the various shafts and bearings wear, this creeping between the teeth with accompanying noise and wear, will become intensified.



Arrangement of Clutches and Epicyclic Gearing

The variations in the resultant force will not be so great when three, four, or more planetary gears are used, but then the manufacturing difficulties are greatly increased; in fact, so many factors require attention as regards accuracy, as to make it almost impossible to insure that each planetary gear would bear its fair share of the duty. Take the case of four planetary gears as an example. Here we have the possible inaccuracies of four radial distances and of the four center-to-center distances between the planetary gears themselves; then there are ten gear diameters to be taken into account, the errors in which may or may not balance each other. Furthermore, each of the double planetary pinions must have their teeth exactly in the same relation on each gear. In fact, the only possible way to get anything like an equal load on each gear is to allow plenty of freedom in all running parts, but this would tend neither to freedom from noise nor from wear.

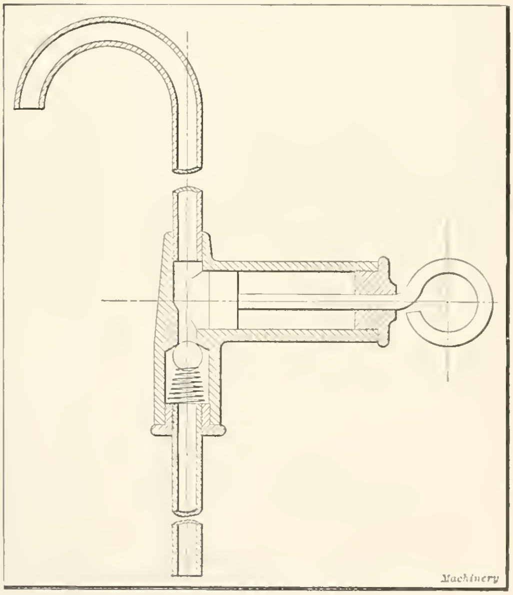
A little incident which occurred in connection with the same machines affords a good example of how small points are apt to be neglected. After the machines were put into operation with a reverse countershaft, it was found that the oil-pump failed to act on the reverse drive, owing to the change in direction of the rotation of the driving pulley. It was, however, necessary to supply oil while the machine was running in the reverse direction also. One remedy, of course, would have been to replace the pump by a reversible one. However, one of the operators conceived the idea of replacing the pump pulley by two pulleys side by side, each bearing a bicycle free-wheel or coaster fixed to drive in opposite directions. Two belts, one open and one crossed, were used to drive the pulleys. Then, no matter which way the machine was running, one of the free-wheels would drive the pump.

E. P. Ciclick

DEVICE FOR EMPTYING OIL DRIP-CUPS

On advertising page 177, in the July number of Machinery, the following "Don't" for machinists is given: "Don't work on any machine if the countershaft hangers are loose." While the writer does not know of any case where anyone has been hurt by the countershaft falling down, he does know of cases where the oil drip-cups have come down. These drip-cups must be emptied at intervals, and, apparently, they are not always put back in position as tightly as they ought to be. Perhaps, also, the looseness is produced by their being removed and put back again at frequent intervals. To empty them, it is necessary to go up on a ladder, which is, in itself, dangerous.

The accompanying engraving shows a device by means of which the oil drip-cups can be emptied without removing them, and much more rapidly than by the ordinary methods. This device the writer has seen in use "on the other side of the pond." The device consists of a long length of piping projecting from the top of the main body, and having a bent or hooked end. The piping used is 3/8-inch gas pipe. At the bottom end a short straight length of piping projects. The ball in the valve shown is held in position by a light spring, just strong enough to support its weight. To the right is a projection containing a pump piston.



A Convenient Device for Emptying Drip-cups

The manner in which this device is used is as follows: The man emptying the oil drip-cups goes around with this device and a pail. To empty the oil drippers he simply hooks the pipe end onto the dripper and pulls out the piston once, so as to start a syphon action; after this the oil will empty into the pail very quickly. The ball valve stops the air from being drawn into the cylindrical section when the piston is drawn out, but it does not stop the oil from flowing past it when it comes down the long pipe. This device does away with the necessity of loosening the drippers; the action is quick, and no danger is attached to its use, as when a ladder has to be employed.

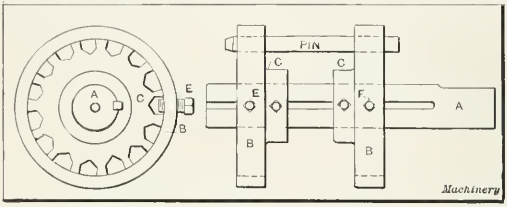
Richard W. Dickinson

Pawtucket, R. I.

DEVICE FOR SIZING PRESSURE PINS

Many mechanics, in making combination cutting and drawing dies for single-acting punch presses, have undoubtedly experienced difficulties with trying to make pressure pins of an equal length. With the aid of the device or mandrel shown in the accompanying engraving, the old cut-and-try methods are entirely done away with, and a complete set of pins can be faced at both ends to equal length at one setting. The mandrel shown has a maximum capacity for fifteen ½-inch pins.

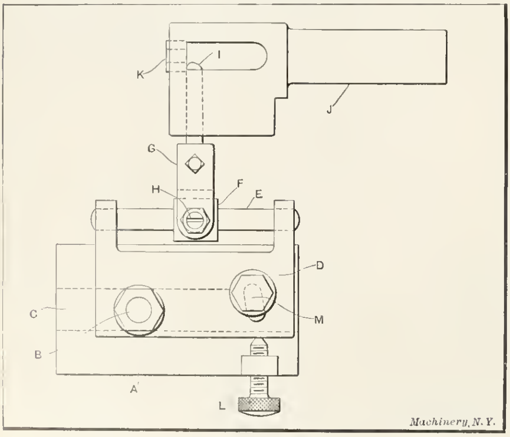
In the engraving, the mandrel *A* is made of tool steel, and has a flat milled for the set-screw of the driver. The collars *C* are made of cast iron and have slots milled in them for the pins. They are fitted to the mandrel *A* by keys to insure rigidity, and the slots are milled after the collars are fitted to the arbor, so that the grooves will line up. The machine steel rings *B* carry set-screws *E*, which latter should be quite smooth and flat on the ends, so as not to mar the pins. Rings *B* are shrunk onto the collars. When using this device, it is advisable to keep the collars as close to the ends of the pins as possible, to insure good support. Light cuts should be taken, and a fine cross-feed used. A grinder is to be preferred to a lathe when such a machine is available. A. J. B.



Mandrel for Holding Sets of Pressure Pins while Sizing

A TAPER TURNING TOOL FOR THE AUTOMATIC SCREW MACHINE

The accompanying illustration shows a taper turning tool used in the automatic screw machine for turning taper pins. This tool, however, cannot be used where it is necessary to revolve the turret, and the feeding finger alone is used to govern the length of the stock. This device consists mainly of a base *A* held on the cross-slide, by a bolt and nut *B*, the base being located by the tongue *C*, which fits in the slot in the cross-slide. Attached to the base *A* is a member *D* which swivels on the bolt *B*. Driven into the member *D* is a pin *E* on which the bushing *F* slides. The tool-holder *G* is cut out to fit over the bushing *F*, and is held to it by two cone-pointed screws *H*. This tool-holder *G* holds the turning tool *I*, which slides freely in the member *J* held in the turret. A bushing *K* which has a hole in it of the same size as the diameter of the stock to be turned, is driven into the front end of the member *J* to support the work.



A Taper Turning Tool used in the Automatic Screw Machine for Turning Taper Pieces

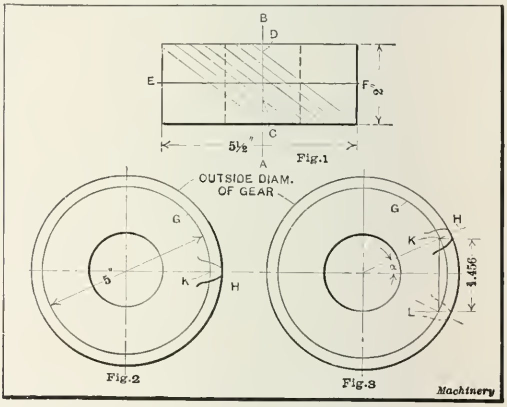
In operation, the cross-slide is held stationary, the turret alone advancing. The taper on the work is governed by swinging the member *D* to the desired angle, and when in the desired position, it is stopped by the knurled screw *L*, and clamped by the cap-screw *M*. A slot is cut in the swinging member *D* so that it can be adjusted to various angles. When the tool is set correctly, the feeding device is then set so that it will feed the stock out to the desired length. When the pin has been turned it is cut off by a circular tool held on the rear cross-slide. While the pins cut off vary slightly in length, they are close enough for most purposes.

Detroit, Mich. David Melville

DETERMINING THE LEAD OF SPIRAL GEARS

A spiral gear of 5½-inch diameter and 2-inch face was sent to the shop with the order, "Make a duplicate at once as something has happened to this one." This last assertion no one was inclined to dispute, as there was not one uninjured tooth on the gear, which, moreover, was broken into two pieces. The first requirement, in order to be able to duplicate the gear, was to find the lead of the spiral.

The usual method, to scribe a line *AB*, Fig. 1, parallel with the axis of the gear, measure with a height gage the distance between two intersections of tooth edges, as *CD*, multiply by the number of teeth in the gear, and divide by the number of tooth spaces between *C* and *D*, is not always entirely accurate in practice, although admirable in theory. In this case, this method could not be employed as the gear was so injured that no place could be found where a line so drawn would cut the edges of two teeth.



Figs. 1 to 3. Method used for Determining Lead of Spiral Gear

The man to whom the job was given drew a line *EF*, Fig. 1, at right angles to the axis and midway between the end faces of the gear. He then tied the two halves together, inserted a size plug in the hole in order to obtain a center, and with dividers scribed a circle *G* as shown in Fig. 2 on each end of the gear. This circle was 5 inches in diameter. He then put the gear on an arbor clamped in a V-groove in the vertical face of a cube-shaped piece which rested on the surface plate. If this appliance had not been available, he could have put the arbor between the centers of a lathe, laying a parallel across the shears as a base from which to measure.

Setting the height gage to the center height of the arbor and using a lens to insure all possible accuracy, he scribed in the center of each end of one tooth a radial line as shown at *H* in Fig. 2, choosing a tooth which showed line *EF* on the top of it; then, turning the gear so that the intersection of *EF* and the center line on the top of the tooth were in a horizontal plane passing through the arbor center, he measured with the height gage to the point *K* on each end of the tooth. The difference between these measurements was 1.456 inch which represented the advance of each tooth in the width of the gear face (2 inches). This advance is not 1.456 inch on the circumference of the circle but is the chordal distance KL, Fig. 3. Now the length of KL divided by the diameter of the circle G equals the sine of angle a.

$$\frac{1.456}{5} = 0.2912; \text{ hence } a = 16 \text{ deg. } 56 \text{ min.}$$

This angle is to 180 degrees as 2 is to the spiral lead L of the teeth. Hence:

$$\frac{16.93}{180} = \frac{2}{L}; \quad L = 21.26 \text{ inches.}$$

As the gear was of 12 diametral pitch, this lead gives an angle of spiral of about 38 degrees.

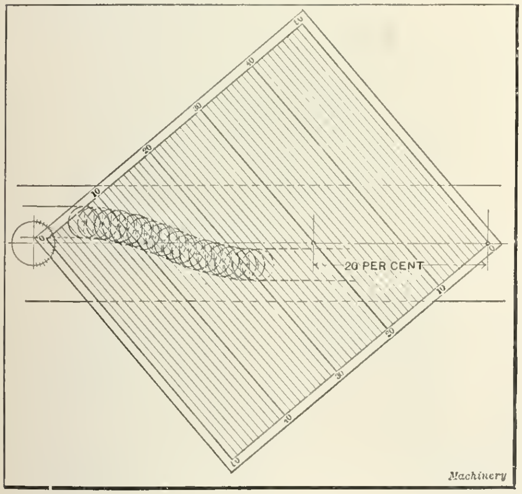
The accuracy of this method is limited only by the workman's ability to scribe and measure accurately, and with a sharp scriber in the height gage and painstaking care, very close results can be obtained. In this instance, the error was small, as subsequent correspondence with the maker of the gear showed that it had been designed for a lead of 21.262 inches, and very likely had been cut with a lead of $21\frac{1}{4}$ inches. The lead of spiral milling cutters often has to be determined in order that they may be recut. A similar method can be followed for these tools, the point K from which the measurement KL is taken being determined by the intersection of the circle drawn on the end of the cutter and the radial face of a tooth.

Guy H. Gardner

Revere, Mass.

DEVICE FOR LAYING OUT DRUM CAMS

The accompanying illustration shows a simple device which is used in laying out drum cams. The writer has found this device to be a time-saver to draftsmen and believes it will prove of interest to some of the readers of Machinery. In laying out drum cams, it is necessary to lay out the percentages of the cam movement on the center line of its lift. When doing this work in the ordinary way, the total length of the cam circumference is first laid out and then this length is divided up into percentages by some geometric method. This procedure, however simple, must be repeated for every section to be laid out.



Device for Laying out Drum Cams

The writer's method consists in having a piece of tracing cloth divided and ruled as indicated in the engraving, each tenth line being made slightly heavier than the others so as to make the counting of the divisions easier. This piece of tracing cloth is laid over the layout with the zero point at one of the ends of the line to be divided, and then the tracing cloth is swung around until the other end of the line to be divided coincides with the line on the tracing cloth numbered with the required number of divisions. The divisions to be laid out can then be pricked through onto the layout by the dividers. In the engraving is illustrated the method for laying out a 20 per cent cam movement. If two sheets are used, ruled with divisions 0.25 and 0.40 inch apart, respectively, these sheets will cover a large range of cam diameters.

Alfred Laurens

CURLING AND CLOSING DIE

The die shown in Fig. 1 is used for curling the hollow ring-shaped cup shown at A in Fig. 2 and locking the steel band shown at B within it. The punched cup shown at A, Fig. 2, is as it comes from the drawing die and trimming lathe, ready for curling and assembling with the band shown at B. The central portion of the cup A is left in place until after the assembling operation is completed, as it serves to stiffen the work and enables it to be held more securely.

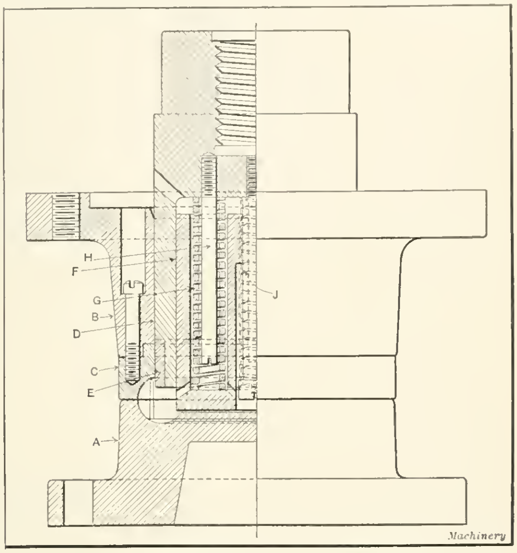


Fig. 1. Curling and Closing Die for Assembling

The base A of the die in Fig. 1 is an iron casting and is recessed in its upper surface to fit the cup, Fig. 2. As there is no rubbing or abrasive action in this die A, the cast-iron surface is of ample hardness, and saves the expense of inserting a steel ring. The upper portion of the tool consists of a cast-iron holder B, to the lower face of which is pivoted and screwed the curling die ring C, made from hardened tool steel. The closing punch-holder D is made of cast iron, bored out to receive the pressure pad F, which is acted upon by four stiff helical springs G, and is limited in its travel by the shoulder stud J.

The pilot studs H are of cold-rolled steel and are screwed into the punch-holder D for the purpose of guiding the helical springs into their pockets, and to prevent the pad F from rotating around the stud J. A steel band E is pressed onto the lower end of the punch-holder D to withstand the abrasive action to which it is subjected.

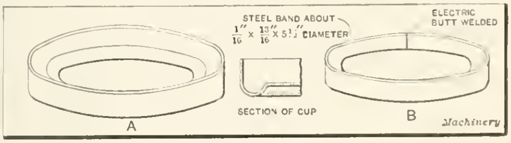

STEEL BAND ABOUT
$\frac{1}{16}'' \times \frac{13}{16}'' \times 5\frac{1}{2}''$ DIAMETER
ELECTRIC BUTT WELDED
SECTION OF CUP
A
B
Machinery

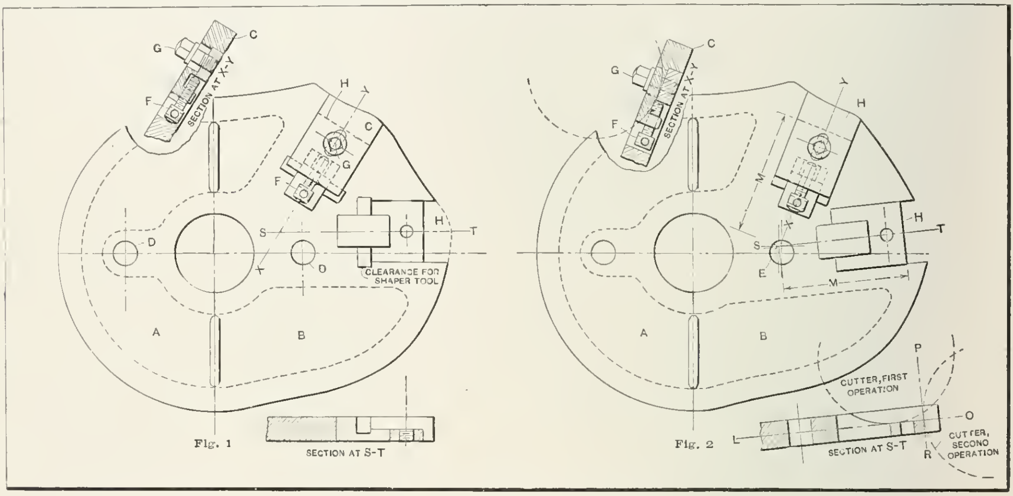
Fig. 2. (A) Cup before Curling and Closing. (B) Band to be assembled with Cup

This die is held in a double-action press and is operated as follows: The cup A, Fig. 2, is placed in the groove in the base A, Fig. 1, and the band B is dropped into the cup. The punch descends, first holding the cup securely with the pressure pad F. Then the curling die descends, closing in the top of the cup, after which the closing plunger, which comes down slightly behind the curling die, operates and locks the band securely in place. The fact that the drawing punch of a double-action press descends after the blank-holder slide, combined with the necessity of holding the work when operating, in this case with the curling die first, makes it essential to use the long-stroke pressure pad and springs.

Detroit, Mich. Aron Lawrence

JIG FOR MILLING CAM SLOTS

In Fig. 1 is shown a cam used on a knitting machine. It consists of two halves, *A* and *B*, fastened to a flange, in the position shown, by the holes *D*. Part *B* is provided with two slots which receive steel parts *C*. The latter fit exactly into the slots and may be adjusted by a hardened adjusting screw *F*. Another screw *G* is provided to hold parts *C* in their respective positions after being adjusted. These parts, however, are adjusted only at intervals, on account of the excessive wear at these points, although the adjustment also makes it possible to alter the shape of the cam to some extent when this is required.



Figs. 1 and 2. Old and New Designs of Cam

Some years ago the slots for these adjustable parts *C* were shaped and the parts made to suit, but as the cams were later used in large quantities, this method proved unsatisfactory and it was decided to mill both slots by one cutter, so as to be sure that they would be of the same width. The parts *C* were to be finished by straddle milling cutters set the required distance apart. It was then required to construct a jig for performing the milling operation for both slots in an easy and convenient manner The design of such a fixture, however, is not as easy as would be thought at first glance, since the center lines of the two slots in the cam intersect at a point which is not at the same distance from the edges *H* of the slots. In order to simplify the design of the fixture, the design of the cam was altered to that shown in Fig. 2. It will be seen that in the new cam the direction of the center lines of the slots is changed in such a way that the point of intersection *E* is at the same distance from the edge *H* of both slots. The parts *C*, however, remain at the same points on the outline of the cam.

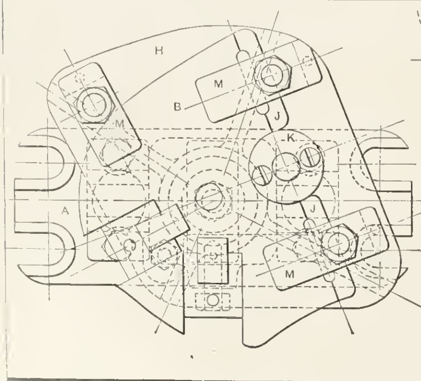


Fig. 3. Plan of Fixture

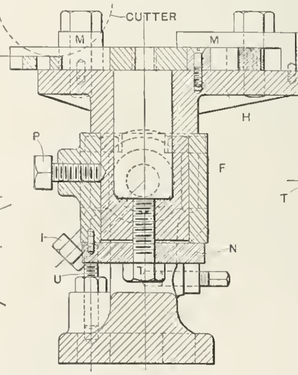


Fig. 4. Section of Fixture

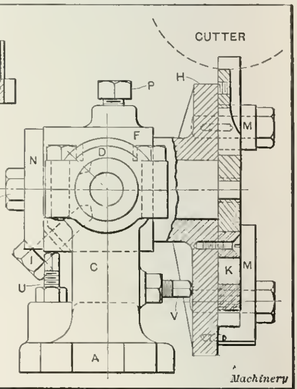


Fig. 5. Side View of Fixture

Two operations are necessary for each slot. During the first operation the cutter finishes the top part of the slot, cutting along the line *LO*, while the second operation takes care of the front part and the correct length *M*, the cutter cutting along the line *PR*. The fixture used is shown in Figs. 3 to 6, inclusive, and is used for all the milling operations. It consists of a cast-iron base *A* (see Fig. 6) with two bearings *C*, each having a removable cap *D*. A cast-iron center piece *F* swings between these bearings by means of two journals *G* extending from *F*. These journals are cast hollow to reduce the weight. In *F* a finished hole is provided at right angles to the axis of bearings *C*, to receive the cast-iron table *H*, which revolves in *F* and is provided with two projections *J* and a round steel disk *K*, the latter of which suits the bore of half-cam *B*. The cam is located by means of lugs *J* and disk *K* in such a way that the intersection point *E* (Fig. 2) of the two center lines of the slots coincides exactly with the axis *L* of the journal bearing about which it revolves.

Clamps *M* serve to hold the cam in position while it is milled. The clamps are provided with small steel pins which prevent it from turning around their bolts. The table *H* may be fixed in two positions so as to bring the center lines of the two slots into line with the cutter. The hardened center point of screw *P* fits into two corresponding holes drilled into the journal of table *H* at the proper places. The table is rigidly held to the center piece *F* by means of screw *T* and the bridge piece *N*. The latter is also provided with a small pin *S* and thus fixed in its position with relation to the center piece *F*. Fig. 6 shows the top view of the table set for the first slot, while Fig. 3 represents the same view with the table turned to cut the second slot.

After the top parts of the slots are finished, the latter must be cut to the correct length, finishing the front part at the same time. To do this, the set-screw *I* is loosened and the center piece and table are swung around 90 degrees. In the first position, shown in the side-view section, Fig. 4, the center piece rests upon a screw *U*, while the top part of the slot is finished. When it is swung over, however, it rests against screw *V*, Fig. 5. Countersinks to suit screw *I* are drilled in the left side of the journal of the center piece *F* at the correct angles. The axis of *F* is arranged in such a way that the fixture is at once ready for the second operation, and no resetting of the cutter is necessary. To cut the front part of the second slot, table *H* is simply revolved as described before. It will be seen that in this way all the operations can be carried out rapidly and conveniently and without resetting the cutter or re-adjusting the milling machine table.

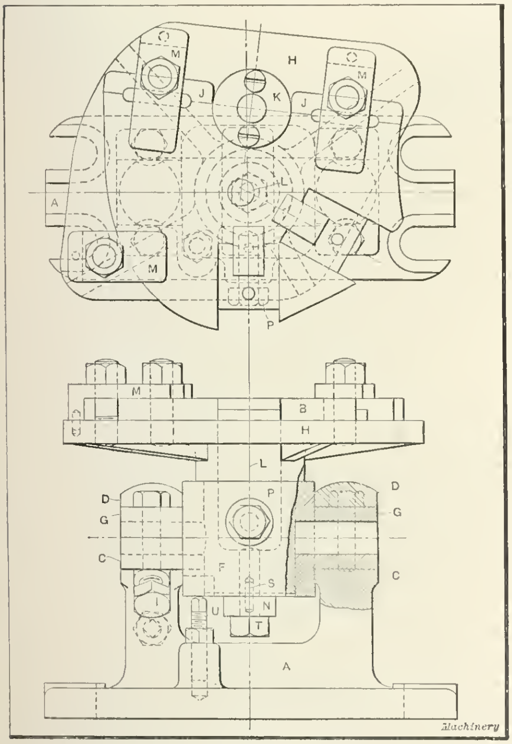


Fig. 6. Plan and Front View of Fixture

Wyomissing, Pa. CHRISTIAN F. MEYER

REPAIRING A CRACKED WATER JACKET

In the April, 1910, number of MACHINERY, a method of repairing a cracked water jacket of a gas engine cylinder was illustrated and described. In the following is given a different method for making repairs of a similar nature.

On the line of the fracture, drill and tap for a 3/8-inch threaded copper rod. This rod is screwed in firmly to a depth about equal to the thickness of the metal of the water jacket. Cut off the copper rod with a hacksaw, allowing it to project about 1/32 inch; then drill succeeding holes, each hole being drilled partly into the previously inserted copper plug, so that when all of the plugs are placed in the cylinder casting, they form a continuous band of copper along the line of the fracture. The copper plugs should now be peened down and trimmed off flush. The only possible chance for leakage, after having repaired the crack in this manner, is for the water to follow the joint between the metal of the jacket and the copper plugs, but, as the copper rods are threaded into the casting, it is not likely to occur. Should leakage take place, a little extra peening will suffice to prevent it.

Wilmerding, Pa. E. R. GROMAN

SEASONING CAST IRON

In response to the question in the "How and Why" section in the June number of MACHINERY, the writer would offer the suggestion that the best solution lies in so designing the parts that seasoning is either no longer necessary or so that the time required would be considerably reduced.

Every foundry-man knows that badly proportioned castings, that is, castings in which the metal cools at different rates, are subject to greater distortion than well proportioned ones. When cold, the stresses in the parts which cooled first are particularly severe, since added to their own stresses are the stresses due to contraction of the last cooled parts. Hence, if in any way an equal rate of cooling can be induced, castings less internally stressed will result. In the first instance, then, it is to the designer one must look for the cure, or rather the prevention. Let him see that the thick parts are reduced to the utmost possible extent, and then balanced by equally thick parts directly opposed. In certain cases the molder can influence the result by baring the thicker parts after solidification. He can also cast in proximity to the thin parts masses of metal to retard the cooling. The writer has often adopted this method. One case which migh be cited involved pulleys with a very thin rim, in which case a ring of metal was cast surrounding but not touching the rim. In another case of long angle bars, two bars of metal were cast along the two edges.

By any of these means the internal stresses are reduced; hence, their effect when metal is removed will be less also. But having attended to all these half remedies, there is another possibility. Take, for instance, a lathe bed, which by the best firms is always subjected to the ageing process. The top is planed and stresses are thereby released. It would, perhaps, be more correct to say that the metal under the severest stress is removed, and the planed surface is distorted by the pull from the metal at the opposite, that is, the bottom side. Why not remove an equal quantity of metal at the opposite side and so neutralize the effect? This is again a matter for the designer. As a rule, in a lathe bed, it is necessary to turn the bed over to plane the seatings for the legs. Why not extend the leg seatings the whole length of the bed? Then, before planing, lay out so as to insure an equal cut on both top and bottom. The writer has, in some instances, adopted this practice with the result that it was no longer necessary to season. FRANCIS W. SHAW

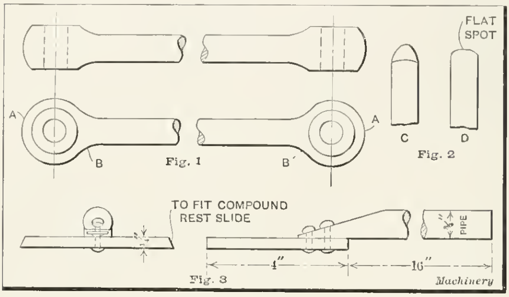
Manchester, England

SPHERICAL TURNING

The spherical turning device described by Mr. C. Boella in the July number of MACHINERY, is probably good for the class of work for which it was designed, but the fixture is expensive and there are many classes of work that can be produced cheaper and simpler by the method described in the following.

In a large air-compressor plant where a great deal of spherical turning is done, various devices have been tried and discarded in favor of the simple method of using the compound rest as a spherical turning device. An example of the work done is shown in Fig. 1. This illustration shows a Corliss valve driving-rod having spherical surfaces turned at the ends *A* and fillets at *B*. When turning these, the compound rest on the lathe is set so that the point about which it is swiveled is vertically beneath the center of the spherical section to be turned. The rest is then oscillated or swiveled so as to turn a spherical surface. The tool can be set at once to the desired radius when forgings are being turned having only a small allowance for finish. When, however, it is desired to take two cuts, the feed of the compound rest can be used for feeding in the tool for the second cut.

In order to be able to oscillate or swivel the compound rest, the binding screws are loosened enough so that an easy working fit is produced. The feed handle is removed and the operator uses the end of the compound-rest feed-screw as a means for swiveling the rest about its center, feeding the tool slowly around the work. Some operators reverse the compound rest so that the feed handle is at the back of the lathe, and then use a handle as shown in Fig. 3. This consists merely of a piece of steel beveled to fit the slide in the rest and having a ¾-inch pipe about sixteen inches long riveted to it. This handle is inserted in the compound-rest slide and the pipe acts as a lever arm making it easier to swivel the slide about its center. In machining the fillet *B*, Fig. 1, the tool point, of course, must be moved past the swivel center of the compound rest.



Figs 1 to 3. Work requiring Spherical Turning, and Tools used

The points of the cutting tools are shown in Fig. 2, where *C* shows an ordinary round-nosed tool which is used for roughing cuts, and *D*, a finishing tool. This is ground off to a comparatively large radius and is flattened off about 3/32 inch at the end. This tool, with soda solution as a cutting lubricant, finishes and polishes the work in one operation.

New Britain, Conn. J. M. Henry

CUTTING TWELVE TEETH IN A THIRTEEN-TOOTH BLANK

In the June number of Machinery, engineering edition, Mr. G. R. Hulsberg, in commenting upon Wuest herringbone gears, takes exception to some of the methods adopted in calculating and cutting these gears. He concludes as follows:

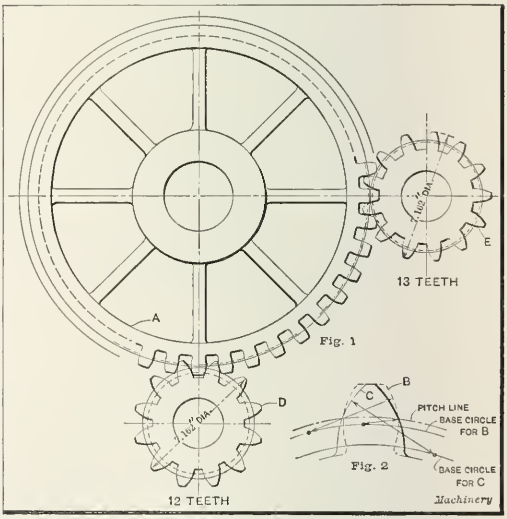
> "Furthermore, in order to keep the center distance to some even dimension, the author simply reduces the pitch diameter of the gear to suit the center distance. By doing this, and keeping all the other quantities the same as before, the pitch of a gear is changed without changing the pitch of the pinion; hence, the gears will not mesh perfectly. The difference may be small, but interchangeability cannot be claimed on this basis."

The writer's experience with involute gearing indicates, however, that this supposition is not correct, and that, in fact, the diameter of the gears may be varied considerably from the calculated diameters without affecting the running qualities in the slightest degree, provided the proper method of forming the teeth is used. Some time ago a number of old planers were renovated, and, among other things, it was necessary to provide a complete set of new gearing and racks. The rack pinion was of mild steel, 13 teeth, 1½-inch pitch; the face width was 9 inches, the bore 3¼ inches, and the total length of bore 21 inches. It will be readily understood that the machining of the blank for this pinion from a solid 7¼-inch diameter steel bar involved considerable work, and that the finished gear was a fairly valuable piece. After the blank had been bored and turned the next operation was the cutting of the teeth. This was done in a gear-cutting machine, two cuts being taken.

Unfortunately, when gearing the indexing motion of the gear-cutting machine, the operator made one of those mistakes which seem almost inexplicable after they are discovered—he geared the machine for twelve teeth instead of for thirteen, and did not discover the error until one-half of the spaces had been roughed out. At first it seemed as if the only thing to do was to discard the blank and start on another. The writer remembered, however, that if a gear was cut in a generating machine (as distinct from a formed cutter machine) variations in the blank diameter were, within limits, unimportant. In fact, it is a recognized practice in some classes of work to increase the diameters in order to give the pinion teeth increased strength and durability. One firm in the town where this work was done had a generating machine large enough to cut pinions of the size mentioned. Arrangements were made with this firm, and in a few hours a finished gear was completed from the blank which had seemed to be only fit for the scrap heap. In fact, the pinion finished with twelve teeth was a better job than if it had had the full complement of thirteen teeth, as originally intended.

It may be suggested that the pinion could have been turned down to the correct diameter for twelve teeth and the teeth cut in the usual way. This, however, would have required another bull gear, and would also have left very little stock at the bottom of the teeth. Of course, the ratio of the gearing was affected by this alteration, but this was allowed for by a slight change in one of the other pairs of gears.

At *E* in Fig. 1, the pinion is shown as originally designed; *A* is the bull gear, and *D* is the pinion as actually made with twelve teeth. The dotted circles just inside of the pitch circles, in each case, represent the tooth curve base circles. It will be seen from Fig. 2 that the teeth of gear *D*, shown by full lines *C*, are stronger than the teeth of gear *E*, as shown by the dotted lines *B*. In this particular example we have the apparently paradoxical situation of a gear having 1½-inch pitch teeth accurately meshing with a pinion having 1⅝-inch pitch teeth, but there is no doubt whatever that if gears are cut by the generating process a slight variation in diameter makes no difference in their smooth working.



Figs. 1 and 2. Comparison of Tooth Forms in Pinions of Same Diameter with Twelve and Thirteen Teeth

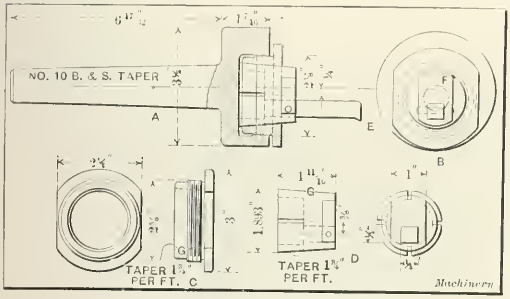
In conclusion the writer might mention that this twelve-tooth pinion has been in operation for about a year and the tool marks are still visible on the teeth. This is a good indication of the durability of the teeth when it is considered that the pressure on the teeth is about 9000 pounds during the cutting stroke and about 5000 pounds during the return stroke.

G. Ear

IMPROVED DESIGN OF BORING-TOOL HOLDER

The accompanying illustration shows a jig-boring tool that requires no set-screw to hold the tool. The use of set-screws, unless of the headless variety or those which do not project, is to be avoided in designing moving parts of machines or tools.

Referring to the illustration, *A* is the front elevation, shown partly in section; *B* is the end view of the assembled tool; *C* is a detail view of the locking nut; *D* shows the tool sleeve and *E* the tool, which can be made of any convenient dimension to suit the work. The shank of the tool-holder is tapered to fit the milling machine spindle. The head of the holder is bored with an eccentricity of ¼ inch, and the square hole through the tool sleeve is also ⅜ inch off center. The circle *F* shows the amount of adjustment possible with the tool, which in this case is ¾ inch. The tool *E* is held in the tool sleeve by a taper pin.



Improved Design of Boring-tool Holder

In operation, this boring tool is similar to any other boring tool, except for the manner of varying the amount of eccentricity. This is accomplished by loosening the retaining nut, turning the tool sleeve and tool slightly, and tightening the sleeve again. The pressure of the retaining nut upon the tool sleeve holds the tool firmly, thus insuring an accurate cut.

Providence, R. I. Robert Mawson

AN EFFICIENT ANGLE-PLATE FOR JIG WORK

When boring out jigs which require being clamped to the faceplate as well as to the angle-plate, strains are set up in the jig, so that when removed to drill a cross-hole, it will be found difficult to get the two holes in perfect alignment. An angle-plate which eliminates clamping strains, and does away with the necessity of clamping the work to the faceplate is shown in Fig 1. This plate differs from the ordinary plate only in that it is provided with a clamping bolt *A*, strap *B*, and is planed out on the front end as shown, so that the jig will have a seat or shoulder to bear up against. A jack consisting of a stud and nut *C* is also provided to block up the strap.

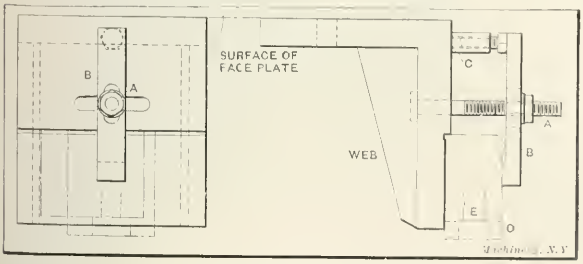


Fig. 1. Efficient Angle-plate for Jig Work

A jig which illustrates the application of this angle-plate is shown in Fig. 2, this being used for drilling and reaming a hole through a round bar. This is a simple jig, and is shown merely to illustrate one use of the angle-plate. In Fig. 1, the dot-and-dash lines *D* indicate the jig block in position for drilling, boring and reaming the large hole *A* in the jig, Fig. 2, while the dot-and-dash lines *E* show the jig block in position for drilling the small holes *B* in the jig Fig. 2. It is important when clamping the jig block to the angle-plate, that the block when changed from one position to the other should always have the same side in contact with the angle-plate, thus insuring that the holes will be in perfect alignment. John R. Jarvis

New Haven, Conn.

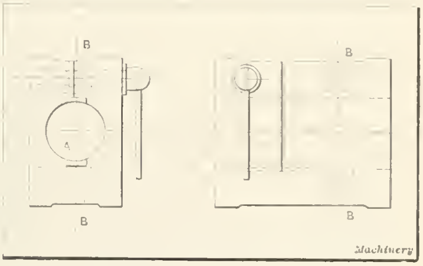
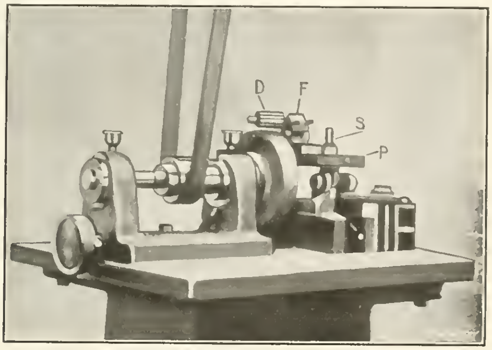


Fig. 2. Block Jig Illustrating Application of Angle-plate in Fig. 1

EMERY-WHEEL TRUING DEVICE

The grinder shown in the accompanying illustration is used for grinding a special edge tool made in large quantities, the tools being gripped in a fixture reciprocated on the table *P*, the table being set at just the right height to clean up the face of the tools as they pass by the grooved surface of the wheel. These tools are ground with their faces straight and parallel within 0.001 inch, and hence the horizontal planes of the wheel, fixture, and table must be parallel. It was found that an adequate device must necessarily be provided for truing the wheel.



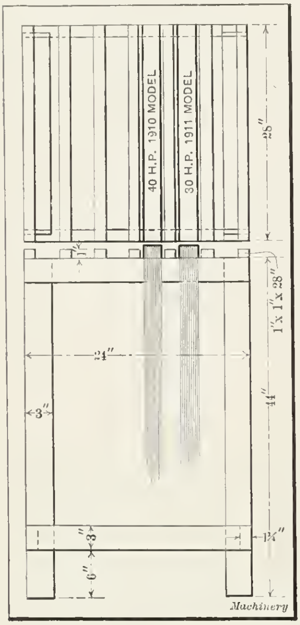
Device for Accurately Truing Emery Wheels

The table *P* swings about a horizontal axis through a short arc, and is held in position by lock-nuts on the stud *S*. The adjustment permits the wheel to be followed up at the predetermined distance as its face wears off. No diamond was at hand for the truing of the wheel, and an ordinary emery-wheel dresser was out of the question for producing a straight parallel surface with sharp corners. The device shown in the illustration was, therefore, made, consisting of the cast-iron base *F* which is quickly attached to table *P* by thumb-screws, a half-inch shaft, and the dresser *D* which is made of a piece of carbon steel having a U. S. standard thread cut on its exterior, and then slotted longitudinally so that an end view has the appearance of a star wheel with sharp points. This tool is hardened but not drawn, and the hole in it is lapped to fit the shaft. When the base is attached to the table, the latter is lowered by the adjusting nuts until the wheel just touches the dresser, the machine being in motion. The dresser is then fed across the face of the emery wheel a couple of times. This device has proved very satisfactory, and produces a straight, sharp-cornered free-cutting face.

Middletown, N. Y. Donald A. Hampson

DRAWING CABINET

The accompanying engraving shows a cabinet or rack for holding drawings or blueprints that have been bound together in volumes and are used regularly in the shop. It is simple in construction, but answers the purpose better than many more elaborate drawing cabinets and racks. It does not take a great deal of floor space, as the drawings are hung in a vertical position, while in most cabinets the drawings are laid flat, in a horizontal position. The title of each set of drawings is written on the back of the cover, so that it is always in plain sight and easily read. The top of the rack can be used as a reference table, it being level and of the proper height for that purpose. The construction of this rack is so simple that it can easily be made by any ordinary carpenter. The dimensions can be arranged to suit the conditions.

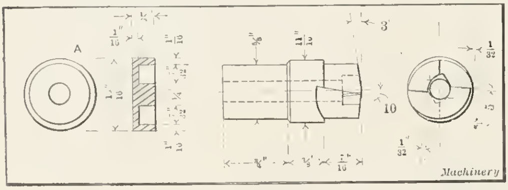


Useful Rack for Bound Volumes of Blueprints

Providence, R. I. **Robert Mawson**

COMBINATION HOLLOW MILL AND COUNTERBORE

The accompanying illustration shows at *A* a section of a part made on the screw machine which, at first, appears to be a rather "mean" job. It will be seen that the recess is not very wide and the principal difficulty, obviously, is that when running at anything like an economical feed, a tool point small enough to do the work would spring slightly, cramp and break off. Having tried several forms of cutters, the two-toothed mill shown was finally adopted and has given excellent results. It will be observed that one tooth cuts the outside of the recess, and the other finishes the cylindrical surface of the hub. Thus, with each tooth finishing a surface of its own, there is no cramping action. By having only two teeth, it is possible to make them strong enough to stand up and cut to size without springing. The large body of the tooth serves at the same time to rapidly dissipate the heat generated. The face angle is five degrees, the clearance three degrees, and the rake ten degrees. The work was done on a No. 2 Brown & Sharpe automatic screw machine.



Combination Hollow Mill and Counterbore and Piece made by it

P. A. Fredericks

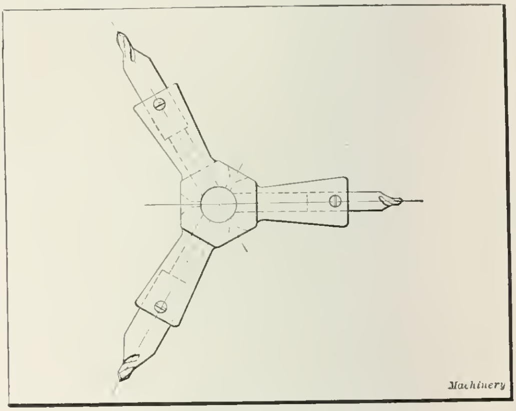
ERASING INK MARKS FROM TRACINGS

Inked-in tracings are easily discolored, marred and sometimes ruined through lack of proper treatment when making changes, but disfigurement of the tracing is not at all necessary if the alterations are made in a suitable manner. The above-mentioned faults can be avoided by observing the following rules. Always allow the ink to dry thoroughly, and do not use a blotter. In rubbing out, constantly turn the eraser so that different edges will be presented to the drawing. Using one portion of an eraser heats it up, and it will soon burn a hole in the tracing. After erasing a line or other inked-in part, rub the section slightly with soapstone. This will restore the finish to the cloth and prevent the ink from spreading. A small piece of soapstone will last an indefinite length of time and should be in every draftsman's kit. It is far superior to a knife handle and other similar contrivances which are sometimes used for this purpose. The above method of erasing will be found efficient if used with discretion.

Los Angeles, Cal. **L. R. W. Allison**

A CENTER REAMER HOLDER

A center reamer holder which will be found useful in connection with lathe work is shown in the accompanying illustration. It saves the trouble of chucking the center reamer every time it is necessary to drill a center in the end of a piece. The holder is held up against the tailstock center of the lathe and the reamer fed into the work. The three holders make provision for accommodating center reamers of various diameters. The holder itself can be made from a 3½-inch round bar by cutting it off to the required thickness and then milling and turning it to form the three arms. Holes to suit the shanks of the center reamers can then be drilled, and 5-32-inch screws supplied for holding them.



Holder for Various Sizes of Center Reamers

C. E. D.

CUTTING WORMS OF STEEP PITCH IN THE LATHE

When cutting worms of steep pitch in the lathe, it is sometimes found impossible to drive the lead-screw through the usual train of gearing on account of the heavy stress that is placed on the first gear in the train, which frequently strips the teeth. The writer has overcome this difficulty by driving the lead-screw directly from the cone gear, using an attachment which would permit of this. The back-gears being in use, the cone on the lathe referred to had a velocity ten times that of the spindle; with the cone gear used as the driving gear in the train for the lead-screw, this had then ten times the velocity that the driving gear would have had if the drive were through the usual gearing. Hence, the stress on the teeth was proportionately reduced. Assume that a worm having 3½-inch lead is to be cut with a lead-screw having four threads per inch. The ratio of the spindle speed to that of the lead-screw is 14 to 1, but, by driving directly from the cone gear, the ratio will be 14 to 10, which makes it easy to obtain the gears; in fact, some leads could not be cut in any other way, as it would not be possible to obtain the required ratio by the gears available.

Brooklyn, N. Y. **George E. Owen**

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

AMERICAN TOOL-ROOM LATHE

The American Tool Works Co., Cincinnati, Ohio, is manufacturing a new design of high-duty tool-room lathe, which is made in 14-, 16-, 18- and 20-inch sizes. These lathes have many features common to the standard design built by this company, including the drop-V bed, double-plate apron, quick-change mechanism giving 48 thread and feed changes, phosphor-bronze bearings, etc. In addition, the lathe is fully equipped with the various attachments required for tool-room work, such as taper, draw-in, and relieving attachments. It also has a pan for retaining the lubricant, as shown by the accompanying illustration Fig. 1. In case all of the attachments mentioned are not needed, any one of them can be furnished separately.

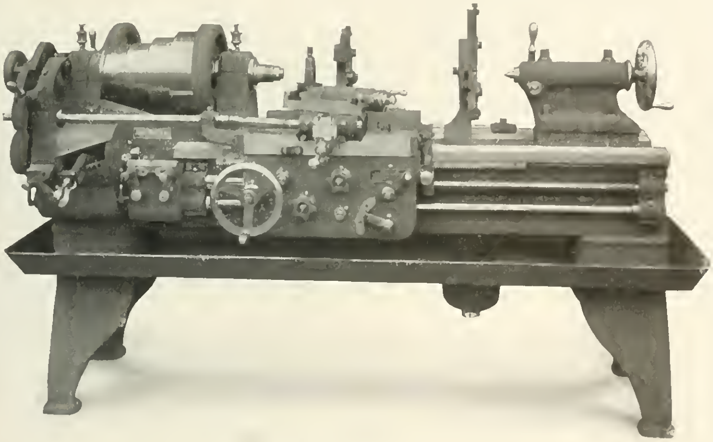


Fig. 1. American High-duty Tool-room Lathe

The taper attachment is simple, both in design and operation, and it is rigidly constructed, thus insuring accurate work. The attachment is bolted to and travels with the carriage, and can be engaged quickly at any point along the lathe bed, by simply tightening one binding nut on the clamping dog. When arranged for taper work, the sliding shoe is directly connected with the bottom slide of the tool-rest by a heavy cast-iron yoke which may be seen in Fig. 2. This construction eliminates lost motion and insures accuracy. The nut for engaging the sliding shoe is arranged to slide in a slot in the connecting yoke, and it is attached or released by tightening or loosening a single screw. Accurate graduations are provided and there is a hand-screw having a graduated collar for obtaining fine adjustments.

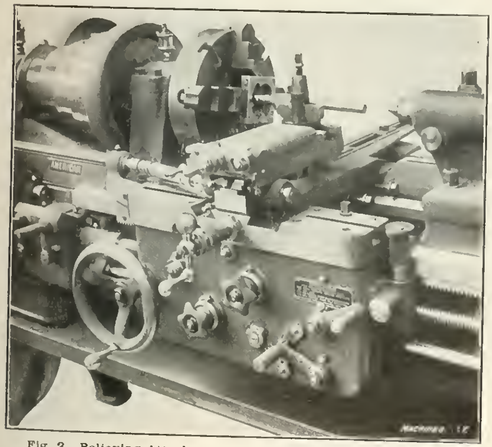


Fig. 2. Relieving Attachment of American Tool-room Lathe being used for Internal Work

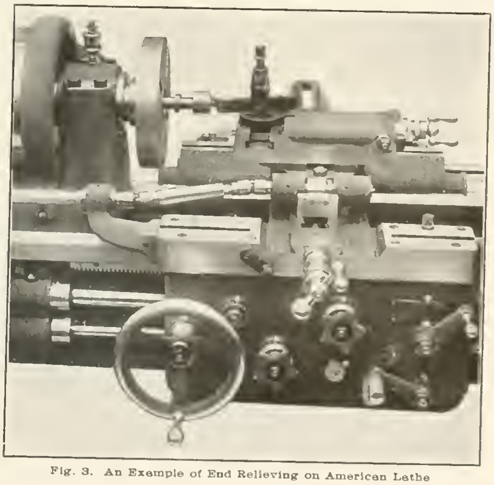


Fig. 3. An Example of End Relieving on American Lathe

The relieving attachment is applicable to relieving or backing off the flutes of cutters, taps, reamers, end mills, hollow mills, dies, etc. This attachment is universal in its operation, and end or internal relieving can be done just as easily as straight work. It has a direct drive and is of simple construction. The change-gear mechanism is supported by a bracket located on top of the quick-change gear-box, as shown in Fig. 1. The change gears are carried by a small quadrant which is used to disengage the drive when not required.

The power is derived from a spur gear located on the end of the main spindle, and motion is transmitted through the change-gear mechanism to the driving shaft which extends through the supporting bracket on the quick-change gear-box, and is journaled at the other end in a bracket fastened to the left side of the carriage as shown. Between the carriage bracket and tool-rest there is a universally jointed telescoping shaft which permits cross movement of the tool-slide.

The driving shaft revolves constantly in one direction until the rotation of the spindle is reversed, at which time the driving shaft ceases to reciprocate the tool-slide; consequently, the latter remains stationary when the direction of the carriage travel is reversed while the half-nuts are engaged. This feature is obtained by interposing a clutch connection between the cam and driver, which is operative in one direction only. Therefore, the reversal of the driving shaft causes the clutch, which is held into engagement by a spring, to be withdrawn from the cam with the result that the cam remains stationary. In order to cover the entire range shown by the relieving attachment index plate, three cams having one, two and four rises, respectively, are provided in addition to the change gears. These cams can readily be interchanged, and they run in an oil bath.

This attachment permits the tool-slide to be operated at positions 30 degrees apart, thus providing twelve operating positions within a circle. This feature makes it possible to relieve side cutters, end mills, and various other tools. Fig. 2 shows the lathe being used for internal work and Fig. 3 its application to end relieving. Aside from adjusting the tool-slide to its proper position, no change or re-adjustment of the mechanism is required for internal or end relieving. Convenient means are provided for obtaining the various degrees of relief for either external or internal work. Adjustment is made at the front of the tool-slide by means of a thumb-screw, and the depth of relief is indicated by a graduated scale. This attachment can be applied and operated independently of the taper attachment.

A standard compound rest is furnished in addition to the special relieving rest, the former being recommended for general work. The compound rest can quickly be interchanged with the special tool-slide. The attachment can be arranged for relieving taps or hobs having spiral flutes by the addition of extra gears. In the construction of this attachment high-grade materials are used throughout. The cam yoke is forged and the cams, cam shoe and crank members are of tool steel, hardened and ground. The index bar in the top slide is of forged steel, and all shafts and gears are well proportioned. All gears are covered for the protection of the operator.

The draw-in attachment furnished with this lathe can be equipped with collets for holding stock up to ⅞ inch diameter on the 14- and 16-inch sizes, and up to 1 inch diameter on the 18- and 20-inch lathes.

COMBINED DOUBLE-HOUSING AND OPEN-SIDE PLANER

The planer illustrated in Figs. 1 and 2 was built for the Gas Traction Co. of Minneapolis, for planing the engine base castings used by that company in the manufacture of tractor engines. These bases require planing on the bottom, top and on both angular sides, as well as on the ends. As they are over six feet long, a standard planer, if used for planing the ends as well as the other surfaces, would, of course, have to be wide enough to permit the casting to pass between the housings, unless some form of extension tool were used, which would be undesirable. As the castings have a width of less than three feet at the top, the planing of the sides on such a wide planer would be objectionable, because of the distance to which the side-heads would have to be extended. Moreover a rigid support for the tools was desired to permit taking heavy cuts when planing the angular surfaces.

The planer illustrated herewith was especially designed for this work by Mr. C. C. McConville (general superintendent of the Gas Traction Co.), assisted by the engineering departments of the Rockford Machine Tool Co. and Jos. T. Ryerson & Son. This machine has two heads on the cross-rail, two side-heads and, in addition, an auxiliary housing carrying a single head and located approximately four feet in front of the main housings. The engine bases are machined by first planing them on the bottom, two castings being finished at one setting. They are next mounted one at a time on a fixture which is pivoted in the center and can be accurately located in the different positions required by a heavy stop-pin. This fixture with an engine base mounted on it, is first placed parallel with the planer table and the top and two angular sides of the work are planed simultaneously. Fig. 2 shows the special tool bars or holders which are attached to the standard side-heads for this operation. This view also clearly shows the brackets which are clamped to the housings to provide a rigid support for the tool bars directly back of the cutting tools. After the sides are planed, the fixture carrying the castings is swiveled to a right-angle position and the end of the casting is finished by means of the head mounted on the auxiliary housing. This housing, which is shown in detail in Fig. 3, is located back far enough to permit the casting to clear it without changing the position of the work.

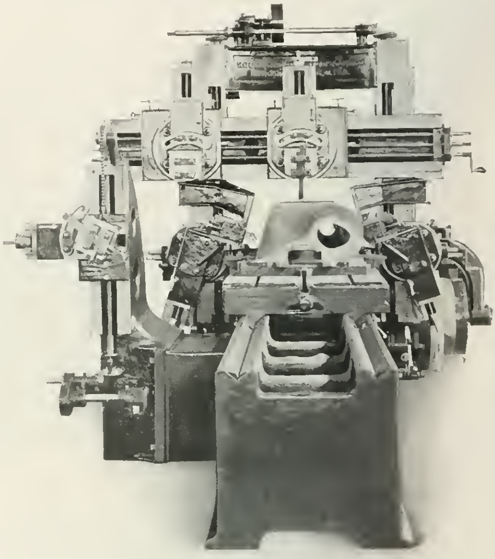


Fig. 2. End View of Combined Double-housing and Open-side Planer

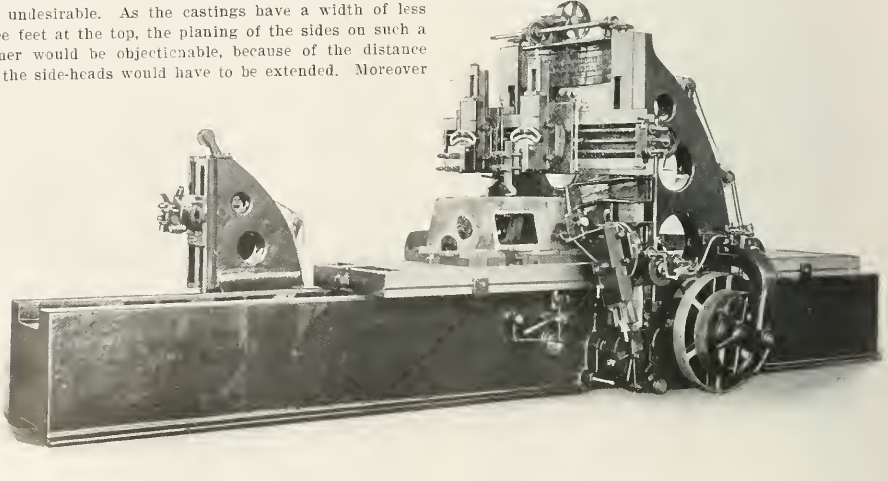


Fig. 1. Special Planer built by Rockford Machine Tool Co., Rockford, Ill.

The bed of this planer is a deep pattern, thoroughly braced by box form cross-girders, and it is further strengthened where the gearing and uprights are mounted. The length is such that there is very little overhang of the table when planing on full stroke. The table is of unusual thickness and the T-slots are exceptionally deep and planed from the solid. The cross-rail is of extra depth, and the down feed to the heads is unusually long. The saddle is graduated in degrees around the entire circle for angular adjustments. The side-heads are provided with vertical, horizonal and angular power feeds, and can be run below the top of the table when not in use. The down feed screws have micrometer dials, which are very convenient for making rapid and accurate adjustments for depth of cut. The shifting device is simple and is designed to transfer the belts quickly and noiselessly. There are shifter levers on both sides of the planer so that the operator can control the motion of the table without walking around the machine. Aluminum driving pulleys are used and all feed racks, pinions, and driving gears are of steel.

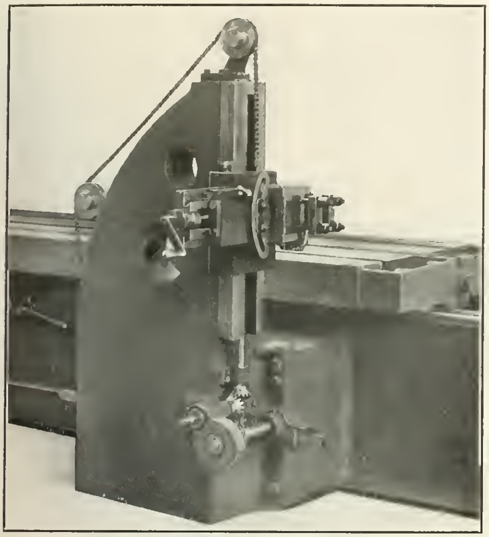


Fig. 3. Auxiliary Housing of Planer shown in Fig. 1

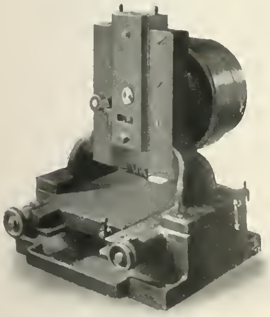


Fig. 1. Slotting Machine built by Swind Machinery Co.

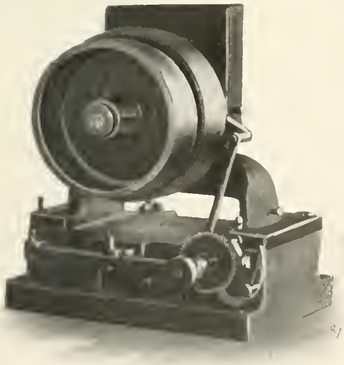
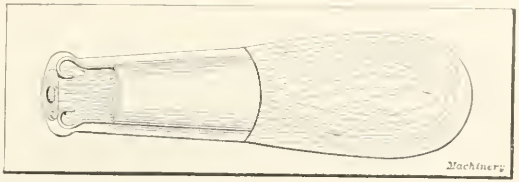


Fig. 2. Rear View of High-speed Slotting Machine

REINFORCED FILE HANDLE

The file handle illustrated herewith is a non-splitable type just placed on the market by the Doane Mfg. Co., Boston, Mass. This handle has a heavy pressed-steel ferrule which is enlarged at the end and curved inward as shown by the sectioned part of the illustration. When the ferrule is driven into place the end of the handle is locked within the enlarged or beaded end. These handles are made in five different sizes. The smallest size takes files from 4 to 6 inches, whereas the largest size takes 18- and 20-inch files.



Non-splitable File Handle

HIGH-SPEED SLOTTING MACHINE

The slotting machine, front and rear views of which are shown in Figs. 1 and 2 respectively, was designed for slotting keyways in milling cutters and small parts such as are used in the manufacture of motorcycles, firearms, typewriters, sewing machines, etc. This machine has a vertical tool-slide and a horizontal work-slide which is gibbed in the body of the machine and serves as a fixture for holding the work. By turning a small handle in the front of the machine, this slide can be removed whenever it is desired to replace it with another slide or fixture especially designed for a given class of work.

The feeding movement, as well as the relieving of the tool, is accomplished automatically by the motion of the work-slide. This slide is advanced for feeding the work to the tool, in intermittent steps between which there is a short reverse motion for withdrawing the work from the tool during the upward stroke. This feeding movement and reverse motion is derived from the tool-slide, which has two lugs on the left side as shown in Fig. 1. These lugs alternately engage a short lever or finger attached to a rockshaft which, in turn, is connected with the feed mechanism by a vertical rod, as shown in the rear view.

The action of the feed mechanism is as follows: When the tool-slide reaches the end of its downward stroke, the upper lug strikes the finger of the rock shaft, thus imparting a vertical reciprocating motion to the rod in the rear. This rod has a cam-shaped end which transmits the motion to a horizontal feed bar and the latter, in turn, gives a reverse movement to the tool-slide for relieving the tool on the upward stroke. When the top of the stroke is reached, the lower lug on the tool-slide engages the finger of the rock shaft and the resulting motion operates a ratchet and pawl mechanism, which, in connection with a screw on the feed bar, serves to advance the work-slide automatically a distance equal to the feed desired.

The feed mechanism has an automatic stop which can be set for any predetermined depth of cut and enables parts to be duplicated within close limits. The tool-head or slide is made of steel and is carefully scraped and gibbed. The vertical motion for the slide is obtained from a crank and connecting-rod driven by the two step cone pulley in the rear. This machine has a capacity for cutting 3/8-inch keyways in cast iron and 5/16-inch keyways in steel. The maximum length of stroke is 2 inches, and a bench space of 16 by 16 inches is required. It is manufactured by the Swind Machinery Co., Bourse Bldg., Philadelphia, Pa.

EXTENSION HACKSAW FRAME

The hacksaw frame shown in the accompanying engraving is a style just placed on the market by the West Haven Mfg.

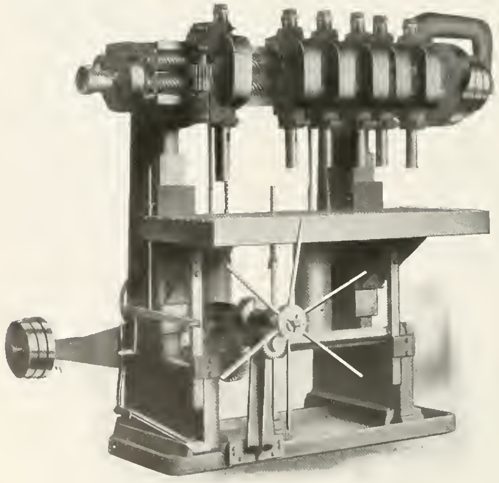
Co., New Haven, Conn. The back of this frame, instead of being collapsible, is made of a solid piece of 3/4 by 3/16-inch cold-rolled stock, thus eliminating any buckling action. The handle of this new frame is another noteworthy feature. It is molded from a special composition and is made to fit the hand so as to give an easy, natural grip. The frame is polished and nickel-plated and can be adjusted for blades varying from 8 to 12 inches in length.

West Haven Mfg. Co.'s Hacksaw Frame

MOLINE BORING AND DRILLING MACHINE

The Moline Tool Co., Moline, Ill., has added to its line of drilling machinery a No. 12D heavy type boring and drilling machine adapted for rod boring and similar work. This machine has the double spiral drive which is regularly used by this company, but instead of having the lower spindle bearing vertically adjustable, the spindles run through the lower bearing full size. The lower bearing is bronze bushed and split so that the spindle wear can always be taken up, making in effect a lathe spindle construction. The spindles can be adjusted vertically by means of the upper bearings which are threaded, and they are equipped with ball-thrust bearings.

The heads are planed and scraped to an exact thickness and they can be equipped with tie-rods and spacer washers for setting them accurately to any distance along the rail. This is not necessary, however, for the general run of work, as the heads can be securely clamped in any position. The spindles can be furnished with the Morse taper extending entirely below the bearing and with a regular driving slot for moving the drills, or with short hollow spindles so that a knockout rod can be used. In the latter case, the Morse taper extends up into the bearing. The spindle shown at the left is back-geared for extra heavy boring.



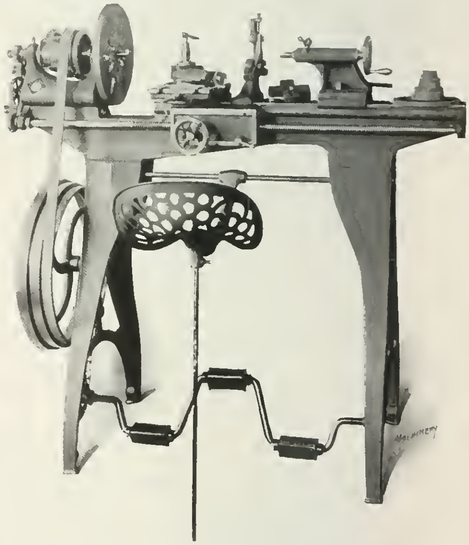
Moline Heavy Type Boring and Drilling Machine

As the illustration shows, the cone pulley is provided with an outboard bearing. A plain table having five T-slots is recommended for cast iron work, but for steel a table that has three T-slots and is entirely surrounded by an oil groove, is furnished. In either case, the table is counterbalanced and it is fed by double, steel racks and pinions. The pinions are cut integral with the feed shaft and the latter is driven by steel and phosphor-bronze 4-pitch spiral gears. The table is provided with an automatic trip, a spring down stop and a positive depth gage. The hand feed is back-geared, and for facing operations the automatic trip can be set to disengage slightly ahead of the depth gage, for feeding the table up to the positive depth gage stop by hand. By pulling the pilot wheel out, a quick return is secured for the table.

BARNES NO. 5 GAP LATHE

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., is now manufacturing a No. 5 gap lathe of 11–15-inch swing. The particular lathe shown in the accompanying illustration is equipped with a foot-power drive, but a friction-clutch countershaft can also be furnished for power driving. This lathe is a screw-cutting type and the change-gears provided can be combined for cutting threads ranging from 4 to 40 per inch. In addition, other pitches not given on the index-plate can be cut.

The carriage has a compound rest, and the tailstock is the offset type which permits the compound rest to be set parallel with the bed. The compound table has transverse T-slots for clamping parts that require boring or milling operations. This is a very convenient and valuable feature, especially when the lathe is to be used for a wide range of work. The headstock boxes are accurately fitted to the spindle and provision is made for taking up wear. The spindles of both head- and tail-stocks are of steel and have accurate taper holes for the reception of the centers. The gearing is accurately cut from the solid, and the works are carefully protected from chips and dirt.



Barnes No. 5 Gap Lathe

The No. 5 gap lathe is made in one style only and with one length of bed. The swing over the bed is 11 inches; over the tool carriage, $6\frac{5}{8}$ inches, and in the gap, 15 inches. The width of the gap from the faceplate is 5 inches, and the maximum distance between the centers, 29 inches. The net weight of the lathe is 500 pounds.

LEBLOND HEAVY-DUTY CONE-TYPE MILLING MACHINE

The R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, has brought out a new line of cone-type milling machines. Figs. 1 and 2 show the side and front views, respectively, of a No. 4 size of the plain type. The distinctive feature of this design is that the machine is essentially right-handed. A study of productive and non-productive movements resulted in placing all the controlling levers on the right-hand side and grouping them for right-hand manipulation. The operator can control every function of the machine without changing his position, unless the range of a machine is so large as to make this impossible.

The column is a one-piece heavy-ribbed box casting and it is cast integral with the base in order to transmit the strains due to heavy milling through the vertical walls to the base.

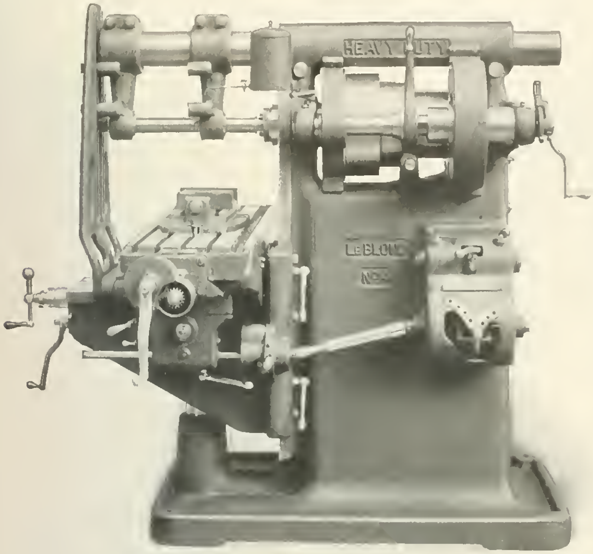


Fig. 1. The Le Blond No. 4 Cone-type Milling Machine

The back-gears are of the double-friction type. They are thrown in and out of mesh by a conventional eccentric shaft arrangement, and are clutched to the back-gear shaft by a powerful friction in the hub of each gear. This friction consists of three parts, *viz.*, a hardened steel double-taper key, a hardened steel plug with an acute taper, and a cast-iron friction ring. When the key is drawn against the plug, the friction ring is expanded in the gear hub. This ring is snapped over the hub to prevent any drag when the clutch is released, so that the lever may be used for starting and stopping. The change from a high to a low ratio can be made while a cut is being taken, and the driving tension can be varied by regulating the pressure on the lever.

The feeding movements are all derived from a single self contained unit attached to the side of the column. Front and rear views of this feed-box are shown in Fig. 3. The initial drive is from a gear, mounted on the cone so that any change in the driving speed also effects a change in the feeds. The initial shaft is given three speeds; first, with the open belt drive, second, with the low ratio back-gear, and third, with the high ratio back-gear engaged. The feed-box is controlled by the two levers shown. The changes are advanced in small steps by the lower lever, whereas the upper one is used for compounding. Sixteen changes are obtained in the feed-box, and as there are three speeds for the initial driving shaft, a total of forty-eight changes, advancing by small increments, is available. The feeds are inversely proportioned to the speeds, thus obviating speeds that are detrimental to the gear-box. When high spindle speeds are used, the box is driven by a pinion, and when heavy cuts are being taken, thus necessitating large cutters and coarse feeds, the box is driven by a large gear, which increases the speeds about eight times. The gears are all made of crucible steel and they are brought into mesh by peripheral and sliding engagement. The sliding gears have rounded teeth to facilitate meshing, and the tumbler gears have pointed teeth and a heavy root section.

A universal shaft transmits power to the feed trip and reverse box. From this point, motion is imparted to the table through accurately cut spiral gears and spur gears. The feeds are tripped by a single plunger having a direct lever arm action. The trip acts directly on the releasing lever which drops into a neutral position after being tripped. Depressing this lever, feeds the table to the right, and elevating it feeds the table to the left.

The spindle is made of 60-point carbon, crucible steel. For the front bearing, a hardened steel taper bushing is pressed over the spindle and runs in a special close-grained cast-iron box that is drawn into the column by a nut on its rear end. The journals soon become highly polished as the result of contact with the hardened steel spindle, which, in conjunction with the thorough lubrication, reduces the bearing friction to a minimum. The rear bearing is a bronze mixture and has a straight fit in the journal, but is tapered on the outside so that it can be drawn into the column to adjust for wear. There are large cored pockets under each bearing from which the oil is drawn through a piece of felt by capillary attraction. In this way, the bearing is supplied with a flow of filtered lubricant and the flow increases as the speed increases.

The steps of the cone pulley are unusually large in order to use a wide belt operating at rational speeds. The countershaft is so speeded that a shift from high to low is always intermediate to a change on the cone pulley. This enables the countershaft speeds to be kept close together so that on the slow speeds, when the most power is required, the countershaft is operating at a high speed, and maintaining a high belt velocity and high initial torque. This also permits the eighteen spindle speeds to be obtained successively, with but eight belt shifts.

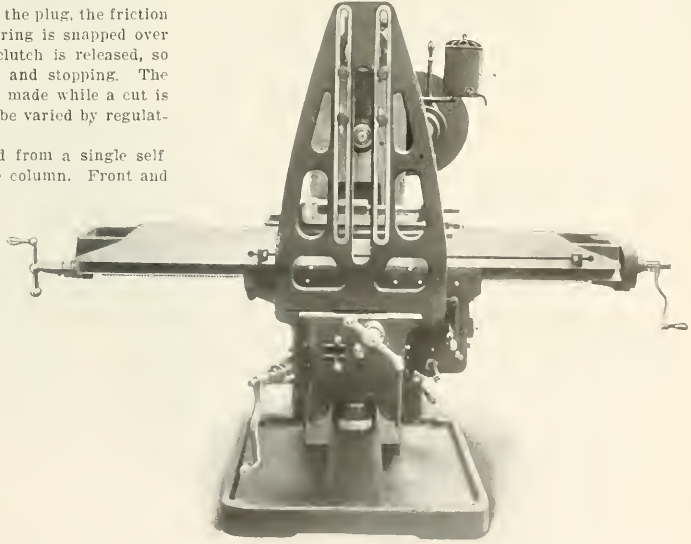


Fig. 2. Front View of Le Blond Milling Machine

The knee is a full box section, ribbed laterally and transversely to resist torsional and collapsing strains. All the openings have been reduced to a minimum and are located so as not to impair the strength. The ribbing divides the casting into a series of box-section compartments. The cross-feed screw is in the center of the knee so that there are no unbalanced strains. The saddle is a heavy well-ribbed casting that occupies as little vertical space as is consistent with the required rigidity. The design of the saddle is shown in Fig. 4, which is a detailed view with the table removed. The knee and saddle are bound in their respective positions by heavy binder handles. By means of these handles a double-angle gib is operated which draws the parts together against the solid angles and at the same time maintains a continuous metal-to-metal contact.

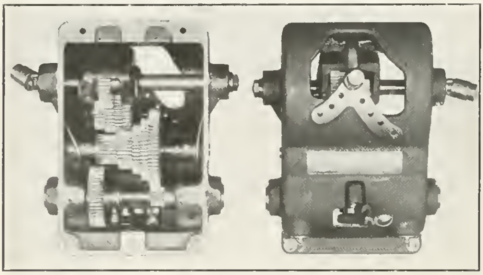


Fig. 3. Feed Mechanism of LeBlond Milling Machine

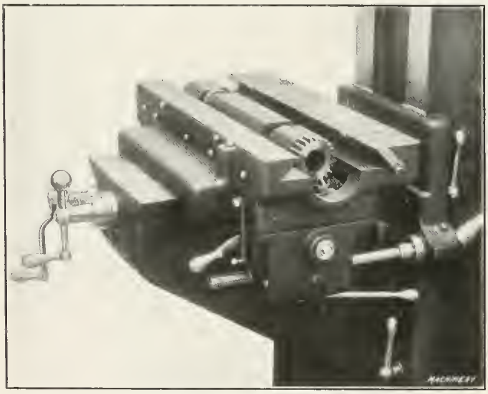


Fig. 4. Saddle and Knee of LeBlond Machine

The table is a semi-steel casting, having considerable vertical depth to resist buckling when the work is clamped to it. An oil channel is cast completely around the table and there is a pad at the extreme end for mounting the dividing head. In this way the capacity between centers is increased about eight inches. The feed-screw is cut from a 50-point carbon, crucible steel bar and has a lead of 2/5 inch. The brace, which is clearly shown in Fig. 2, is a solid casting designed to resist the strains to which it is subjected. The overarm is a solid steel bar which is accurately ground to size. This new line of milling machines includes sizes from No. 0 to No. 4, in both plain and universal designs.

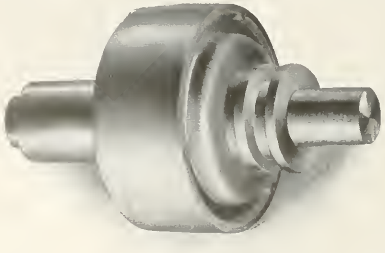
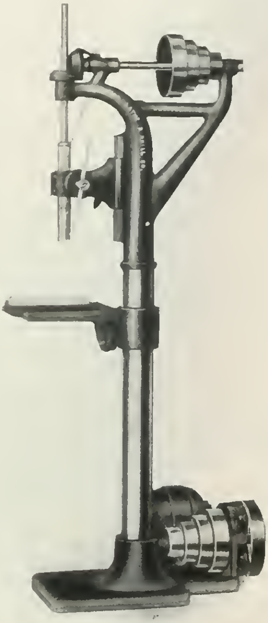


Fig. 1. Cleveland Friction Clutch

ROCKFORD 14-INCH MOTOR-DRIVEN DRILL

The motor-driven drilling machine shown herewith is an improved design brought out by the Rockford Lathe & Drill Co., Rockford, Ill. This machine is driven by a ½-horsepower motor which can be furnished to run on either a direct or alternating current of any required voltage. The power is transmitted to the lower cone pulley through a train of gears containing a rawhide idler which gives a silent drive. There is a tilting table which can be securely clamped at any angle. This feature, in conjunction with an angular bracket on the table, makes it comparatively easy to do many difficult drilling jobs.



Rockford 14-inch Motor-driven Drilling Machine

The spindle is of high-carbon steel, forged and ground. It is fitted with a ball thrust bearing and is counterbalanced either by a weight and chain or a quick-return spring. The distance from the column to the center of the spindle is 7¼ inches; the diameter is ⅞ inch; and the diameter of the sleeve 1⅝ inch. The spindle has a vertical travel of 5½ inches, and the maximum distance from the end of the spindle to the table is 35 inches. The head has a vertical adjustment of 9 inches. The table is 11 inches square. The largest and smallest steps on the cone pulleys have a diameter of 7¾ inches and 3⅝ inches, respectively, and the steps have a face width of 1⅝ inch. The machine has a ¾-inch capacity, and its net weight is 355 pounds.

CLEVELAND FRICTION CLUTCH

The friction clutch shown in the accompanying illustrations is made by the Cleveland Clutch Co., 224 High Ave., Cleveland, Ohio. This clutch is an expanded-ring self-oiling type. The principal advantages claimed for the design are, durability, simple construction, smooth positive action, ease of adjustment, adaptability and high efficiency. In addition, it is dust-proof and oil-tight and is well balanced.

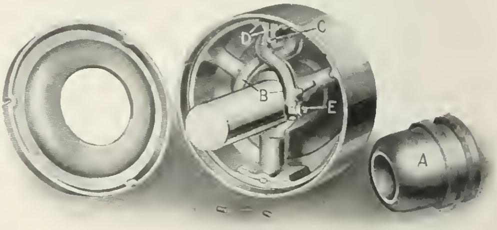


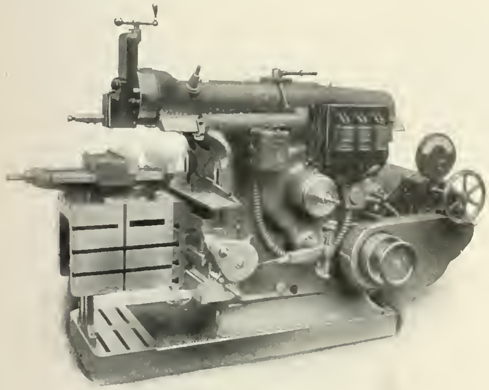
Fig. 2. Interior View of Cleveland Clutch

Fig. 2 shows clearly the construction. The spider is keyed to the shaft and the clutch is operated by shifting cone *A*, which engages fingers *B*. The latter are held by a floating center *C*, which causes points *D* to move along the same arc as the friction band. Both casing and spider are made of cast iron. The expansion band is of semi-steel and the fingers are drop-forgings. The cone is of Bessemer steel and the pins are of casehardened steel.

Provision for easily adjusting the clutches for a given load is made by set-screw and lock-nut *E*. The friction surfaces have metal-to-metal contact and no wood or fiber is used in the construction. A film of oil has to be displaced before the clutch is fully engaged, so that it takes hold gradually but releases instantly. After the clutch is once oiled, it can be operated for months without further attention. It is not affected by centrifugal force and is adapted to either high or low speeds.

GOULD & EBERHARDT 24-INCH SHAPER

Gould & Eberhardt of Newark, N. J., has recently designed a new line of shapers adapted to the heavy work required in steel mills, railroad shops, drop-forging shops, etc. The bull gear of this new design has been raised considerably and it is a new patented construction. This improved feature is said to greatly increase the mechanical efficiency of the shaper. In addition to this change in the design, there are the following improvements: The outside diameter of the bull gear hub has been increased from $3\frac{3}{4}$ to 6 inches; there are larger V-bearings, and the gib is so arranged that there is a solid metal-to-metal construction on each side of the ram bearing; the main lever has a solid top; the overhang of the crankpin has been reduced to a minimum; the crankpin thrust is taken by solid walls in the bull gear similar to the ways of the ram; the ratio of the "double-train gear drive" has been increased; the front table support is of heavier design; and the head, ram and frame are of more massive construction.



Gould & Eberhardt Shaper with Variable-speed Motor Drive, Automatic Starter, and Dynamic Brake Control

In the design of the V-gib bearing, which gives a solid metal construction on both sides of the ram, a taper gib is provided having two parts. These can be adjusted independently of each other from the side, near either the front or the back end. This adjustment is in an upward direction between the ram bearing and the solid bearing in the frame, and it is effected by means of set-screws. The arrangement is such that the ram has a solid metal-to-metal bearing for all positions of the adjustable gibs.

In order to determine the relative merits of the V-form of ram, as compared with the square-gib type, a test was made at the University of Michigan with two Gould & Eberhardt shapers, one having the V-ram and the other the square-gib construction. A partial report of this test is as follows:

"The results show the V-form of ram to be superior in all but one of the points investigated. In the horizontal deflections, the square machine has a uniform advantage. In vertical deflections, wear, efficiency and convenience, the V-shaper shows a marked superiority, and it is the author's opinion that a more thorough and exhaustive test would place the V-slide even further in the lead as an accurate, efficient and economical means of transmitting linear motion."

The V-gib of this new shaper has an angle of 55 degrees instead of 45 degrees. This angle was adopted as being better able to withstand the horizontal strains of the ram, without sacrificing the advantages of the V-type bearing for taking the vertical strains. The amount of bearing surface has also been increased in order to further preserve the alignment and accuracy of the ram.

The main lever, instead of having a hole at the top for use when keyseating long shafts, has been made solid to increase the strength, and means are provided for keyseating by placing a hole in one side of the frame, through which shafts up to 3 inches in diameter can be passed. This arrangement is patented. By reconstructing the main bull gear, the overhang of the crankpin, with relation to its distance from the large gear hub bearing in the frame, has been reduced to a minimum. Straps and bolts for holding the crankpin to the large bull gear have been done away with, and solid V-ways similar to the ways of the ram are provided. This forms a solid dovetail bearing for the crankpin, which is superior for taking the strains and thrusts.

The ratio of the double-train gear drive has been increased by giving the shaper a greater initial speed and increasing the ratio of the gearing. This gives more power to the machine when running in single gear or with the back-gear engaged. The ratio of the single gearing is 6.61 to 1; the ratio of the back-gearing, 32.06 to 1.

This shaper weighs 4800 pounds, and is shown in the illustration with a direct-connected, Reliance, variable-speed motor, an automatic starter and dynamic brake control. The horizontal travel of the table is $28\frac{1}{4}$ inches and the vertical travel, 14 inches. The maximum distance from the ram to the table is $17\frac{1}{2}$ inches and the tool-head has a vertical movement of 8 inches. The vise jaws measure $14\frac{1}{2}$ by 3 inches and the vise has a maximum opening of 16 inches.

NEW BRITAIN AUTOMATIC MULTIPLE SPINDLE CHUCKING MACHINE

The "size 33" automatic multiple spindle chucking machine shown herewith (which is built by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.) embraces several improvements, and also permits the machining of pieces which heretofore could not be done on this machine. It will be noticed by referring to Fig. 1 that this machine is of the single-head type.

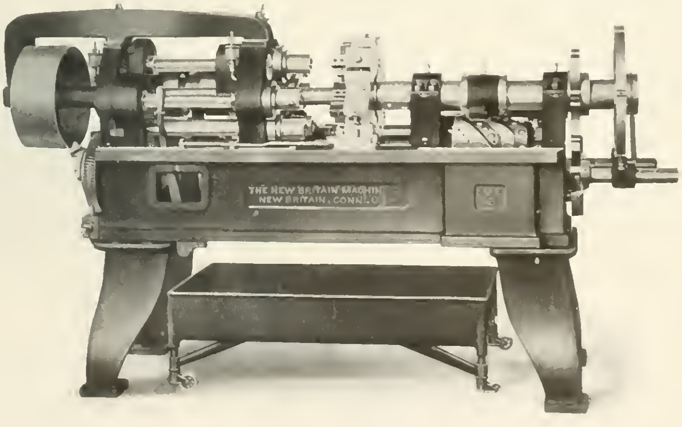


Fig. 1. New Britain Multiple Spindle Chucking Machine

The most important improvement is that the machine has five working spindles, the chuck turret being equipped with six openings, all but one of which are in line with the spindles. Thus work can be performed on five pieces simultaneously. If desired, either of the last two spindles can be used plain for reaming, or if fitted with frictions, either or both may be used for threading. As on other machines of this type, the time for completing a piece equals the time required for the longest single operation; and as it is possible to distribute long operations over the different spindles, it will be seen that such operations can be performed in the time required for a comparatively short operation.

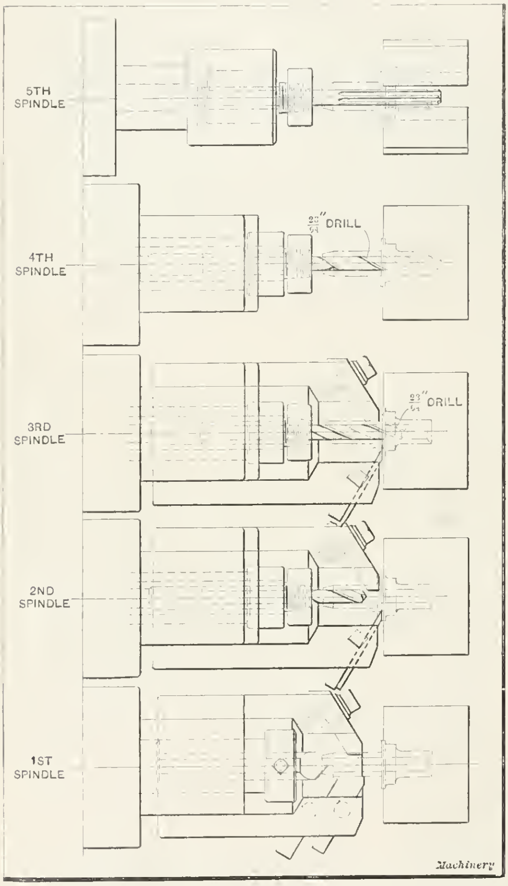


Fig. 2. Example of Work done on New Britain Chucking Machine

On the size 33 machine, an overhead arm has been added which securely ties the two heads together, and, moreover, extends so as to form an outboard bearing for the driving pulley, thus equalizing the belt pull upon both ends of this bearing. It is interesting to note the method used in tying this overhead arm to the two heads, the construction being such that the heads are held rigidly but without subjecting the attaching bolts to a shearing strain. This is done by providing the two bearings of the overhead arm with longitudinal tongues which fit into corresponding slots which have been milled in the two head bearings. In addition, the bolt holes are fitted with hardened steel bushings which extend into the heads and thus protect the attaching bolts from shearing action.

The cam roll yoke which was formerly held in a fixed position on the turret barrel, is now adjustable lengthwise. The yoke runs on a split sleeve which is clamped to the turret barrel by two tangent screws. The advantage of this feature lies in the fact that if it is desired to advance the action of all tools a short distance, it can be done by simply moving the position of the yoke upon the barrel. Formerly it was necessary to move each tool or to change the cam position to secure this result. The size of the turret barrel has been materially increased, thus providing for handling heavier turrets or faceplates with fixtures. The turret bar, or shaft upon which the turret slides as it moves forward, is supported at one end in the head of the machine and at the other in a ground hole in the turret barrel.

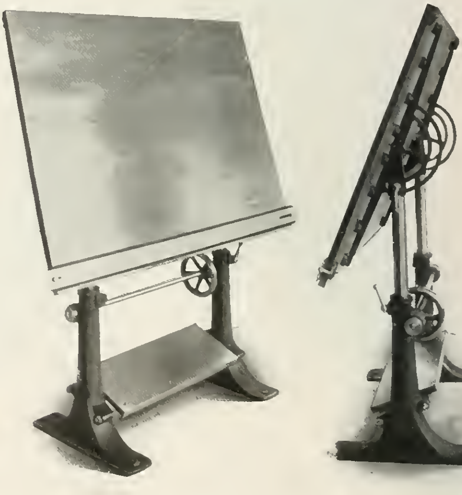
A steadyrest of the sliding-key design automatically locks the chuck turret in both directions while the tools are in operation. This steadyrest, which can plainly be seen in Fig. 1, is actuated during indexing by a cam and roll action which is entirely automatic. The faces of the steadyrest are adjustable to compensate for wear, and maintain the accuracy of the machine by supporting the turret chuck near the working position. By supporting the turret at that point, the turret barrel is relieved of all torsional strain and the indexing mechanism from pressure.

The working range of the machine covers pieces requiring a cam stroke of 3¾ inches, and diameters up to 1½ inch can be turned or bored. Larger diameters may be finished when the length of cut is less than the full stroke of the cam.

As an illustration of a typical job which may be handled on the size 33 machine when equipped with high-speed drilling spindles in the No. 2-3-4 spindles, the tool lay-out for a valve stem guide is shown in Fig. 2. These valve stem guides are 3 inches long, the maximum diameter is 1⅜ inch, and they are finished at the rate of 50 per hour. The material is cast iron. It is required to drill and ream a hole 23/64 inch in diameter; chamfer the outside of one end; turn a ⅝-inch diameter for a distance of 1⅜ inch, and face the side of the shoulder adjacent to this turned section. A second chamfering operation is performed on the opposite end of the piece, but this tool lay-out refers simply to the first operation. At the first spindle position, the piece is spot-centered, the end chamfered, and the outside turned for half its length. At the second spindle position, one-third of the length of the hole is drilled, the remainder of the ⅝-inch section is turned and the flange rough-faced. At the third spindle position, another third of the 23/64-inch hole is drilled and the flange is finished-faced. At the fourth spindle position, the remainder of the hole is drilled. At the fifth spindle position, the full length of the hole is reamed thus completing the operations on the piece.

NEW BRITAIN ADJUSTABLE DRAFTING TABLE

The drafting table illustrated herewith is a high-grade design having both vertical and angular adjustments. The front and side views clearly show the construction. The board measures 36 by 48 inches and is equipped with a Keuffel & Esser parallel attachment. The board is firmly secured to cast brackets which are pivoted to the vertical supporting mem-



New Britain Adjustable Drafting Table

bers. The table is rigidly held in an angular position by tightening the hand lever shown in the view to the right. This lever binds against a segment of the supporting bracket and it is threaded to a long bolt, the head of which clamps the bracket on the opposite side. The table is adjusted vertically by the handwheel shown. This wheel is mounted on a cross shaft having pinions at each end, which engage teeth cut on the supporting legs. This table is a product of the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.

BESLY 53-INCH VERTICAL-SPINDLE DISK GRINDER

A vertical-spindle disk grinder manufactured by Charles H. Besly & Co., Chicago, Ill., is shown in the accompanying illustrations. This machine is intended for "jointing or flatting" such work as stove doors, foundry flasks, meter cases, large gear cases, split shafting bearings, etc., or for other parts which do not have to be ground to a given size or angle. The work is laid on the horizontal disk wheel and is ground by gravity feed. Where work is too light to be ground satisfactorily by its own weight, the practice is to lay on weights. As many parts as the disk wheel will accommodate can be ground simultaneously. As soon as one piece is finished, it is taken off the wheel and immediately replaced by a rough piece. In this way the disk wheel is loaded constantly practically to its limit. When grinding castings for split shaft bearings, as many as thirty five are ground at once, and a laborer attends to the machine.

A hollow exhaust ring extends around the outer edge of the disk wheel for exhausting the grinding dust. This exhaust ring tapers from nothing to about five by five inches at the end where the exhauster is connected. This gradual increase of section is to give a uniform suction all around the disk wheel. The rear view, Fig. 2, shows the exhaust fan and the method of connecting it with the grinder. A removable guard ring which is cast in sections and projects two inches above the grinding face is provided around the disk wheel. This prevents the work from flying off the wheel while being ground, and aids in properly exhausting the grindings. Suitable wooden bars are usually secured to this guard ring as shown, to prevent the work from revolving with the grinding wheel. A section of the exhaust ring twenty-six inches wide, is removable, so that free access may be had to the edge of the disk wheel at this point, for grinding work which may have bosses or lugs projecting beyond the plane of the ground surface. This feature is very desirable, especially on stove work.

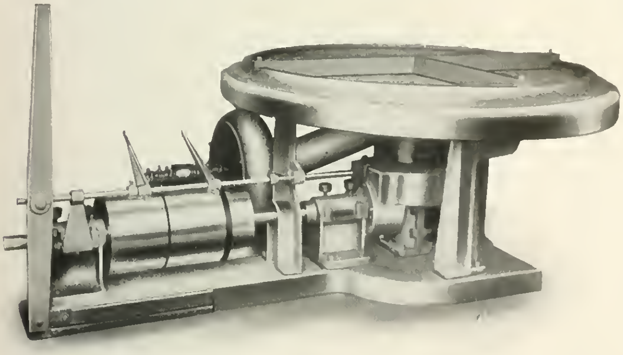


Fig. 1. Besly 53-inch Vertical-spindle Disk Grinder

The disk wheel is of wrought steel, 53 inches diameter by 1¼ inch thick. It is machined on both sides so that both faces of the wheel can be set up with circles. When the circle on one face is worn out the disk wheel can be turned over and the opposite circle used. The machine is usually furnished with an extra steel disk wheel. A suitable press is also provided so that one wheel can be "set up" while the other is in use on the grinder. In this way the grinder can be operated continuously. The disk wheels weigh 800 pounds each. For convenience in handling, they are drilled and tapped to receive eye-bolts for connecting to a crane or hoist hook. The grinder and press are usually served by a chain hoist suspended from a suitable trolley.

The bevel gears for transmitting power from the horizontal driving shaft to the vertical spindle, are fully enclosed in a cast-iron gear case and run immersed in oil. All bearings are bushed. The tight-and-loose pulleys on the horizontal driving shaft are twelve inches in diameter and take an eight-inch belt. A countershaft is not necessary, as the machine can be driven direct from a lineshaft or motor located above or below it. A suitable pulley for driving the exhauster can be mounted on the horizontal shaft as shown in Fig. 1. The grinder is thirty-four inches high and weighs, complete with two disk wheels and a press, 6000 pounds.

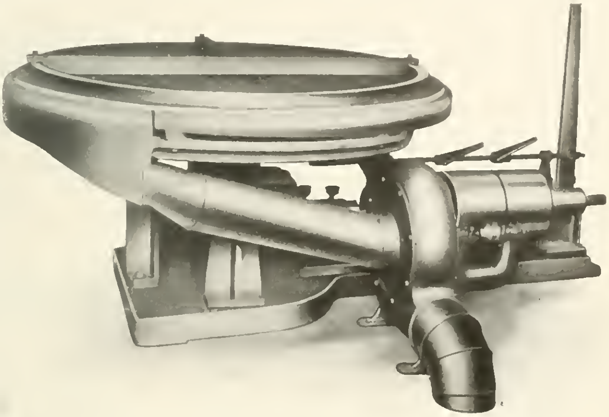


Fig. 2. Rear View of Vertical Disk Grinder, showing Exhaust System

On work for which it is adapted, this grinder is very efficient as is indicated by the following examples. When jointing cast-iron split shaft bearings, this 53-inch grinder does the work six times faster than was accomplished with two milling machines operated by one man. For facing narrow ribs on cast-iron boxes so large that a 53-inch disk wheel accommodates only four boxes at a time, the 53-inch machine does the work twenty times faster than by the profiling process formerly employed. For facing spots on power-pump bedplate castings measuring thirty-three inches by thirty-eight inches and weighing 115 pounds, the vertical disk grinder does the work ten times faster than by the former planing process.

INGERSOLL OPEN-SIDE HORIZONTAL-SPINDLE MILLING MACHINE

The Ingersoll Milling Machine Co., Rockford, Ill., has recently built and installed several open-side horizontal-spindle milling machines of the faceplate drive type. Fig. 2 shows the driving and operating side of this machine, and Fig. 1 is another view showing the machine in operation at the Dean Bros. steam pump works in Indianapolis.

The bed and table of this new design are of the standard planer-type construction. The table has twelve feed changes, and, in addition, a rapid power traverse in either direction, of thirty feet per minute. The feed motion for the table is transmitted through a Sellers rack and worm, the latter being immersed in oil. As the illustration shows, this machine has but one main upright which is of heavy construction and is further stiffened by the addition of an auxiliary housing placed at right angles.

All the driving and feed gears and also the motor for driving the machine, are assembled upon the main housing. This means that the machine can be entirely controlled from the operator's working position. Perhaps the most interesting mechanical feature of the machine is the saddle. This is an entirely new construction. The main driving gear for the spindle, instead of transmitting the power through the spindle, delivers the full power of the machine directly to the cutter through a hardened steel driving pinion. The function of the spindle, in such a case, is simply that of supporting the driving gear, this being the arrangement when cutters of from 18 to 36 inches in diameter are used. The cutters of smaller diameter are attached to the spindle by means of a shank and draw-in bolt, and the machine is driven by the main spindle gear.

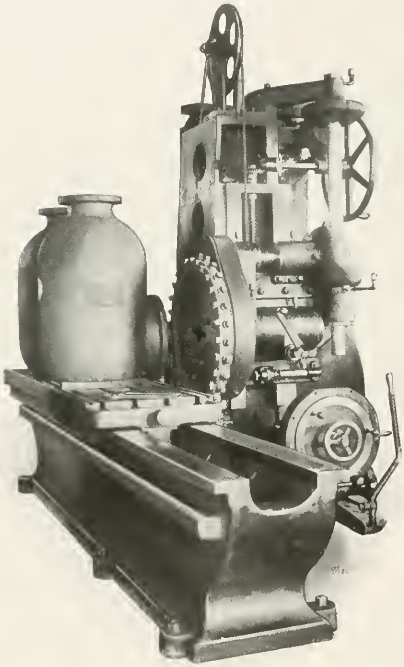


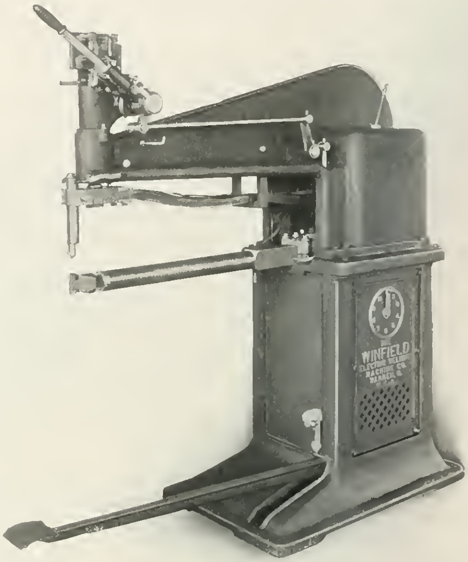
Fig. 1. Ingersoll Machine Milling Flanges of Steam Pump Air Chambers

The saddle has an in-and-out adjustment by hand, and in order to provide a fine adjustment, it is equipped with a patented micrometer stop. This stop gives accurate adjustments for any position within the travel of the saddle, so that cutters as large as 36 inches in diameter can be adjusted to a thousandth of an inch, just as easily as smaller cutters on a small tool-room milling machine.

WINFIELD ELECTRIC WELDING MACHINE

The Winfield Electric Welding Machine Co., of Warren, Ohio, is the manufacturer of the 36-inch spot welder shown herewith. This is a special design particularly adapted to the spot welding of pipe. It has a capacity for stock up to $\frac{1}{4}$ inch in thickness, and pipes ranging from 3 inches in diameter and up can be welded.

There is a swiveling head and a combination double-pole, non-arcing, automatic switch and circuit cut-out. The one-inch welder points are water cooled. In addition to a hand lever, the machine is equipped with a removable, adjustable foot-treadle having a stop. The transformer has a capacity for 16 kilowatts, and a single-phase alternating current is used. The voltage is regulated by a 10-point, self-contained regulator having an indicating dial at the side of the column, as shown.



Winfield Pipe Spot Welding Machine

This welder has an overhang of 36 inches and a die opening of 3 inches. The distance between the horns is 8 inches. The height from the floor to the center of the dies is $43\frac{1}{2}$ inches. The lower horn is round and has a diameter of $2\frac{3}{4}$ inches. The welder requires a floor space of 26 by 42 inches, and its net weight is 2100 pounds.

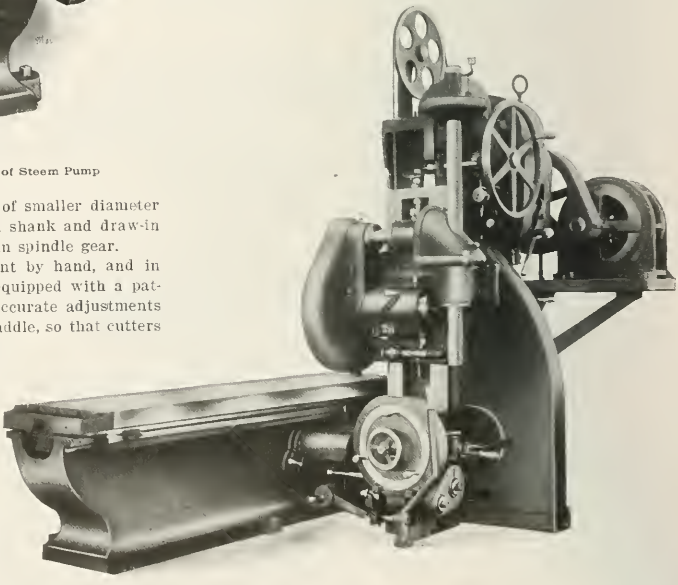


Fig. 2 Ingersoll Open-side Horizontal-spindle Milling Machine

* * *

A hexagon nut should always be used wherever the movement of the wrench is limited.

NEW MACHINERY AND TOOLS NOTES

Die-Stock: J. M. Carpenter Tap & Die Co., Pawtucket, R. I. Die-stock having holes in the handle which act as guides for the work. Twenty-two sizes of dies can be used in one stock.

Spacing Collar: Schuchardt & Schutte, Cedar and West Sts., New York. Adjustable spacing collar intended for spacing straddle mills. It is provided with graduations indicating an endwise movement of 0.002 inch.

Portable Grinder: Chicago Pneumatic Tool Co., Chicago, Ill. Portable pneumatic grinder which weighs 20 pounds and will take an 8 by 1 inch wheel. It is equipped with a grip handle and trigger similar to a pneumatic hammer.

Screw Driver: L. J. Watson, Port Huron, Mich. Screw driver made of spring-tempered steel and having a split end which, when pressed into the slot of a screw, holds the latter firmly while it is being entered into a hole.

Tool-holder: Double Grip Tool Co., Belleville, N. J. Tool-holder in which the cutting tool is held by a set-screw in the usual manner and also by a long gib on the top, which is forced down against the tool by the toolpost screw.

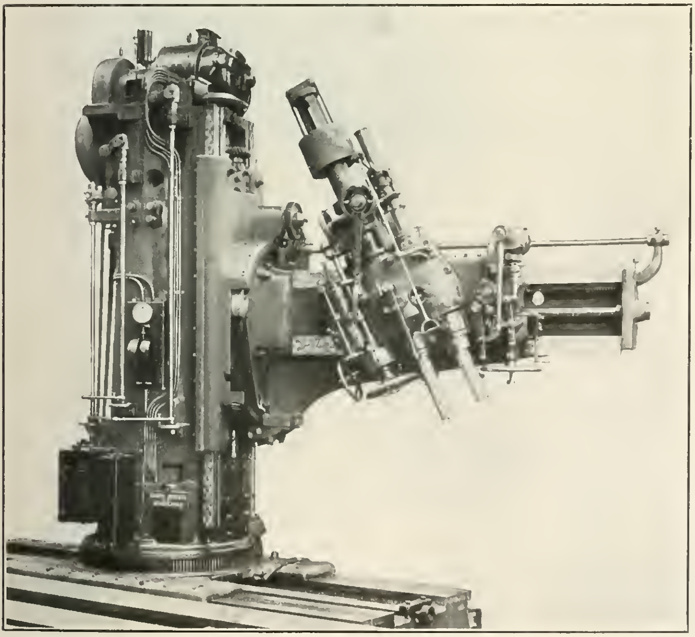
Horizontal Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special machine for boring chords used in the construction of the new Quebec bridge. These chords have sections as large as 7 feet 10 inches, and weigh from 75 to 100 tons.

Belt Idler: Charles Miller, Industrial Bldg., Syracuse, N. Y. This idler is placed beside the driving pulley and has rollers on its periphery so that the belt can be easily shifted on or off. It is intended for use where a belt is not in continuous operation.

Tool-holder: A. O'Keefe & Sons, 353 Mulberry St., Newark, N. J. Combination tool-holder which will take three sizes of tools made of either round or square stock. The cutting tool can be held straight or tilted to the right or left for angular cutting.

Toolpost Grinder: G. Horvath, 190 Hague Ave., Detroit, Mich. Toolpost grinder consisting of an angle-plate which bolts to the tool-slide and carries the spindle head. The latter has a vertical adjustment, and can be arranged for internal as well as external grinding.

Automatic Planer Stops: Lamb Knitting Machine Co., Chicopee Falls, Mass. Two devices for automatically stopping a planer when the tool has reached a predetermined point. One stop operates by disengaging the feed gear, whereas the other shifts the belt on the countershaft.



Heavy Radial Drilling Machine of German Design

Saw Sharpening Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Automatic saw sharpening machine designed for either solid or inserted-tooth saw blades. The latter type are ground with the teeth in the blades, and the machine is so arranged that the rake of the teeth can be varied to suit conditions.

Multiple-Spindle Drilling Machine: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. Multiple-spindle drilling machine designed for drilling bolt holes in steel-tired car wheels. This is an all-geared machine, power being transmitted from the main spindle of the drill through bevel gearing and shafts, instead of universal joints. There are twelve spindles each capable of driving a 1½-inch drill.

Convertible Open-side Planer: Detrick & Harvey Machine Co., Baltimore, Md. Open-side planing machine which may be converted into a double-housing type. The auxiliary housing is attached to the base and also at the cross-rail end by heavy bolts, and it is further secured by pockets in the base and rail end. The auxiliary housing can be quickly removed for work that cannot pass between the two housings.

Screw-Plate: A. J. Smart Mfg. Co., Greenfield, Mass. A compact screw-plate which is only about half the size of an ordinary screw-plate of the same capacity. It is known as No. X5 and cuts threads 1/8, 5/32, 3/16, 7/32 and 1/4 inch in diameter. The stock is 5 inches long, and round adjustable dies ⅝ inch in diameter are used. A tap wrench fits into the die-stock, and the entire outfit with a set of plug taps is contained in a neat and compact box.

Cylindrical Boring Machine: Automatic Machine Co., Bridgeport, Conn. Four-spindle vertical boring machine for boring and facing engine cylinders and similar work, ranging from 4 to 10 inches in diameter and having a maximum depth of 24 inches. The time required for boring and facing a cylinder 7½ inches in diameter and 18 inches deep is 1½ hour, but with the four spindles, all of which are in operation part of the time, the actual time per cylinder is less than thirty minutes. The boring is done in four operations, including a roughing cut, a semi-finishing cut and two finishing cuts. This machine was designed for boring cylinders with such precision that grinding would be unnecessary, and also to insure economical production by utilizing the entire time of one operator with a single machine.

* * *

RADIAL DRILLING MACHINE OF GERMAN DESIGN

The accompanying illustration shows a large radial drilling machine built by the firm of Ernst Schiess of Düsseldorf, Germany. It differs in its design considerably from the conventional type of radial drilling machine, it being entirely universal and provided with every possible adjustment; nevertheless, all the operating handwheels and levers remain close to the operator at all times. The main column is mounted on a large base-plate which is provided with ways, about 18 feet in length, on which the column can slide back and forth, this movement being actuated by an electric motor. The inner column of the upright is fixed on the slide and provided with a large spur gear at the bottom which is used for turning the whole machine around. The power for this movement is derived from the main shaft in the horizontal arm. This construction makes it possible to swing the arm through a full circle of 360 degrees.

An electric motor of 18 horsepower is placed on the top of the upright. This motor is of the variable speed type (400-1200 R.P.M.), the current being carried through a sliding contact in the base-plate. The motor drives, through suitable gearing, a vertical shaft, which, in turn, transmits power to the horizontal shaft located on the arm, both shafts being provided with keyways for their full length. The vertical movement of the slide carrying the radial arm is also derived from the main vertical shaft. The motor is reversible.

All the rough or approximate adjustments of the machine are made by power, while the fine adjustments of the spindle and of the radial arm are made by handwheels and levers provided for the operator on the spindle head. Some adjustments which are very seldom required, like the swinging of the arm from the vertical plane, or swiveling of the spindle head itself, are effected only by hand through worm and worm-gears.

The spindle is 4 5/16 inches in diameter. From the main spindle a secondary spindle is driven by spur gearing. This is used only for thread cutting. A lever in the front is provided for reversing the motion of this second spindle. The feed is provided for by a gear box giving eight changes. In addition to the power arrangement for swinging the arm around the column, a pawl and ratchet construction is used for obtaining a fine adjustment of the arm. The machine is capable of drilling holes and cutting threads up to 4 inches in diameter in armor plate, using high-speed steel drills. The spindle makes from 2 to 72 revolutions per minute, and the feed varies from 0.0035 to 0.040 inch per revolution of the spindle.

The general dimensions of the machine are as follows: The horizontal movement of the upright along the baseplate, 9 feet 10 inches; maximum height of lower end of spindle over bed, 7 feet 6 inches; minimum height of lower end of spindle, 3 feet 11 inches; maximum distance of spindle from axis of column, 10 feet 4 inches; vertical movement of drill spindle, 22 inches; vertical movement of thread-cutting spindle, 9 inches; distance between spindles, 12 inches; total weight of machine, 45 tons.

* * *

WATSON-STILLMAN CAR COUPLER SHEARING AND RIVETING PRESS

The hydraulic shearing and riveting press shown in Figs. 1 and 2 has been designed by the Watson-Stillman Co., 192 Fulton St., New York, for shearing riveted coupler yokes from their couplers, and also for clamping and riveting the couplers and yokes together. Either operation is rapidly effected by a single stroke of the ram, and the use of hydraulic power further tends toward economy, as compared with the common practice of doing this work by hand and the pneumatic hammer.

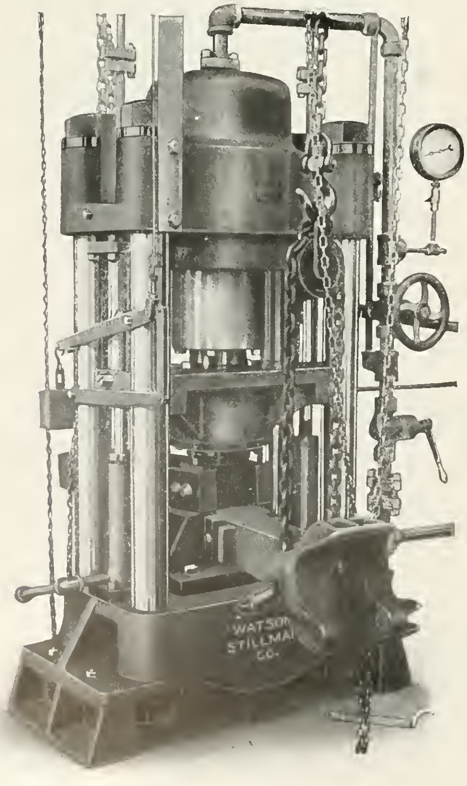


Fig. 1. Watson-Stillman Shearing and Riveting Press—View showing Coupler sheared from Yoke

In the operation of the press, the coupler is first sheared from its yoke. The yoke is placed upon supporting blocks which the coupler shank clears, and the ram descends upon the coupler shank, thus forcing it downward and shearing both ends of the rivets. Fig. 1 shows the position of the coupler and yoke after the shearing operation is completed. This view also indicates the method of handling the separated parts. Fig. 2 shows the coupler with the yoke and rivets attached and everything in readiness for heading the rivets. The main ram and clamping rams start downward simultaneously, the small rams first clamping the yoke to the coupler shank. The riveting die which is attached to the large ram, then descends upon the rivets and heads them.

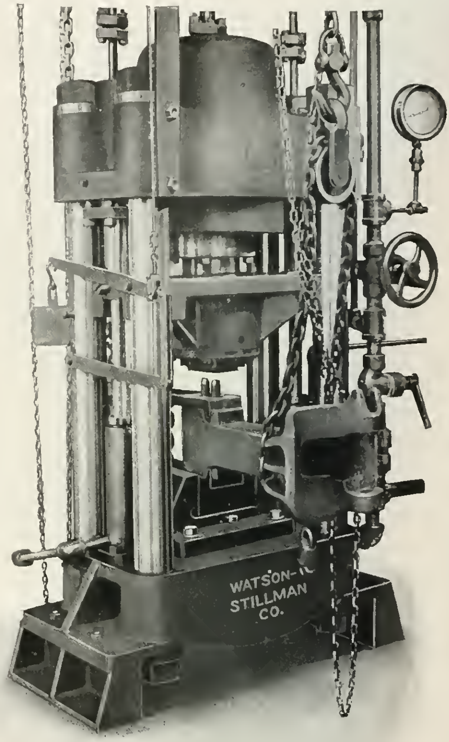


Fig. 2. Coupler and Yoke ready for Riveting

This press is built with heavily-ribbed platens and has plenty of room for removing and replacing the work. There are two "push-back" rams for quickly and automatically returning the large ram. The diameter of the main ram is 12 inches and the stroke, 6 inches. The clamping cylinders have 3-inch rams with a 6½-inch stroke, and the push-back cylinders have 1¾-inch rams. The overall height of the press is 6 feet 8 inches; the complete weight 7858 pounds, and the capacity, 200 tons.

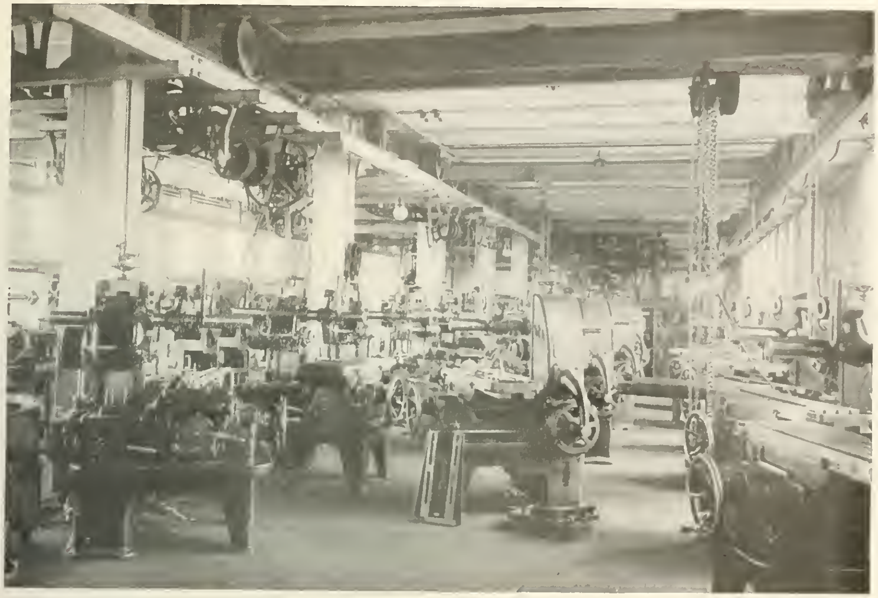
* * *

PERSONALS

William L. Wardleigh, formerly superintendent of the Baush Machine Tool Co., Springfield, Mass., is now superintendent of the Electric Goods Mfg. Co., Canton, Ohio.

Lieut.-Col. William S. Peirce of the ordnance department at Washington, D. C., has been appointed commandant of the U. S. Armory at Springfield, Mass. Col. Peirce assumes his new duties in September. He succeeds Col. Stanhope E. Blunt.

A. M. Powell, president of the Powell Machine Co., Fitchburg, Mass., left August 6 on the *Franconia* of the Cunard Line from Boston, for an extended trip abroad in the interests of his company, and for the demonstration of the Powell patent high-speed planer.

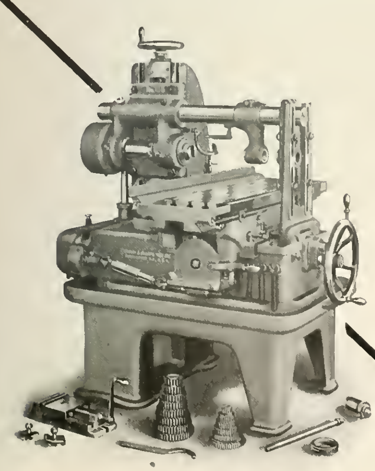


WE ARE BUILDING A LARGE NUMBER OF THE

No. 13B PLAIN MILLING MACHINES

This new manufacturing milling machine is very successful in producing duplicate pieces at a rapid rate, and we are building a large number to fill the demand that has arisen for it. A portion of an erecting room is shown in the cut above.

The machine is accurate and its efficiency is high—important factors in manufacturing. The constant speed drive and stiff construction make the machine powerful. Wide ranges of independent spindle speeds and table feeds are available. Controlling levers and handwheels are arranged to give the greatest convenience in operation, as it is realized that the rate of production of a machine of this type is largely dependent upon handiness.



Send for special circulars giving full description and specifications.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

Albert S. Smith, president of the Smith & Mills Co., Cincinnati, Ohio, shaper manufacturer, returned August 24, having made a trip around the world. Mrs. Smith accompanied him.

Adolph O. Krieger has resigned his position as publicity manager of the Busch-Sulzer Bros. Diesel Engine Co., St. Louis, Mo., with which he had been connected for a number of years, and has opened an office at 916 Victoria Bldg., St. Louis, for the sale of the Tacchella oil burning device.

C. J. Nyquist, superintendent of the Davis-Bournonville Co., was given a dinner by the New York officers and members of the sales force, and employes of the Jersey City shops, at Myers Hotel in Hoboken, July 17, Mr. Nyquist having returned from abroad the previous day. His trip abroad was made in the interests of his employers. He visited several cities in Germany, Denmark and France, investigating the progress being made in oxy-acetylene welding.

* * *

OBITUARIES

Harold R. Walker, secretary of the Union Caliper Co., Orange, Mass., died at his home, July 24.

Emil Von Wyck, of the Von Wyck Machine Tool Co., Cincinnati, Ohio, died suddenly in his office, July 11, aged forty-seven years.

Baxter B. Noyes, senior member of the firm of B. B. Noyes & Son, Greenfield, Mass., manufacturers of hardware specialties, small tools, blacksmiths' machinery and iron castings, died July 22, aged sixty-eight years, as the result of an accident, Mr. Noyes having fallen from a staging in the factory.

Joseph LeConte Davis, engineer in charge of design of direct-current railway type motors in the electric railway department of the Westinghouse Electric & Mfg. Co., recently deceased, was a graduate from the University of South Carolina in 1897 with the degree of electrical engineer. He was professor of physics at Bingham Academy High School, North Carolina from 1897 to 1900, and in 1904 was employed by the General Electric Co., Schenectady, N. Y. He was also at one time in charge of the developments of the National Electric Signalling Co., which embraces the Fessenden wireless system. Since 1904 Mr. Davis was with the Westinghouse Electric & Mfg. Co. He was regarded as one of the brightest and most promising of the younger electrical engineers of the present day. His work in connection with the design of the direct-current motors used on the Pennsylvania terminal electrification in Greater New York and many other large installations brought him into prominence before the electrical profession.

Charles A. Haney, vice-president and general manager of the Sloan & Chace Mfg. Co., Ltd., Newark, N. J., died after a brief illness August 10. Mr. Haney was born in Brooklyn, N. Y., July 27, 1867. He started to learn his trade with George Griswold, New Haven, Conn., at the age of fourteen years. From this time and until he became connected with the Sloan & Chace Mfg. Co. he was employed by a number of different manufacturing concerns as toolmaker, foreman and assistant superintendent. Among these concerns may be mentioned the Yost Typewriter Co., Bridgeport, Conn., the Mergenthaler Linotype Co., Brooklyn, N. Y., and the S. S. White Dental Mfg. Co., Staten Island, N. Y. At one time he was employed by Thomas A. Edison on making the early models of the phonograph. In 1902 he became general manager, vice-president and principal owner of the stock of the Sloan & Chace Mfg. Co. Through Mr. Haney's efforts and untiring energy the plant of this company was remodeled, new machinery replacing the older types, and the business grew considerably in volume, necessitating, in 1906, new and more spacious quarters. Mr. Haney was the inventor of a cyclometer and a typographical numbering machine. His unusually varied experience enabled him to successfully handle all kinds of mechanical problems. He was a member of the National Metal Trades Association, the National Machine Tool Builders' Association, and the Newark Board of Trade, as well as of a number of other organizations. He is survived by a wife and two children.

* * *

COMING EVENTS

September 2-7—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 9-11.—Ninety-third meeting of the National Association of Cotton Manufacturers at the Griswold, Eastern Point, New London, Conn. C. J. H. Woodbury, secretary, Boston, Mass.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

September 30-October 4.—Autumn meeting of the Iron and Steel Institute at Leeds, England. G. C. Lloyd, secretary, 28 Victoria St., London.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

October 16-18—Annual convention of the National Machine Tool Builders' Association in New York; headquarters, Hotel Astor. James H. Herron, general manager, Cleveland, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Newberry College, Newberry, S. C. Catalogue for 1911-1912, containing 80 pages, 6 by 9 inches, of information relating to the departments and courses of instruction of the college. The catalogue is illustrated with a number of halftones showing the various buildings, as well as interior views.

American Society of Swedish Engineers, 271 Hick St., Brooklyn, N. Y., announces two lectures for its meetings during September. On Sept. 7 at 8:30 P. M., Mr. L. Pelletier, advertising representative of Machinery, will speak on "Advertising in Its Relation to Engineering." On September 21, Mr. C. J. Nyquist, superintendent of the Davis-Bournonville Co., will speak on "Oxy-Acetylene Welding and Its Applications." Mr. Nyquist will be assisted by a demonstrator who will show the oxy-acetylene welding and cutting apparatus in action.

National Metal Trades Association, New England Bldg., Cleveland, Ohio. Pamphlet entitled "Industrial Betterment Activities of the National Metal Trades Association." The pamphlet outlines the history of the society and its constructive activities along the lines of industrial education, apprenticeship systems, cooperative profit-sharing plans, safety appliances, hygiene and sanitation, systematic compensation for industrial accidents, legislation, extension of transportation facilities and local branches and employment bureaus. It should be of interest to manufacturers generally, whether members of the association or not.

Iowa State College, Ames, Iowa, announces that two new scholarships have been established in agricultural engineering, one being founded by the M. Rumely Co., of Laporte, Ind., and the other by the International Harvester Co., of Chicago, Ill. These scholarships are intended for young men qualified to do special research work along the lines of agricultural engineering, and amount to $250 a year each. They were established at the Iowa State College on account of the fact that this college was the first to institute a four-year course in agricultural engineering, and because instruction in this branch of engineering has been most highly developed at this college.

American Society of Engineer Draftsmen, 116 Nassau St., New York, held its regular monthly meeting in the Engineering Societies Building, Thursday, August 15. A paper was read by Mr. W. T. Walters of Chicago, on "Safety Devices—Their Application and Design." Prof. Charles W. Weick of Columbia University spoke on "Practical Perspective," and the question of whether to place dimension figures on drawings perpendicular to the bottom of the drawing or perpendicular to the dimension line was discussed. The general opinion seemed to be that the figures should be placed perpendicular to the dimension line. The American Museum of Safety, which adjoins the society's meeting room, was thrown open for the evening to members and visitors, and an opportunity was afforded to inspect the collection of the museum.

NEW BOOKS AND PAMPHLETS

Report of the Commissioner of Education for the Year Ended June 30, 1911. Volume II. 1407 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

The Physical Testing of Rock for Road Building. By Albert T. Goldbeck and Frank H. Jackson. 96 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Washington, D. C.

Railroad Operating Costs. By Suffern & Son. Volume II. 144 pages, 8 by 11 inches. Published by Suffern & Sons, New York. Price $2.

This volume includes the reports on the operations of railways for 1911, and comprises a continuation of studies in operating costs of the leading American railroads, undertaken by the authors. The book is divided into eight chapters, of which the first is of a general introductory character; the second deals with the maintenance of way and structures; the third with maintenance of equipment; the fourth with freight car maintenance; the fifth with locomotive maintenance; the sixth with passenger car maintenance; the seventh with transportation expenses; and the eighth with fuel. The last chapter gives exhaustive information about the cost and amount of fuel required under various conditions.

Hendricks' Commercial Register of the United States. 1574 pages, 7½ by 10 inches. Published by S. E. Hendricks Co., New York. Price, $10.

This is the twenty-first annual edition of this most useful book for buyers and sellers in the architectural, mechanical engineering, contracting, electrical, railroad, iron, steel, hardware, mining, milling, quarrying, exporting and kindred industries. The aim of the book is to furnish a complete classification list of manufacturers of various products for the benefit of those who want to buy as well as for those who want to sell. It contains over 350,000 names and addresses of manufacturers and dealers, arranged under nearly 40,000 business classifications. One of the main features of this book is the complete index of classifications included, which covers 122 pages with about 350 classifications on each page. The most important and valuable feature of this commercial register, outside of its unusual completeness, is the simplicity of its classifications, making it possible to locate a manufacturer of any product very quickly. Another valuable feature is that the trade names of all articles classified in the book have been included as far as it has been possible to secure them. These trade names appear in parentheses between the names and addresses of the manufacturers under the classifications where they appear. The new edition has been considerably enlarged, an addition of 155 pages having been made. As there are 230 pages of concellations, etc., omitted from the present edition, there is a total of 385 pages of new matter. The book should prove very useful to any business firm who has dealings with manufacturers or dealers in any of the lines mentioned above.

NEW CATALOGUES AND CIRCULARS

Standard Mfg. Co., Bridgeport, Conn., manufacturer of gear cutting machines, has issued a new catalogue.

Emerson Electric Mfg. Co., St. Louis, Mo. Bulletin No. 3711 on laboratory lathes for alternating and direct currents.

Temco Electric Motor Co., 99 Sugar St., Leipsic, Ohio. Folder showing applications of the Temco portable electric drill.

L. S. Starrett Co., Athol, Mass. Booklet descriptive of the Chicago store of the L. S. Starrett Co., illustrated with halftones.

Bausch & Lomb Optical Co., Rochester, N. Y. Catalogue describing large photomicrographic apparatus for laboratory work.

Bosch Magneto Co., 223-225 W. 46th St., New York. Catalogue describing the Bosch magneto ignition for one-cylinder motor-cycles.

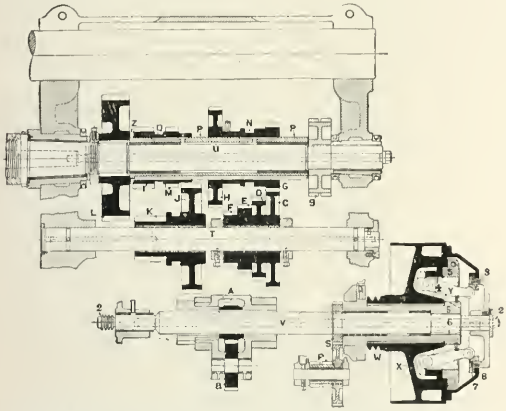
THE CINCINNATI HIGH POWER SPINDLE DRIVE

All the spindle drive gears are cut from solid steel forgings.

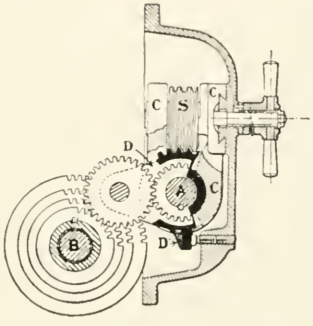
The eight that are chiefly used for speed changing—A, B, C, D, E, F, G and H—are nickel steel and hardened.

They all have stout teeth, resulting from a 20° pressure angle.

There are never any of them engaged when not required for the speed being used.



The Cincinnati gear train set for one of the eight fast speeds, which use only the tumbler gears A and B, the cone gear and G (or H). The bracket W carries the pulley and relieves shaft V of the belt pull. The tumbler gears, cone gears and sliding gears are nickel steel and hardened.



The massive tumbler frame C is clamped securely between its bearing and abutment D by screw S, at each working position.

The drive is always through the face gear "L," close to the working end of the spindle.

Neither the spindle nor any of the shafts are subjected to combined bending and torsional strains.

All shafts are supported in adequate bearings at both ends.

Because of the simplicity and rigidity of all its members the friction loss is small, and it transmits more of the power to the cutter at any speed, than others.

In other words, CINCINNATI HIGH-POWER MILLERS produce more work with the power used.

And they last longer and hold their accuracy better than others subjected to the same heavy duty of which ours are capable.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

European Agents—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

Canada Agent—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. Australian Agents—Thos. McPherson & Son, Melbourne.

Japan Agents—Andrews & George, Yokohama. Cuba Agent—Krajewski-Pesant Co., Havana.

Argentine Agents—Robert Pusterla & Co., Buenos Aires.

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Kerr Turbine Co., Wellsville, N. Y. Bulletin No. 26 describing the "Economy" steam turbine. Steam consumption curves are shown and size comparisons made.

Fulton Machine & Vise Co., Lowville, N. Y. 1912 catalogue of vises and centrifugal pumps. The catalogue illustrates and describes the Star, Peerless, F. & R., and Fulton types of vises.

Beaudry & Co., 141 Milk St., Boston, Mass. Catalogue of "Beaudry" power hammers comprising the Beaudry Champion, 50- to 500-pound rams, and the Beaudry Peerless, 25- to 200-pound ram.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York. Bulletin No. 902 describing and illustrating Sprague electric grab-bucket cranes, and showing examples of their use.

Gould & Eberhardt, Newark, N. J. Circular illustrating and describing the "Invincible Type" 24 inch shaper, designed to take care of extra heavy work required in steel mills, railroad shops and drop forging die shops.

American Stoker Co., 11 Broadway, New York. Bulletin B-1, entitled "The Class 'E' Stoker," illustrating and describing in detail the devices made by the company for obtaining high efficiency in the burning of coal.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 491, describing direct-current steel frame motors. The construction of the various parts is shown in detail, and instructions for starting and operating electric motors are given.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 153 on direct-current lighting and power generators from 200 to 1500 kilowatts; Bulletin No. 154 on oil insulated, self-cooled and water-cooled power transformers from 50 to 5000 KVA.

Gilbert & Barker Mfg. Co., Springfield, Mass. Catalogue B of gas furnaces, showing various types of furnaces built by the company, and giving information regarding the work for which they are adapted and tables of dimensions and capacities.

Autogenous Welding Equipment Co., 41 Bay St., Springfield, Mass. Circular containing a reprint from *The Locomotive* of an article entitled "Autogenous Welding for Repairing Boilers," together with additional material on autogenous welding.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 149, illustrating and describing direct-current motors and generators of 50 horsepower and larger. Details of the magnet frame, bearing brackets, armature laminations, armature and armature core are shown.

Fort Wayne Engineering & Mfg. Co., Fort Wayne, Ind. Catalogue No. 2022 illustrating and describing the "Paul" non-storage system of water supply, pumping water direct from well; Catalogue No. 2023 on "Paul" pneumatic systems of water supply.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin G-5 on Standard high-power small portable electric grinders, including tool-post electric grinders, parallel grinders and bench grinders; Bulletin No. D-6 of Standard high-power ball-bearing electric drills.

American Blower Co., Detroit, Mich. Bulletin No. 324, "The 'A B C' High-pressure Exhaust Fan, Type P"; Bulletin No. 344, "The 'A B C' Cast-iron Blowers and Exhaust Fans, Type V"; Bulletin No. 347, "Unit Heaters," adapted to all types of factory buildings.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 67 of differential recording gages. The bulletin shows the application of the instrument to boilers; reproductions of records made by it are included, as well as a table giving general dimensions of the device.

General Electric Co., Schenectady, N. Y. Lithographic poster in colors showing, full size, all the Edison "Mazda" lamps made by the company. The "Mazda" lamps range in capacity from 5 watts (for signs) to 500 watts (used for street lighting, railway terminals, etc.).

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets: No. 47A, Thrust Collar Bearings; No. 59A, Driving Clutch Thrust Bearings; No. 82, Ball Bearings in Horse Vehicles; Nos. 83, 84 and 85, Ball Bearing Mountings for Vertical Armature Shafts of Electric Motors.

A. J. Kelting Engineering Works, 459 Carroll St., Brooklyn, N. Y. Catalogue entitled "Positive Pressure Blowers," containing a comparison of the different methods of moving air for high, low and intermediate pressures, and a complete description of the Kelting pressure blowers.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 87 describing and illustrating hydraulic coupler yoke shearing and riveting press. This type of machine shears riveted coupler yokes from their couplers or clamps and rivets the couplers and yokes together with a single stroke of the ram.

Dayton Pump & Mfg. Co., Dayton, Ohio. Bulletin No. 15 illustrating and describing duplex double-acting power pumps and water supply systems for service conditions where the vertical suction lift does not exceed twenty feet. These pumps are built in twelve sizes, with capacities from 3 to 60 gallons per minute.

Eugene Dietzgen Co., 214-220 E. 23rd St., New York. Circular of the "Premier" ellipsograph for drawing ellipses and circles. The instrument is adapted for either pen or pencil work and is useful for draftsmen on cams, wheel spokes, apertures, projections, etc.; also circular of the "Dietzgen" fountain ruling pen.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 8007 illustrating and describing "Little David" pneumatic drills adapted for general drilling, reaming, tapping, flue rolling and wood boring. Illustrations showing the valve action of the drill are included, as well as several halftone illustrations showing the drill in actual use.

Winter Bros. Co., Wrentham, Mass. Catalogue No. 7 of high-speed steel taps and dies. This catalogue contains, in addition to price lists of taps and dies, considerable valuable information relating to tapping and threading, brief, concise paragraphs on such subjects as the size of taps, lead, speed of operation, lubrication, form of cutting edges, etc., being included.

Bullard Machine Tool Co., Bridgeport, Conn. Circular V-21 illustrating and describing the turret head of the Bullard vertical turret lathe. The illustrations show the construction of the turret in detail, giving the names of the various parts and describing the features of the new turret design and its advantages. An interesting record of tests for the accuracy of indexing and registry is included.

Gould & Eberhardt, Newark, N. J. Catalogue of high-duty automatic gear hobbing machines for spur, helical and worm gears. This catalogue contains a complete description of the design and operation of the Gould & Eberhardt automatic gear hobbing machines, as well as illustrations and specifications of the four sizes of machines built, ranging from 12 by 10 inches to 36 by 14 inches capacity.

E. Horton & Son Co., Windsor Locks, Conn. 1912 catalogue of lathe chucks, faceplate jaws, and drill chucks. This catalogue contains illustrations and descriptions of all the chucks designed and made by the S. E. Horton Machine Co., and the E. Horton & Son Co., which are now made by the consolidated company known by the latter name. The catalogue covers a wide line of independent, universal and combination chucks, two jaw chucks, drill chucks, and planer chucks.

Cleveland Hardware Co., Cleveland, Ohio. Safety poster in English and German illustrating hospital room, caring for an emergency case, safety device for trimming presses, danger from carelessly operated trucks, lineshaft dangers; danger to female operators running drill presses, etc. The poster carries blanks to be torn off and filled out by employes whenever defects in machinery or conditions injurious to health are noted; also reports of accidents when workmen are injured.

Ingersoll-Rand Co., 11 Broadway, New York. Catalogue form 75 entitled "Water Lifted by Compressed Air." During recent years considerable progress has been made in the development of compressed air pumping apparatus. The air lift has been found especially useful for asylums, hospitals, plantations, railway water tanks, etc. The catalogue describes the various methods employed for utilizing air for lifting water, and gives figures showing cost of operation of various installations.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn. Catalogue of multiple-spindle automatic chucking machines. This catalogue contains 38 pages, 9 by 12 inches, describing in detail the main features of the New Britain automatic multiple-spindle chucking machines. It is profusely illustrated with both halftones and line engravings and contains specifications and tables of capacities of the various sizes of these machines, as well as illustrations of the work for which these machines are peculiarly adapted.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., Circular No. 1516 illustrating and describing Baldwin-Westinghouse electric locomotives; Circular No. 1524 describing switchboard indicating meters; Leaflet No. 2494 describing synchronous booster rotary converters; Leaflet No. 2499 describing commutating-pole direct-current motors; Leaflet No. 2480 containing rules for the selection of machine tool motors; Leaflet No. 3505, on motors for paper mill service; Leaflets Nos. 2465 to 2471, on various kinds and types of meters.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue No. 82 of twist drills, reamers, drop-forged and screw wrenches, spring cotters, flat spring and riveted keys and drill chucks. This catalogue comprises 170 pages, 6 by 9 inches, and covers completely the extensive

Supplement to MA

Tables for Article in this number entitl

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GEAR RATIOS AND THEIR DECIMAL EQUIVALENTS—I

0.0167	1/60	0.0455	1/22	0.0862	5/58	0.1277	6/47	0.1698	9/53	0.2105	4/19
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0.0217	1/46	0.0571	2/35	0.0976	4/41	0.1389	5/36	0.1818	2/11	0.2222	2/9
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0.0278	1/36	0.0667	1/15	0.1071	3/28	0.1489	7/47	0.1897	11/58	0.2308	3/13
0.0286	1/35	0.0678	4/59	0.1081	4/37	0.1500	3/20	0.1904	4/21	0.2321	13/56
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0.0333	1/30	0.0714	1/14	0.1136	5/44	0.1538	2/13	0.1944	7/36	0.2364	13/55
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0.0345	1/29	0.0732	3/41	0.1154	3/26	0.1556	7/45	0.1956	9/46	0.2373	14/59
0.0351	2/57	0.0741	2/27	0.1163	5/43	0.1562	5/32	0.1961	10/51	0.2381	5/21
0.0357	1/28	0.0750	3/40	0.1167	7/60	0.1569	8/51	0.1964	11/56	0.2391	11/46
0.0364	2/55	0.0755	4/53	0.1176	2/17	0.1579	3/19	0.2000	1/5	0.2400	6/25
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0.0377	2/53	0.0784	4/51	0.1190	5/42	0.1600	4/25	0.2037	11/54	0.2414	7/29
0.0385	1/26	0.0789	3/38	0.1200	3/25	0.1607	9/56	0.2040	10/49	0.2424	8/33
0.0392	2/51	0.0800	2/25	0.1207	7/58	0.1613	5/31	0.2045	9/44	0.2432	9/37
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0.0435	1/23	0.0851	4/47	0.1250	1/8	0.1667	1/6	0.2083	5/24	0.2456	14/57
0.0444	2/45	0.0857	3/35	0.1273	7/55	0.1695	10/59	0.2093	9/43	0.2500	1/4

Contributed by G. M. Bartlett

No. 158, Data Sheet, MACHINERY, September, 1912

GEAR RATIOS AND THEIR DECIMAL EQUIVALENTS—II

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0.2586	15/58	0.3000	3/10	0.3429	12/35	0.3833	23/60	0.4250	17/40	0.4667	7/15
0.2593	7/27	0.3019	16/53	0.3437	11/32	0.3846	5/13	0.4255	20/47	0.4681	22/47
0.2600	13/50	0.3023	13/43	0.3448	10/29	0.3860	22/57	0.4259	23/54	0.4687	15/32
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0.2647	9/34	0.3056	11/36	0.3488	15/43	0.3898	23/59	0.4324	16/37	0.4727	26/55
0.2653	13/49	0.3061	15/49	0.3500	7/20	0.3902	16/41	0.4333	13/30	0.4737	9/19
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0.2683	11/41	0.3095	13/42	0.3519	19/54	0.3929	11/28	0.4359	17/39	0.4762	10/21
0.2692	7/26	0.3103	9/29	0.3529	6/17	0.3939	13/33	0.4364	24/55	0.4773	21/44
0.2703	10/37	0.3111	14/45	0.3542	17/48	0.3947	15/38	0.4375	7/16	0.4783	11/23
0.2708	13/48	0.3125	5/16	0.3548	11/31	0.3953	17/43	0.4386	25/57	0.4792	23/48
0.2712	16/59	0.3137	16/51	0.3556	16/45	0.3958	19/48	0.4390	18/41	0.4800	12/25
0.2727	3/11	0.3143	11/35	0.3559	21/59	0.3962	21/53	0.4400	11/25	0.4808	25/52
0.2745	14/51	0.3148	17/54	0.3571	5/14	0.3966	23/58	0.4407	26/59	0.4815	13/27
0.2750	11/40	0.3158	6/19	0.3585	19/53	0.4000	2/5	0.4412	15/34	0.4821	27/56
0.2759	8/29	0.3166	19/60	0.3590	14/39	0.4035	23/57	0.4419	19/43	0.4827	14/29
0.2766	13/47	0.3171	13/41	0.3600	9/25	0.4038	21/52	0.4423	23/52	0.4833	29/60
0.2778	5/18	0.3182	7/22	0.3611	13/36	0.4043	19/47	0.4444	4/9	0.4839	15/31
0.2791	12/43	0.3191	15/47	0.3617	17/47	0.4048	17/42	0.4464	25/56	0.4848	16/33
0.2800	7/25	0.3200	8/25	0.3621	21/58	0.4054	15/37	0.4468	21/47	0.4857	17/35
0.2807	16/57	0.3206	17/53	0.3636	4/11	0.4062	13/32	0.4474	17/38	0.4865	18/37
0.2812	9/32	0.3214	9/28	0.3654	19/52	0.4068	24/59	0.4483	13/29	0.4872	19/39
0.2821	11/39	0.3220	19/59	0.3659	15/41	0.4074	11/27	0.4490	22/49	0.4878	20/41
0.2826	13/46	0.3226	10/31	0.3667	11/30	0.4082	20/49	0.4500	9/20	0.4884	21/43
0.2830	15/53	0.3235	11/34	0.3673	18/49	0.4091	9/22	0.4510	23/51	0.4889	22/45
0.2833	17/60	0.3243	12/37	0.3684	7/19	0.4103	16/39	0.4516	14/31	0.4894	23/47
0.2857	2/7	0.3250	13/40	0.3696	17/46	0.4107	23/56	0.4524	19/42	0.4898	24/49
0.2881	17/59	0.3256	14/43	0.3703	10/27	0.4118	7/17	0.4528	24/53	0.4902	25/51
0.2885	15/52	0.3261	15/46	0.3714	13/35	0.4130	19/46	0.4545	5/11	0.4906	26/53
0.2889	13/45	0.3265	16/49	0.3721	16/43	0.4138	12/29	0.4561	26/57	0.4909	27/55
0.2895	11/38	0.3269	17/52	0.3725	19/51	0.4146	17/41	0.4565	21/46	0.4912	28/57
0.2903	9/31	0.3273	18/55	0.3729	22/59	0.4151	22/53	0.4571	16/35	0.4915	29/59
0.2909	16/55	0.3276	19/58	0.3750	3/8	0.4167	5/12	0.4576	27/59	0.5000	1/2
0.2917	7/24	0.3333	1/3	0.3776	20/53	0.4182	23/55	0.4583	11/24	0.5085	30/59

Contributed by G. M. Bartlett

No. 158, Data Sheet, MACHINERY, September, 1912

GEAR RATIOS AND THEIR DECIMAL EQUIVALENTS—III

0.5088	29/57	0.5435	25/46	0.5854	24/41	0.6275	32/51	0.6731	35/52	0.7111	32/45
0.5091	28/55	0.5439	31/57	0.5862	17/29	0.6279	27/43	0.6735	33/49	0.7115	37/52
0.5094	27/53	0.5455	6/11	0.5870	27/46	0.6286	22/35	0.6739	31/46	0.7119	42/59
0.5098	26/51	0.5472	29/53	0.5882	10/17	0.6296	17/27	0.6744	29/43	0.7143	5/7
0.5102	25/49	0.5476	23/42	0.5893	33/56	0.6304	29/46	0.6750	27/40	0.7167	43/60
0.5106	24/47	0.5484	17/31	0.5897	23/39	0.6316	12/19	0.6757	25/37	0.7170	38/53
0.5111	23/45	0.5490	28/51	0.5909	13/22	0.6326	31/49	0.6765	23/34	0.7174	33/46
0.5116	22/43	0.5500	11/20	0.5918	29/49	0.6333	19/30	0.6774	21/31	0.7179	28/39
0.5122	21/41	0.5510	27/49	0.5926	16/27	0.6341	26/41	0.6780	40/59	0.7187	23/32
0.5128	20/39	0.5517	16/29	0.5932	35/59	0.6346	33/52	0.6786	19/28	0.7193	41/57
0.5135	19/37	0.5526	21/38	0.5937	19/32	0.6364	7/11	0.6792	36/53	0.7200	18/25
0.5142	18/35	0.5532	26/47	0.5946	22/37	0.6379	37/58	0.6800	17/25	0.7209	31/43
0.5151	17/33	0.5536	31/56	0.5952	25/42	0.6383	30/47	0.6809	32/47	0.7222	13/18
0.5161	16/31	0.5556	5/9	0.5957	28/47	0.6389	23/36	0.6818	15/22	0.7234	34/47
0.5167	31/60	0.5577	29/52	0.5962	31/52	0.6400	16/25	0.6829	28/41	0.7241	21/29
0.5172	15/29	0.5581	24/43	0.5965	34/57	0.6410	25/39	0.6833	41/60	0.7250	29/40
0.5179	29/56	0.5588	19/34	0.6000	3/5	0.6415	34/53	0.6842	13/19	0.7255	37/51
0.5185	14/27	0.5593	33/59	0.6034	35/58	0.6429	9/14	0.6852	37/54	0.7273	8/11
0.5192	27/52	0.5600	14/25	0.6038	32/53	0.6441	38/59	0.6857	24/35	0.7288	43/59
0.5200	13/25	0.5610	23/41	0.6042	29/48	0.6444	29/45	0.6863	35/51	0.7292	35/48
0.5208	25/48	0.5614	32/57	0.6047	26/43	0.6452	20/31	0.6875	11/16	0.7297	27/37
0.5217	12/23	0.5625	9/16	0.6053	23/38	0.6458	31/48	0.6889	31/45	0.7308	19/26
0.5227	23/44	0.5636	31/55	0.6060	20/33	0.6471	11/17	0.6897	20/29	0.7317	30/41
0.5238	11/21	0.5641	22/39	0.6071	17/28	0.6481	35/54	0.6905	29/42	0.7321	41/56
0.5250	21/40	0.5652	13/23	0.6078	31/51	0.6486	24/37	0.6909	38/55	0.7333	11/15
0.5254	31/59	0.5660	30/53	0.6087	14/23	0.6491	37/57	0.6923	9/13	0.7347	36/49
0.5263	10/19	0.5667	17/30	0.6098	25/41	0.6500	13/20	0.6939	34/49	0.7353	25/34
0.5273	29/55	0.5676	21/37	0.6102	36/59	0.6512	28/43	0.6949	41/59	0.7358	39/53
0.5278	19/36	0.5682	25/44	0.6111	11/18	0.6522	15/23	0.6957	16/23	0.7368	14/19
0.5283	28/53	0.5686	29/51	0.6122	30/49	0.6531	32/49	0.6964	39/56	0.7381	31/42
0.5294	9/17	0.5690	33/58	0.6129	19/31	0.6538	17/26	0.6970	23/33	0.7391	17/23
0.5306	26/49	0.5714	4/7	0.6136	27/44	0.6545	36/55	0.6977	30/43	0.7400	37/50
0.5312	17/32	0.5741	31/54	0.6140	35/57	0.6552	19/29	0.6981	37/53	0.7407	20/27
0.5319	25/47	0.5745	27/47	0.6154	8/13	0.6562	21/32	0.7000	7/10	0.7414	43/58
0.5333	8/15	0.5750	23/40	0.6167	37/60	0.6571	23/35	0.7018	40/57	0.7419	23/31
0.5345	31/58	0.5757	19/33	0.6170	29/47	0.6579	25/38	0.7021	33/47	0.7429	26/35
0.5349	23/43	0.5763	34/59	0.6176	21/34	0.6585	27/41	0.7027	26/37	0.7436	29/39
0.5357	15/28	0.5769	15/26	0.6182	34/55	0.6591	29/44	0.7037	19/27	0.7442	32/43
0.5366	22/41	0.5778	26/45	0.6190	13/21	0.6596	31/47	0.7045	31/44	0.7447	35/47
0.5370	29/54	0.5789	11/19	0.6200	31/50	0.6600	33/50	0.7059	12/17	0.7451	38/51
0.5385	7/13	0.5800	29/50	0.6207	18/29	0.6604	35/53	0.7069	41/58	0.7455	41/55
0.5400	27/50	0.5806	18/31	0.6216	23/37	0.6607	37/56	0.7073	29/41	0.7458	44/59
0.5405	20/37	0.5814	25/43	0.6222	28/45	0.6610	39/59	0.7083	17/24	0.7500	3/4
0.5417	13/24	0.5818	32/55	0.6226	33/53	0.6666	2/3	0.7091	39/55	0.7544	43/57
0.5424	32/59	0.5833	7/12	0.6250	5/8	0.6724	39/58	0.7097	22/31	0.7547	40/53
0.5429	19/35	0.5849	31/53	0.6271	37/59	0.6727	37/55	0.7105	27/38	0.7551	37/49

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No. 158, Data Sheet, MACHINERY, September, 1912

GEAR RATIOS AND THEIR DECIMAL EQUIVALENTS—IV

0.7561	31/41	0.7949	31/39	0.8378	31/37	0.8788	29/33	0.9189	34/37	0.9600	24/25
0.7568	28/37	0.7955	35/44	0.8387	26/31	0.8793	51/58	0.9200	23/25	0.9608	49/51
0.7576	25/33	0.7959	39/49	0.8393	47/56	0.8800	22/25	0.9211	35/38	0.9615	25/26
0.7586	22/29	0.7963	43/54	0.8400	21/25	0.8810	37/42	0.9216	47/51	0.9623	51/53
0.7593	41/54	0.7966	47/59	0.8409	37/44	0.8814	52/59	0.9231	12/13	0.9630	26/27
0.7600	19/25	0.8000	4/5	0.8421	16/19	0.8824	15/17	0.9243	49/53	0.9636	53/55
0.7609	35/46	0.8036	45/56	0.8431	43/51	0.8833	53/60	0.9250	37/40	0.9643	27/28
0.7619	16/21	0.8039	41/51	0.8437	27/32	0.8837	38/43	0.9259	25/27	0.9649	55/57
0.7627	45/59	0.8043	37/46	0.8444	38/45	0.8846	23/26	0.9268	38/41	0.9655	28/29
0.7632	29/38	0.8049	33/41	0.8448	49/58	0.8857	31/35	0.9273	51/55	0.9661	57/59
0.7636	42/55	0.8056	29/36	0.8462	11/13	0.8864	39/44	0.9286	13/14	0.9667	29/30
0.7647	13/17	0.8065	25/31	0.8475	50/59	0.8868	47/53	0.9298	53/57	0.9677	30/31
0.7660	36/47	0.8070	46/57	0.8478	39/46	0.8889	8/9	0.9302	40/43	0.9687	31/32
0.7667	23/30	0.8077	21/26	0.8485	28/33	0.8909	49/55	0.9310	27/29	0.9697	32/33
0.7674	33/43	0.8085	38/47	0.8491	45/53	0.8913	41/46	0.9318	41/44	0.9706	33/34
0.7679	43/56	0.8095	17/21	0.8500	17/20	0.8919	33/37	0.9322	55/59	0.9714	34/35
0.7692	10/13	0.8103	47/58	0.8511	40/47	0.8929	25/28	0.9333	14/15	0.9722	35/36
0.7708	37/48	0.8108	30/37	0.8519	23/27	0.8936	42/47	0.9348	43/46	0.9730	36/37
0.7714	27/35	0.8113	43/53	0.8529	29/34	0.8947	17/19	0.9355	29/31	0.9737	37/38
0.7719	44/57	0.8125	13/16	0.8537	35/41	0.8958	43/48	0.9362	44/47	0.9743	38/39
0.7727	17/22	0.8136	48/59	0.8542	41/48	0.8966	26/29	0.9375	15/16	0.9750	39/40
0.7736	41/53	0.8140	35/43	0.8545	47/55	0.8974	35/39	0.9388	46/49	0.9756	40/41
0.7742	24/31	0.8148	22/27	0.8571	6/7	0.8980	44/49	0.9394	31/33	0.9762	41/42
0.7750	31/40	0.8158	31/38	0.8596	49/57	0.8983	53/59	0.9400	47/50	0.9767	42/43
0.7755	38/49	0.8163	40/49	0.8600	43/50	0.9000	9/10	0.9412	16/17	0.9773	43/44
0.7759	45/58	0.8167	49/60	0.8604	37/43	0.9020	46/51	0.9423	49/52	0.9778	44/45
0.7778	7/9	0.8182	9/11	0.8611	31/36	0.9024	37/41	0.9429	33/35	0.9783	45/46
0.7797	46/59	0.8200	41/50	0.8621	25/29	0.9032	28/31	0.9434	50/53	0.9787	46/47
0.7800	39/50	0.8205	32/39	0.8627	44/51	0.9038	47/52	0.9444	17/18	0.9792	47/48
0.7805	32/41	0.8214	23/28	0.8636	19/22	0.9048	19/21	0.9455	52/55	0.9796	48/49
0.7812	25/32	0.8222	37/45	0.8644	51/59	0.9057	48/53	0.9459	35/37	0.9800	49/50
0.7818	43/55	0.8230	14/17	0.8647	32/37	0.9062	29/32	0.9464	53/56	0.9804	50/51
0.7826	18/23	0.8246	47/57	0.8654	45/52	0.9070	39/43	0.9474	18/19	0.9808	51/52
0.7833	47/60	0.8250	33/40	0.8667	13/15	0.9074	49/54	0.9483	55/58	0.9811	52/53
0.7838	29/37	0.8261	19/23	0.8679	46/53	0.9091	10/11	0.9487	37/39	0.9815	53/54
0.7843	40/51	0.8269	43/52	0.8684	33/38	0.9107	51/56	0.9492	56/59	0.9818	54/55
0.7857	11/14	0.8276	24/29	0.8696	20/23	0.9111	41/45	0.9500	19/20	0.9821	55/56
0.7872	37/47	0.8286	29/35	0.8704	47/54	0.9118	31/34	0.9512	39/41	0.9825	56/57
0.7879	26/33	0.8293	34/41	0.8710	27/31	0.9123	52/57	0.9524	20/21	0.9828	57/58
0.7885	41/52	0.8298	39/47	0.8718	34/39	0.9130	21/23	0.9535	41/43	0.9831	58/59
0.7895	15/19	0.8302	44/53	0.8723	41/47	0.9138	53/58	0.9545	21/22	0.9833	59/60
0.7907	34/43	0.8305	49/59	0.8727	48/55	0.9143	32/35	0.9555	43/45	......	..
0.7917	19/24	0.8333	5/6	0.8750	7/8	0.9149	43/47	0.9565	22/23	......	..
0.7926	42/53	0.8364	46/55	0.8772	50/57	0.9153	54/59	0.9574	45/47	......	..
0.7931	23/29	0.8367	41/49	0.8775	43/49	0.9167	11/12	0.9583	23/24	......	..
0.7941	27/34	0.8372	36/43	0.8780	36/41	0.9184	45/49	0.9592	47/49	......	..

Contributed by G. M. Bartlett

No. 158, Data Sheet, MACHINERY, September, 1912

MACHINERY

OCTOBER, 1912

WIRE DRAWING

METHODS AND MACHINES USED BY THE DRIVER-HARRIS WIRE CO.

BY ERIK OBERG

THE making or drawing of wire of small diameter has, for centuries past, formed an industry by itself. As the methods used in this industry are comparatively unknown to the average mechanic, a description of them and of the machines used will probably be of interest. On account of the fact that wire drawing is a very old art, many of the methods used have been handed down from generations. Improved machinery, however, has been introduced, and the rapidity and accuracy by which the wire can be produced has been greatly increased during recent years.

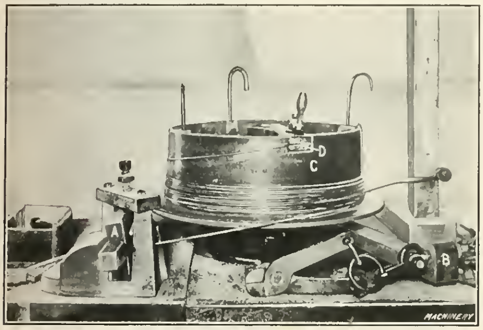

Fig. 1. A Typical Wire Drawing Machine for Heavy Wire

The earliest mention of wire drawing is in an historical document which shows that in 1351 there were men engaged in this work in Augsburg in Germany, and it is believed that the art was originated by a man named Rudolph, from Nuremberg, about that time. It is definitely known that in 1370 there was a wire drawing mill in the latter city making wire from a number of different metals. From Germany the art of wire drawing was introduced into England in the seventeenth century. The first wire drawing mill in America was built in 1775 in Norwich, Conn., by Nathaniel Niles, who was granted a loan of $1500 by the court for this purpose. Previous to the development of wire drawing, wire was made by hammering or beating metal into thin sheets or plates, which were cut into continuous strips. These strips were then afterwards rounded by hammering.

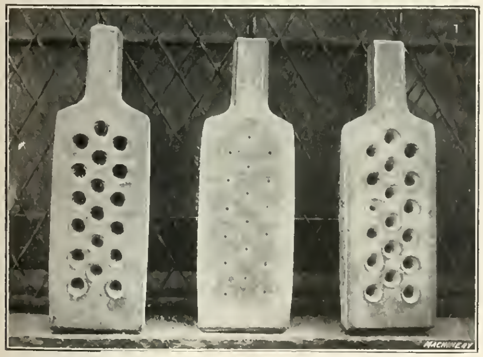

Fig 2. Front and Rear Views of Draw Plates

Modern Wire Drawing Machines

The machines illustrated in connection with the present article, and the methods described, are those used by the Driver-Harris Wire Co., Harrison, N. J. This company manufactures high-class wire, mainly for electrical purposes, the wire being drawn from nickel-steel and nickel-chromium alloys, copper and nickel alloys, copper and brass. The methods employed for drawing wire of different materials must be varied to suit the metal or alloy being drawn, and, therefore, a number of different types of wire drawing machines are employed. The diameter to which the wire is drawn also has an influence on the choice of method used. The special qualities required of the wire used for electrical instrument work, especially electrical heating devices, pyrometers, etc., are that it shall have a high resistance and a high melting point. This is the reason for the use of the many special alloys mentioned.

In describing the methods used, three main divisions or classes of wire may be distinguished, and the special machines and methods used for each class will be illustrated and described. The first class comprises iron and nickel, and nickel and copper alloy wire drawn to a diameter of from No. 3 to No. 18 Brown & Sharpe wire gage (from 0.229 to 0.040 inch in diameter). The second class comprises wire of the same materials from No. 18 Brown & Sharpe gage (0.040 inch) down to 0.002 inch in diameter. The third class comprises brass and copper wire in sizes from 1/4 inch in diameter down. In addition, flat wire is manufactured. This is first drawn round, however, to a given diameter, and is then merely flattened out between ground rollers.

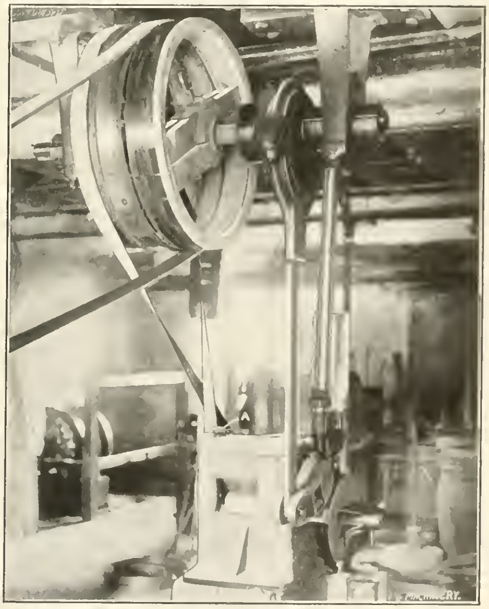

Fig. 3. A Wire Pointing Machine

Drawn Wire made from Nickel Steel, Nickel Chromium, and Nickel and Copper Alloys

The wire from which the finer sizes are drawn is about 1/4 inch in diameter. It is rolled to this dimension in the wire rolling mill connected with the wire drawing mill, and is wound up into coils suitable to be put onto the reels used in connection with the wire drawing machines. In the rolling mill department the various alloys are melted, cast into ingots, hammered and rolled out, in much the same way as is ordi-

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* Associate Editor of MACHINERY.

nary drill-rod or tool-steel wire. (A description of the methods used for this work was published in MACHINERY, in the November, 1909, number, in an article entitled "The Making of Tool Steel").

After having been received from the rolling mill, wire of the size and material constituting the first class mentioned in the foregoing, is drawn in wire benches or machines of the type shown in Fig. 1. Before the drawing commences, the wire must be pointed so that the operator can push the end of it through the draw plate, this plate being provided with holes through which the wire is pulled in order to reduce its diameter. The pointing is done in the machine shown in Fig. 3, which is provided with two rollers, oscillated back and forth by means of the lever shown on the right-hand side of the machine, and the eccentric mounted on the countershaft near the ceiling. The rollers are provided with a number of grooves in their faces, the grooves of the two rollers meshing with each other and the diameters of the grooves decreasing successively from one end of the roller to the other. The upper roller can be raised and lowered by manipulating a handle at *A*. By pushing the wire into a number of successive grooves, the operator obtains a point for starting it through the draw plate.

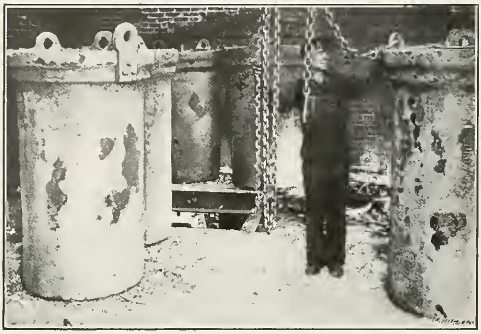


Fig. 4. A Number of Large Annealing Pots used in Wire Mill

Referring to Fig. 1, the wire is pushed, by hand, through the hole in the draw plate *A*, which is of the correct diameter to which the wire is to be reduced. It is then pulled through by power for a distance of about 24 to 30 inches by means of an arm *B* provided with a tong or grip jaws at its end, and operated by a cam on the vertical shaft of the machine upon which pulley *C* is mounted. As soon as a sufficient portion of the wire has thus been pulled through to permit it to be attached to the pulley or block upon which the drawn wire is wound, the end of the wire is clamped between jaws *D*, as shown, and the block is set in motion by a foot treadle, which permits it to engage a clutch, thus connecting it to the driving mechanism beneath the wire bench. This driving mechanism consists of a longitudinal shaft which drives a number of blocks by means of spur and bevel gearing.

The blocks are driven at different speeds according to the diameter of the wire being drawn and the characteristics of the alloys used. A general idea of the speeds allowable may be had from the fact that iron and brass may be drawn at velocities varying from 12 to 45 inches per second. Wire of less tensile strength must, of course, be drawn at a slower speed than that of a higher tensile strength. On the other hand, more ductile wire can be drawn at a much higher speed than that which is less ductile. One of the important considerations in wire drawing is that a line passing at right angles through the center of the hole in the draw plate through which the wire is drawn, and at right angles to the face of the plate, should be tangent to the pulley or block upon which the wire is wound; otherwise, the wire is liable to become kinky and will not be of a uniform structure throughout its cross-section.

When drawing, the wire is pulled off from a reel on which the coil is laid previous to drawing, and is reeled off as the drawing proceeds. These reels are not shown in Fig. 1, but one of them can be seen to the left in Fig. 6. Before the wire goes through the draw plate, it passes through a container holding the lubricant. Grease, soap water or pulverized soap are used for lubricating the wire, according to the material being drawn. Music wire, the characteristic of which is that it possesses exceedingly high tensile strength, must be drawn wet or very thoroughly lubricated, and, in this case, the reels with the wire are set into tubs containing the lubricating solution of soap water and are reeled off from the submerged reels and immediately drawn through the draw plate. At first thought it might seem that the same result would be obtained by flooding the wire in soap solution immediately before it enters into the hole in the die. Undoubtedly the same effect would be obtained in this manner, but the method of submerging the coils in a tub containing the lubricating solution has been found simpler, as in this way pumping arrangements, piping and pans for taking care of the lubrication become unnecessary.

The draw plates, three of which are shown in Fig. 2, are made of a high-grade tungsten steel into which usually eighteen holes of different sizes are drilled and reamed. These holes taper, having the correct diameter of the wire to be drawn at that face of the plate which is towards the block or pulley. The draw plate in the center shows the face, while those at the sides show the back of the plate with the tapered hole where the wire enters. The draw plates are furnished already drilled and reamed by the steel makers, and the only work required to be done on these plates in the wire drawing mill is to keep the holes to size. This is done by heating the plates and hammering them so as to reduce the diameter of the holes. After the plates have been hammered the holes are reamed out by small hand reamers, the size being gaged by drawing a wire through the hole and measuring it by micrometers. The diameter of the wire drawn is also measured by micrometers after each time it has been passed through the draw plates, in order to guard against inaccuracies due to the wear of the holes in the plates. These holes wear very rapidly, and it is, therefore, necessary to keep constant watch as to their performance.

The wire is reduced in diameter at each drawing or pass by one number or step in the Brown & Sharpe wire gage scale. This wire gage, which was compiled in 1864 by Messrs. Brown & Sharpe, is not entirely arbitrary, as one might think after a casual inspection of the wire diameters of the various sizes, but the diameters of the wires of successive numbers increase according to a geometrical ratio. For example, the step between Nos. 17 and 18 B. & S. gage is about 0.005 inch, while the step between Nos. 8 and 9 is about 0.014 inch. The ratio of the diameter of No. 8 to No. 9 is the same, however, as the ratio of No. 17 to No. 18. Each succeeding number can be found by multiplying the preceding number by 1.123, this being the constant factor of the geometrical ratio on which the Brown & Sharpe wire gage system is based. The basic size is No. 36 wire, which is 0.005 inch in diameter.

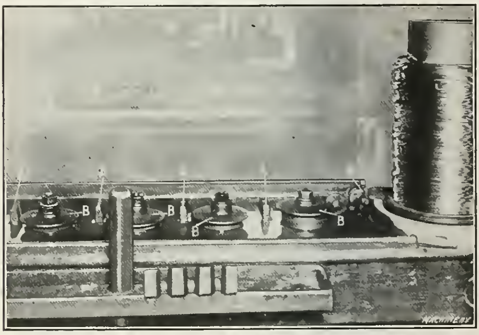


Fig. 5. Part of a Continuous Wire Drawing Machine for Finer Sizes of Wire

The drawn wire wound up on the block of the wire drawing machine requires to be annealed either between each pass, as in the case of certain materials, or between, perhaps, only every fifth or sixth pass, as in the case of other alloys. For the annealing process the wire is packed in large cast-iron pots about three feet in diameter and six feet high, some of these pots being shown in Fig. 4. Four furnaces are provided, each capable of holding one of these pots, the pots being lowered down into the furnace in a vertical direction. The temperature of the furnace is gaged by means of pyrometers. The pots containing the wire coils are heated for about ten hours and are then permitted to cool for about twenty-four hours. According to the material being annealed, the wire is either put in the pots without any packing at all, or, in other cases, packing of charcoal, sand or lime is used. After the annealing pots have cooled off and the wire coils have been taken out of them the coils are pickled by being dipped in tanks containing diluted sulphuric or hydrochloric acid. This acid is then dried off by drying the wire coils in an oven heated by means of steam coils to a temperature of about 220 degrees F.

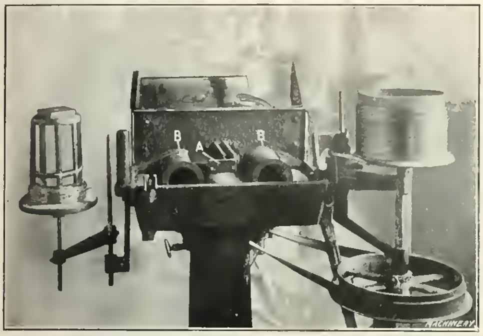


Fig. 6. Another Continuous Wire Drawing Machine for Fine Wire

Drawing Fine Sizes of Wire

The finer sizes of iron, nickel and chromium alloy wire—those between 0.040 and 0.002 inch in diameter—are drawn through a succession of dies at one operation. These finer sizes are pointed either by merely pulling the wire apart by hand or by filing the end. Part of one of the machines used for drawing wire down to 0.010 inch in diameter is shown in Fig. 5. The wire is reeled off from a reel at the left, which is not shown in the illustration, and then passes successively through the dies shown at *A*. After the wire has passed through one die it passes around a pulley *B*, mounted on a vertical shaft, and then through the next die, and so on until it has gone through the required number of successive dies. The maximum number of dies provided in this machine is ten, of which only five are shown. To the right is shown the block or drum upon which the drawn wire is coiled.

Each die reduces the diameter of the wire one number in the Brown & Sharpe wire gage scale. The various pulleys *B* are geared to the proper speed for the diameter and speed of the wire at the time it passes around each respective pulley. It is evident that as the wire travels through die after die and is gradually reduced in diameter, the speed at which the wire passes around the pulleys and through the next die increases. As the Brown & Sharpe gage numbers decrease according to a geometrical ratio, the speeds of the pulleys are also in a geometrical ratio, increasing with the decreasing diameter of the wire. In designing the machine, it is assumed to be preferable to have the pulleys run a trifle too slow rather than too fast, in order to prevent the wire from coiling up in front of the die it is to pass through. If the speed is a trifle too slow there will be merely a pull on the wire which, within limits, has no detrimental effect. The rollers and dies are all immersed in a soap solution for which the machine bed itself forms a trough, as shown, so that the wire is thoroughly lubricated while being drawn.

Sizes finer than 0.010 inch are drawn in machines of the type shown in Fig. 6. In these machines the dies are all placed in the central bracket *A*, while the wire is wound back and forth over drums *B*. The reel from which the wire is being wound off is shown at the left, and the block on which it is wound after having passed from the last drawing die is shown to the right. Block *A* contains twelve dies, and the drums *B* are grooved so that the wire is wound around them from the back towards the front, passing through a die each time it passes on the upper side from the left to the right drum. In this case the wire is reduced, for each pass, only one-half of a number in the Brown & Sharpe wire gage scale. As the wire between the various passes runs over drums rotating at a uniform speed, the increase in speed of the wire as it is reduced in diameter must be taken care of by the slipping of the wire over the drums. At first sight it might seem that this would cause difficulties, but practical experience shows that this method is perfectly feasible. The drums and the dies are immersed in soap solution the same as in the case of the machine shown in Fig. 5. While twelve dies are provided in this case, it is evident, of course, that when the reduction to be made is less than that for which all the twelve dies would be required, only the number of dies that corresponds to the required reduction is used. After the wire has been drawn, it is annealed as already mentioned in the case of wire of larger diameter.

Diamond Dies

The dies used for the drawing of the finer wire are so-called diamond dies, a number of these being shown in Fig. 8. These dies consist of a body made from brass into which is counterbored a hole of about ½ inch diameter. A small hole for the wire is drilled clear through the brass body. The counterbored hole in the body constitutes a seat for the diamond which is set in the center of the hole with molten brass or solder poured in around it until the hole is filled.

A view of the diamond die drilling department is shown in Fig. 7. The machines shown in the foreground are for recutting or enlarging the holes in dies which are worn, while the machines in the background are used for cutting or drilling the holes in new diamonds.

When a diamond die is to be made, the diamond (of the variety known as bort) is first prepared in a regular bench lathe. The diamond or "stone," as it is ordinarily termed in the shop, is held to a small faceplate in the bench lathe by diamond cement. It is then flattened on two sides by means of another stone held in a pair of pliers. The stone is then cupped or centered (also by the use of another stone) to provide a starting point for the diamond drill, by means of which a fine hole is drilled with the drilling machine shown in the background of Fig. 7. The stone is held in this machine on the flat end of the spindle with diamond cement. The drill used for the hole is made from an ordinary sewing needle ground on the end by hand to the correct diameter. This needle, the end of which is supplied with diamond dust and oil, is put into a rotating spindle in the machine and revolves at a speed of about 2000 revolutions per minute. The stone itself does not revolve, but merely oscillates back and forth towards the needle, the oscillation being produced by a cam. Provisions are made for increasing or decreasing these oscillations, and for feeding the stone forwards towards the needle as the hole is being drilled through. Ordinarily, about ten hours is required for piercing an average stone. The hole in the stone is gaged by drawing a wire through it and measuring the wire with a special micrometer, graduated so as to

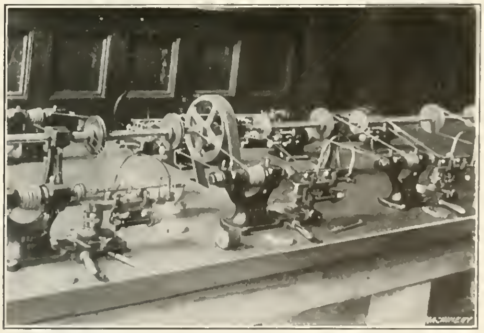


Fig. 7 Some of the Diamond Die Drilling Machines

read directly to 0.0001 inch, and on which it is easy to estimate one-half of a ten-thousandth of an inch on account of the size of the graduations.

After the hole has been drilled through to the proper diameter it must be tapered at the back end, much the same as the holes in the large draw blocks in Fig. 3 are tapered. The taper in the stones is produced by grinding the needle to a taper and using the same machine with diamond dust and oil as before. After the stone has been drilled, tapered and properly gaged, it is placed in the holder. While pouring the molten brass into the counterbored hole in the holder the stone is held in place with a center in a small machine similar to a bench drill press.

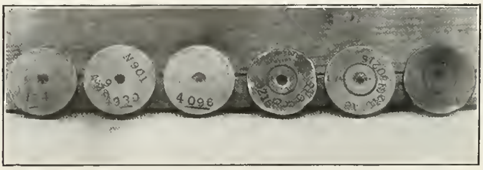


Fig. 8. A Collection of Diamond Dies

After having thus secured the stone in the die, the die-holder is faced off in a bench lathe, and the proper setting of the diamond in the die is tested by placing the die on a needle of the correct diameter for the hole in the diamond. If the die "balances" perfectly on the needle it indicates that the diamond is properly set into the body. It is important that a die be set with its axis accurately at right angles to the face of the brass disk or body, as, otherwise the wire drawn through it will not be straight. Should the die show a tendency to stand off at an angle when pushed onto the testing needle, this would indicate that the hole in the diamond was not set squarely with the face of the die. To the observer, the method of making a diamond die is apparently simple, but it requires a great deal of skill and patience.

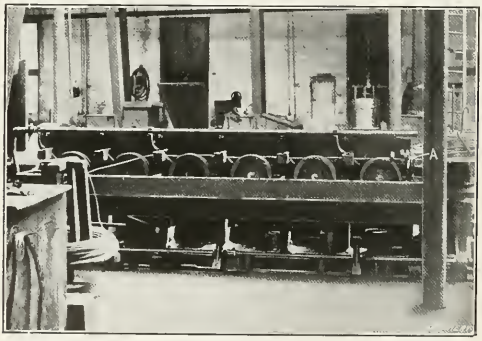


Fig. 9. A Machine known as "Bull-block," used for Heavy Sizes of Copper and Brass Wire

A record is kept of the performance of all dies, showing the material on which they are used and the length of time that the hole remains true to size. When the dies are found to be worn they are sent back to the diemaker, who first tests them for size and examines them under a microscope to determine the condition of the die. Sometimes the dies crack after having been used for some time, in which case they are either used for smaller dies or are crushed to provide the diamond dust by the aid of which the holes in the dies are drilled and enlarged. Those dies which upon their return are found to be perfect, except that they have worn so that they cannot be used for the size to which they were originally cut, are enlarged so as to be used for the next larger size of wire.

The recutting is done in the recutting lathes shown in the foreground in Fig. 7. In this case the die is held with wax onto the faceplate of the spindle of the machine and is revolved at about 1800 revolutions per minute. The needle which enlarges the hole is not revolved in this case, but is oscillated in the longitudinal direction by a cam and by the spring shown bent over the tailstock end of the machine. The stones vary in hardness, and while the average time for enlarging a hole 0.001 inch in diameter is about one and one-half hours, in many cases it happens that ten or twelve hours is required for removing a single thousandth of an inch. In this department there are thirteen recutting lathes and three machines for cutting new diamond dies constantly in operation, and the diemaker must keep a careful record of the conditions under which each machine operates, so that he can stop a machine and test his die at the right time. The machines are all driven from a shaft running through the center of the table, as shown, this shaft being driven from a motor underneath the bench.

Brass and Copper Wire

Brass and copper wire is drawn more easily than are the larger sizes of alloy wire, and can, therefore, be drawn, for all sizes, in machines having a number of successive dies. The machine shown in Fig. 9 is called a "bull block," and is used for drawing brass and copper wire in sizes between 1/8 and 1/4 inch in diameter. This machine has a capacity for seven dies, although, of course, the number of dies being used at any one time is determined by the required reduction of the wire. In the illustration five dies are used. Each pass reduces the wire one number on the Brown & Sharpe wire gage scale. The reel on which the coil of wire being drawn is held, is shown to the left, and at the extreme right is shown the block onto which the drawn wire is wound. The last die at *A* revolves about the wire being drawn in order to produce a smoother surface. The dies proper are made of rectangular blocks of chilled cast iron. The wire passes through the dies and around the pulleys shown between each pair of dies in a manner similar to that described for the machine shown in Fig. 5. The lower half of the pulley is immersed in lubricating solution, the bed of the machine forming a trough for this. The wire is threaded through the various dies by a special machine by means of which it is pulled through each die an amount

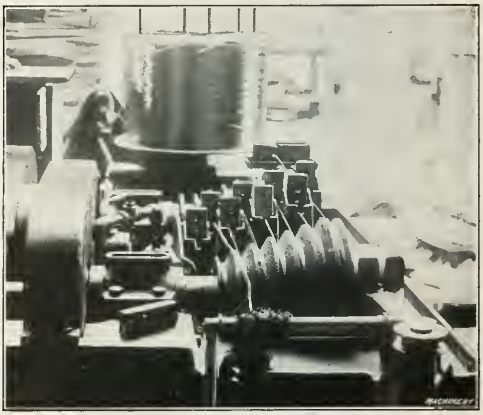


Fig. 10. Another Type of Wire Drawing Machine used for Copper and Brass Wire

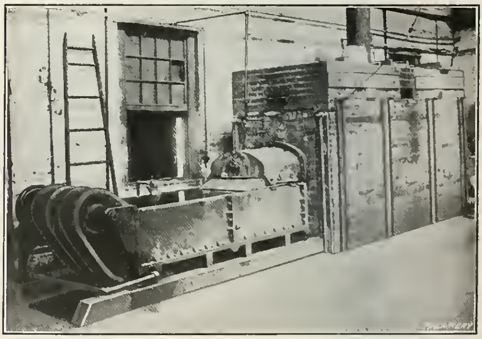


Fig. 11. Annealing Furnace for Copper Wire

sufficient to wind it around the pulleys once or twice before starting the operation.

Another machine used for drawing copper wire is shown in Fig. 10. This machine is constructed somewhat on the same principle as that shown in Fig. 6, except that the drums over which the wire passes between each pass through the dies are not cylindrical, but conical in shape. This takes care of the increasing velocity with which the wire travels as it is reduced in diameter. It passes over the smallest diameter pulley when it is large in diameter and successively mounts the higher steps as it is reduced in size, until it finally is wound onto the block or drum shown in the background.

An interesting method is used for annealing brass and copper wire. The heat for annealing this wire need not be as high as that for annealing the alloy wire, and, hence, a different furnace is used. This furnace is shown in Fig. 11, the furnace proper being shown towards the right, it having an extension in the right-hand direction similar to that shown on the left-hand end in the illustration. The coils of wire are placed on an endless chain which moves from the left to the right. This chain is shown in the illustration passing over rollers at the extreme left-hand end. The furnace proper is in the center and the extensions at the ends are tanks filled with water which serves as a water seal, preventing the air from entering the furnace, thus avoiding oxidation and insuring uniformity in temperature.

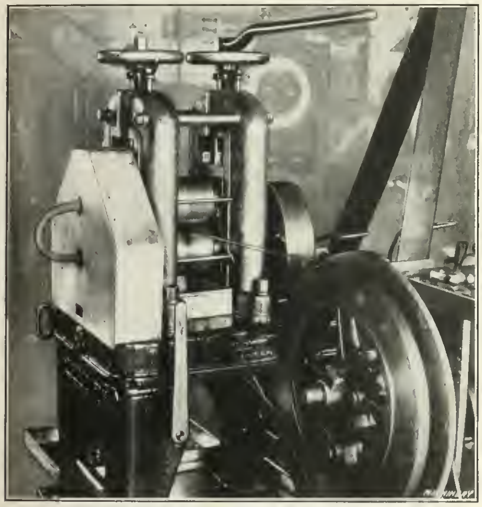


Fig. 12. Machine for Rolling Flat Wire

The furnace is fired with soft coal, but the gases of combustion do not come into contact with the material being annealed. The endless chain moves slowly, carrying the coils down through the water tanks and up into the furnace, the speed of the chain being so timed that the coils remain in the furnace for a certain length of time to heat them to the required temperature. The speed of the chain can be regulated so that the coils of wire will remain from one to five hours in the furnace. The coils pass out of the furnace at the right-hand side through a water tank similar to that shown at the left-hand end and are removed as they reach the right-hand end.

Making Flat Wire

The flat wire, as already mentioned, is produced from drawn, round wire of the required diameter. One of the machines used for flattening the wire is shown in Fig. 12. The machine consists principally of two hardened steel rollers, the upper one of which is adjustable for height. These rollers are carefully ground, and as the round wire is passed between them it is gradually flattened out to the required thickness in a series of successive passes between the rollers. The rollers must be very hard and are not tempered after hardening. They are imported, being made of a special alloy steel, and the cost of a pair of these rollers may be as high as $300 or $400. It is highly important that they be of uniform hardness throughout, as otherwise they would wear more on one side than on the other and produce a wire which would not be uniform in thickness.

The diameter of the round wire to be used for a given size of flat wire is determined by experiments, and these experiments must be repeated for wires of different materials, as some materials cannot be successfully flattened to the same degree as others. On the side of the machine from which the wire passes in between the rollers there is a clamping device which provides the proper tension for the wire, so that it is fed in under tension. On the side where the wire passes out from between the rollers, as shown in the illustration, a large wheel is placed, onto which the flat wire is wound up as it comes from the machine.

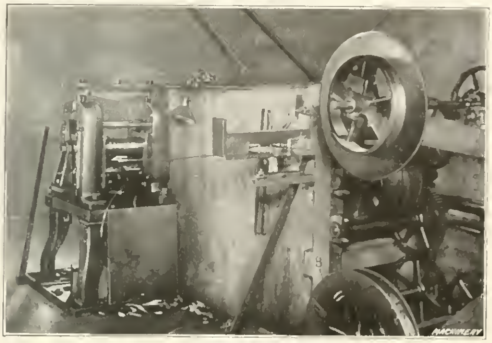


Fig. 13. Flat Wire Slitting Machine

When very wide, flat wire is to be made, uniformity of width cannot be obtained by a mere rolling process, but it is necessary to slit or trim off the sides of the wire to a uniform width after rolling. Should an attempt be made to flatten the wire, say in a grooved roller, so as to insure thickness and width at the same time, the rollers for this purpose would be so expensive that the method would not be commercially useful. Slitting machines, such as shown in Fig. 13, are, therefore, used for cutting the wire to a uniform width. These machines consist mainly of three steel disks, two on the lower shaft and one on the upper. The upper disk trims the wire between the two lower disks. Very wide, flat wire can be slit into several uniform widths at a time, if required. The sizes of flat wire that can be rolled in the manner described vary from 2½ inches wide by 0.020 inch thick down to 1/64 inch wide by 0.002 inch thick. Flat wire 1 inch wide can be rolled as thin as 0.003 inch thick by this method.

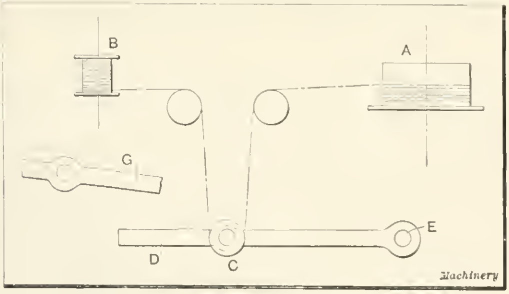


Fig. 14 Diagrammatical Sketch of an Ingenious Safety Trip

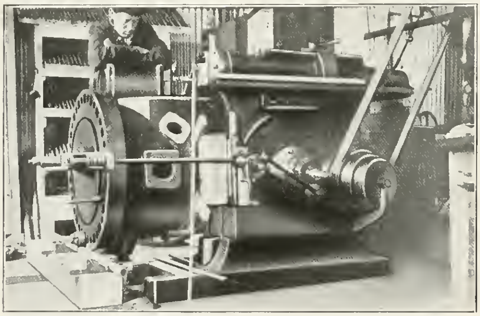
When the wire is slit, the band of flat wire that has been cut to the correct width is wound up on a block or drum, as shown at *A* in Fig. 13. It is also necessary, however, to take care of the scrap cut off, as otherwise this would be likely to cause trouble. The scrap wire is, therefore, wound up on the lower drum shown at *B*, these drums being geared to the proper speed so as to wind up the material as fast as it comes from the machine.

After the wire has been rolled and annealed, it is wound onto spools of the required size for the market. Some wire is spun over with insulating material and some braided, according to the requirements for which it is to be used. A diagrammatical sketch of an interesting feature of one of the spooling machines, which may be worthy of mention, is shown in Fig. 14. In this *A* represents the reel on which the wire coil is put, while *B* is the spool on which it is wound. This spool is driven at a constant speed. Now, if a kink should occur in the coil of wire at *A*, or, for some other reason, it should be prevented from reeling off easily, the wire would, if it passed directly from the reel to the spool, either be pulled off, or some damage would be done to the machine. In order to prevent this, the wire is passed over an idler pulley at *C*, which is mounted on a lever *D* moving about a fulcrum *E*. When the spooling is proceeding under normal conditions the weight of the lever is great enough to prevent the pull on the wire from lifting the lever, but should an abnormal resistance be placed on the wire, as mentioned, the lever will strike another lever or trip *G*, which will throw out the clutch driving the spool and, hence, stop the machine.

* * *

AN UNUSUAL SHAPER JOB

The accompanying illustration shows a 24-inch shaper, built by the Smith & Mills Co., Cincinnati, Ohio, taking a cut across the exhaust manifold of a 125-horsepower Nuenzel gas engine cylinder head. An idea of the size of this cylinder-head casting may be obtained by comparison with the four-foot rule standing against it. When doing the work on the shaper, the vise and table of the latter were removed and the casting was bolted by a strap and two hook bolts to the apron. Two wooden blocks were used to prevent the bolts from marring the apron, and blocking was also put between the casting and the apron because of the overhanging portion or manifold not being flush with the body of the casting. A roller is fastened to the face of the casting at the bottom. This roller runs on a bar held in V-blocks resting on wedges at the proper height. This arrangement of roller and bar relieves the apron from excessive strain. This unusual shaper job was accomplished in the works of the Olympia Brewing Co., Olympia, Wash.



A Shaper Job on a Gas Engine Cylinder Head

* * *

WHAT A MAN CAN DO WHEN HE GETS MAD

BY A. P. PRESS

I saw an incident the other day that showed what a man can do when he gets provoked good and proper.

It happened in the toolroom; one of the toolmakers had a fuse tip die to make. The blank was ⅞ inch thick and the fuse tip was about 1 inch long, round at one end and square at the other, with a wing-like projection on each side. The toolmaker was a good man, all right—in fact one of the very best that ever filed a die—but I guess it must have been the "morning after". He had laid out the die all right and had drilled and roughed out most of the stock when it dawned on him that he had made it left-handed, that is, he had laid the templet on the die blank wrong side up. While the die was all right, it, at the same time, was all wrong, or at least the work from it would not fold up so as to bring the burr edge of the metal together.

What did he do? He slapped that piece of work into the scrap-box, took another blank (they were all machined out ready for the templet) and in two hours and twenty minutes he had drilled out his die, roughed out the stock and finished it up ready to harden.

I have seen quick work, but never did I see the same amount of hand work performed in the same length of time as in this case. It pays to get mad once in a while.

* * *

SAFE-BREAKING AT PANAMA

BY F. E. R.

"Yes, a burglar has trials and disappointments", said Blackaller. "To spend four or five exciting hours drilling and blowing open a safe, expecting every minute to hear a watchman's whistle, and then find next to nothing for your pains, is not exactly a salubrious occupation. No, I never was a burglar, but I once helped to blow open a safe under painful conditions, and so have some first-hand knowledge of the 'art'."

"The episode occurred when I was third officer of the *Empress of India* and we were lying at Panama. The machinery used by the French in their attempt at digging the canal was rusting and rotting away under the tropic sun. Our second engineer, Sandy McGuire, invited me to go with him on shore leave and look around a bit. We found many curious evidences of the French occupation. The engines, excavators and other machinery were different from any I had seen and we spent several interesting hours poking around in the jungle that had grown up around them. Suddenly the engineer gave a shout. 'See here, Blackaller; here's a find—a paymaster's safe. It's locked. Some rascal stole it and hid it here, and probably died of the fever before he could get out of the country. See, it's the regular small safe used for carrying money. I'll bet it contains several thousand francs—probably in gold.'"

"Well, I looked at that rusty safe and saw a vision of easy money. The strangeness of the find there in the jungle among those rusty piles of junk almost took my breath away. 'How can we open it?' 'Why we'll go to the ship and get a ratchet, drills, tools and powder, and blow it open—that's what. But we'll have to keep it dark—every blessed nigger around here will want a share in the contents if they see what we've found. You and I will open that safe and share the loot. There's no use in letting a lot of others in', and Sandy's little eyes glittered avariciously."

"Back to the ship we went, and that night we got together the tools and powder. Next morning bright and early we started out to our treasure trove with hearts beating high with anticipation."

"Maybe you think it's an easy job to open a small cast-iron safe, but I don't—that is when you have only a few poor tools and a hell to work in. How we sweated and swore there rigging up a chain around that blasted thing to hold a brace for our ratchet drill! But at last a hole was drilled between the combination lock and the knob, and after much more trouble a half pound of powder was poured into the hole. A fuse was pushed in, and after looking all around to see if the coast was clear, Sandy touched it off and we skurried to cover. A loud explosion rent the air and the door torn from its fastenings sailed away a dozen feet. When the smoke lifted we eagerly peered into the opening. It was absolutely empty—but worse than that the safe had no bottom! If we had only taken the trouble to tip the blamed thing over we could have seen that the bottom had been knocked out long before and that it was as empty as a spendthrift's pocket."

"We stole back to the ship like a pair of sheep-killing dogs, but the story was too good to keep."

* * *

It has been found unprofitable to use old tin cans in the process of detinning for recovering the tin. The cost of collecting, transportation and inability to dispose of the black iron plate are responsible for the cans not being utilized. This information was recently published by the United States Geological Survey which investigated the subject.—*Brass World.*

DIES FOR DROP-FORGING A CRANKSHAFT

BY J. W. JOHNSON*

The dies for drop-forging the crankshaft shown in Fig. 1 comprise an interesting set of tools, especially to those unaccustomed to crankshaft diemaking. The principal interest of these dies lies in the fact that they were made to forge the collars, pin and adjacent parts of the crankshaft only, the remainder of the ends of the crankshaft being forged under an ordinary trip hammer. The advantages to be gained in forging the crankshaft in short dies are that on account of the small amount of stock being acted upon, the forging can be thus made under a lighter hammer and stock of smaller dimensions may be used, for it can be worked up by passing it back and forth from the break-down to the impression. Another important advantage in forging this job in short dies is that there is less liability of the forging sticking in the dies while being forged. If long dies were used there would be more or less trouble from this source. Moreover, when the forgings stick in a long die it is harder to free them than it is from short dies. Short dies are also much easier to keep lined up than long ones; in fact dies long enough to forge this entire crankshaft would give constant trouble by working out of alignment.

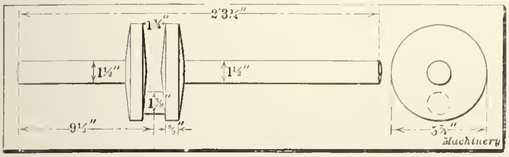


Fig. 1. The Drop-forged Crankshaft

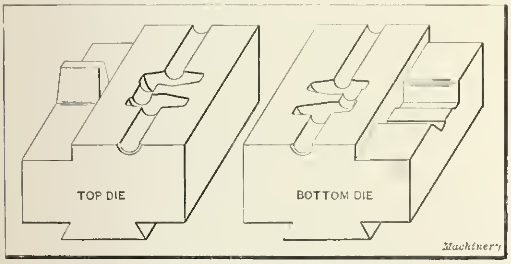


Fig. 2. Forming Dies for Forging a Crankshaft

Fig. 2 shows the drop-forging dies for forming the forging, the finishing being done in a separate pair of dies. It will be noticed that the break-down is of unusual width, which is necessary on account of the spreading of the stock. All corners in the forming impressions were well rounded to prevent cold shuts. In making the top die for the forming operation, the projecting piece on the break-down was made by dovetailing a separate piece into the side of the die. If this were not done, a great deal of superfluous labor would have to be done in shaping away the rest of the face of the die. The finishing dies are illustrated in Fig. 3, and, of course, the impressions are like those in the forming dies, except that the corners are not rounded as much and are flashed. It is obvious that no break-down or anvil was required on the finishing dies.

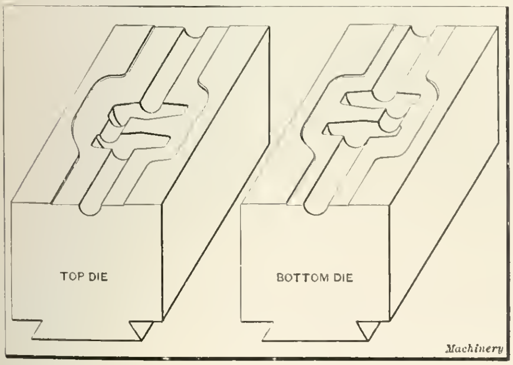


Fig. 3. Finishing Dies

The trimming die and punch for this forging are shown in Fig. 4, and it will be noticed that the die is made in halves and left open at the front for hot trimming. The punch was milled out to receive the forging for trimming so that it would not bend during the trimming operation.

The stock used for forging this crankshaft was nine inches long and four inches square. The first operation consisted of forging a tong-hold on one end. The piece was then put back in the fire, heated all over to a good forging heat, and the first blow of the hammer given the piece when in the break-down. Care was necessary in locating the piece in the die for the first blow, for this crankshaft is longer on one side of the collars than on the other. The stock worked up very rapidly, as it drew from the smaller sections and flowed into the collars. Quite a number of blows were necessary to draw enough stock from the ends to get the collars full.

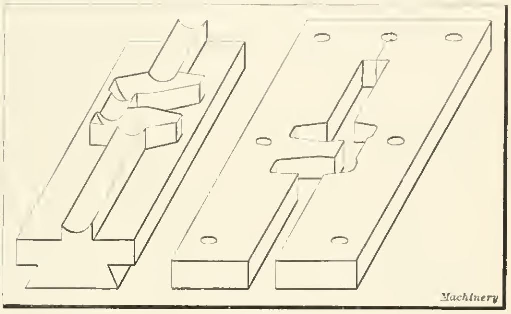


Fig. 4. Trimming Dies

After distributing the stock by means of the forming dies, a few blows in the finishing die brought the corners up and sized the forging, after which it was hot-trimmed in the ordinary manner in the trimming dies shown in Fig. 4.

* * *

The statistics compiled by the *Archiv für Eisenbahnwesen* give the total mileage of the world's railways in 1910 as 640,158 miles; the total increase in the last year was 14,460 miles and in the last decade, 149,092 miles. This increase in mileage had been exceeded by but one previous decade, that between 1880 and 1890, when 152,179 miles of railway were built. Of all the railways in Europe more than 50 per cent are owned by the respective governments: 60 per cent of the railways in Africa, nearly 60 per cent of those in Asia and about 95 per cent of those in Australia are owned and operated by the State. It is interesting to note that while Great Britain has no state railways, and Canada only 1718 miles out of a total of 24,731 miles, this form of administration prevails almost exclusively in the British possessions of Asia, Africa and Australia.

It is also of interest to record the growth of the world's railway system from the time of its beginning. In 1840 there were about 4800 miles of railway in the world; in 1850, 24,000; in 1860, 67,000; in 1870, 130,000; in 1880, 231,000; in 1890, 383,000; in 1900, 490,000; and in 1910, as mentioned, 640,000 miles.

* * *

At a recent meeting of the Society of German Engineers, Herr Hammer, after having reviewed the improvements in the locomotives shown at the recent Turin exposition in Italy, stated that the following lines of development are being followed: A high steam pressure; the use of steam more highly superheated; valve gear improvements; utilization of the heat of the waste gases now escaping through the smoke-stacks; and the purification and pre-heating of the feed water.

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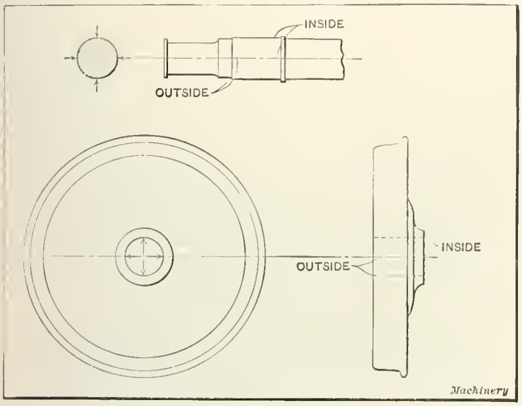
TABLE OF WHEEL AND AXLE PRESS FITS

	Axle								Wheel												
Size of Journal, Inches	Diameter, Wheel Fit		Condition of Finish	Cutting Speed, Feet per Min.	Depth of Cut, Inches	Feed, Inches	Make of Lathe	Condition of Lathe	Diameter, Inches	Material	Diameter of Bore		Condition of Bore	Cutting Speed, Feet per Min.	Feed, Inches	Cuts per Wheel	Pressure for Fit, Tons	Service of Wheel	Make of Mill	Condition of Mill	General Remarks
	Outside End, Inches	Inside End, Inches									Outside End, Inches	Inside End, Inches									
5 x 9	6.345 6.343	6.349 6.349	G	40	1/32	1/8	Bridgeford	G	33	C. I.	6.339 6.337	6.336 6.337	G	25	3/16	2	50	T T	Putnam	G	Gage used, Niles Lubricant, Paint
4¼ x 8	5.708 5.704	5.706 5.704	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.700 5.702	5.700 5.702	G	25	3/16	2	50	T T	Putnam	G	
3¾ x 7	5.341 5.341	5.345 5.345	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.332 5.332	5.336 5.331	G	25	5/16	2	65	T T	Putnam	G	
3¾ x 7	5.339 5.339	5.338 5.338	G	40	1/32	1/8	Bridgeford	G	33	C. I.	5.333 5.333	5.333 5.333	G	25	5/16	2	40	T T	Putnam	G	
5½ x 10	5.480 5.480	5.480 5.480	G	25	1/32	1/8	Bement-Miles	G	30	S. T.	5.469 5.467	5.465 5.470	G	25	3/16	2	75*	E T	Putnam	G	
5½ x 10	6.802 6.802	6.803 6.803	G	40	1/32	1/8	Bridgeford	G	33	S.	6.802 6.802	6.802 6.802	V G	25	3/16	2	32*	T T	Putnam	G	
4¼ x 8	5.766 5.762	5.764 5.760	V F	50	1/32	1/16	Bridgeford	G	33	C. I.	5.744 5.744	5.743 5.743	G	18	1/8	2	75*	Fr	Niles-Bement	G	Gage used, Crosby Lubricant, Paint
4¼ x 8	5.763 5.763	5.761 5.763	P	50	1/32	1/16	Bridgeford	G	33	C. I.	5.7445 5.7445	5.743 5.743	G	18	1/8	2	61	Fr	Niles-Bement	G	
4¼ x 8	5.769 5.775	5.770 5.769	V F	50	1/32	1/16	Bridgeford	G	33	C. I.	5.756 5.756	5.7545 5.7545	F	18	1/8	2	62	Fr	Niles Bement	G	
5½ x 10	6.873 6.8715	6.872 6.869	P	50	1/32	1/16	Bridgeford	G	33	C. I.	6.851 6.851	6.851 6.851	G	18	1/8	2	75	Fr	Niles-Bement	G	
5½ x 10	6.969 6.969	6.972 6.971	V G	50	1/32	1/16	Bridgeford	G	33	C. I.	6.956 6.956	6.9545 6.9545	G	18	1/8	2	75	Fr	Niles-Bement	G	
5½ x 10	6.912 6.912	6.912 6.912	G	50	1/32	1/16	Bridgeford	G	33	C. I.	6.898 6.896	6.900 6.898	V F	18	1/8	2	62	Fr	Niles-Bement	G	
4¼ x 8	5.746 5.749	5.752 5.751	P	25	1/32	3/32	Niles	F	36	C. I.	5.740 5.740	5.738 5.738	V G	16	9/16	2	80	Pa	Putnam	G	Gage used, Niles Lubricant, Paint
4¼ x 8	5.748 5.743	5.749 5.749	V F	25	1/32	3/32	Niles	F	36	C. I.	5.740 5.740	5.740 5.740	G	16	9/16	2	57	Pa	Putnam	G	
5 x 9	6.371 6.371	6.380 6.382	G	25	1/32	3/32	Niles	F	33	C. I.	6.362 6.362	6.362 6.362	G	18	9/16	2	65	T T	Niles	G	
3¾ x 7	5.355 5.355	5.356 5.359	V F	25	1/32	3/32	Niles	F	33	C. I.	5.352 5.352	5.348 5.348	V F	18	3/32	1	60	T T	Niles	G	
3¾ x 7	5.388 5.390	5.395 5.398	G	25	1/32	3/32	Niles	F	33	C. I.	5.383 5.383	5.383 5.383	G	18	9/16	2	60	T T	Niles	G	
3¾ x 7	5.260 5.257	5.257 5.256	G	25	1/32	3/32	Niles	F	33	C. I.	5.252 5.252	5.250 5.250	V F	18	9/16	2	32	T T	Niles	G	
4¼ x 8	5.763 5.762	5.763 5.762	G	30	1/32	1/8	Bement & Son	V G	33	C. I.	5.753 5.753	5.752 5.752	G	24	1/8	2	52†	Fr	Bement-Miles	G	Gage used, Bristol Lubricant, White Lead and Oil
4¼ x 8	5.787 5.783	5.797 5.792	G	35	1/32	5/32	Bement-Miles	G	36	S.	5.785 5.785	5.785 5.785	G	18	1/16	2	119*	Pa	Niles	V G	
4¼ x 8	5.774 5.774	5.777 5.776	V F	35	1/32	5/32	Bement Miles	G	36	S.	5.767 5.771	5.775 5.776	V F	18	1/16	2	51	Pa	Niles	V G	
5 x 9	6.436 6.438	6.432 6.433	P	35	1/32	5/32	Bement-Miles	G	33	C. I.	6.401 6.404	6.412 6.410	V G	24	1/8	2	85	Fr	Bement-Miles	G	
3¾ x 7	5.336 5.345	5.341 5.345	V F	35	1/32	5/32	Bement-Miles	G	33	C. I.	5.333 5.333	5.337 5.337	V F	24	1/8	2	64	Fr	Bement-Miles	G	
4¼ x 8	5.768 5.765	5.776 5.773	V F	25	1/32	5/32	Bement-Miles	V G	36	C. I.	5.7125 5.7125	5.7115 5.7115	G	18	1/8	2	Wheels not pressed on	Pa	Niles	V G	. . . .
4¼ x 8	5.7765 5.778	5.780 5.780	G	35	1/32	5/32	Bement-Miles	G	36	C. I.	5.728 5.729	5.728 5.729	G	18	1/8	2		Pa	Niles	V G	
4¼ x 8	5.781 5.781	5.7865 5.788	V G	35	1/32	5/32	Bement-Miles	G	33	C. I.	5.729 5.729	5.729 5.729	G	18	1/8	2		Pa	Niles	V G	

V G = very good; G = good; V F = very fair; F = fair; P = poor.—C. I. = cast iron; S. T. = steel-tired; S = steel.—T T = tender truck; E. T. = engine truck; Fr = freight car; Pa = passenger car.
* Taken off. † Taken off before pressed full distance.

WHEEL AND AXLE PRESS FITS

The accompanying table gives data for wheel and axle press fits, as used in different railroad shops. The data given in the tables requires no further explanation, as it merely records the practice followed in various shops. The writer had the opportunity of obtaining this data during the carrying out of a systematic investigation covering the points recorded. He believes that a great deal of interest is attached to this subject, as he found that in all the railroad shops visited the men were very much interested in the methods followed in other shops. It will be seen that the practice differs considerably in the various places, both as regards the speeds and feeds used in wheel and axle turning and as regards the allowances for fits. Five shops are represented in the table, the data from each being grouped together as indicated. Two dimensions are given for each axle or bore diameter, these being measured in two directions at right angles to each other as indicated in the accompanying illustration. H.



Illustrations showing where Dimensions given in the Accompanying Table are measured

* * *

CHECKING LIST FOR DRAWINGS

BY E. E. MINARD*

The questions are sometimes asked. "Why is it necessary to check drawings? Why cannot the draftsman be depended upon to make them right in the first place?" As a matter of fact, however, draftsmen are no more infallible than other men, although probably no less so. There are few who can make a drawing with the average amount of detail without some error or omission being found by a competent checker. The errors in design or dimensions are apt to be quite costly if not discovered before the parts are machined or assembled. It has been the experience of the writer that the most costly errors occur where they are least expected, and particularly with regard to matters which it has not been considered necessary to check. If the drawings cover simple and inexpensive parts, the checking might cost more than an occasional spoiled piece, and, in that case, it might be dispensed with, but when the drawings cover expensive parts, like tool work, careful checking is imperative.

It is often claimed that draftsmen are apt to be careless when they know that their work is to be checked afterwards. This may be true if the discipline is lax and the checker is inefficient, but if a standard checking list, such as given in this article, is handed to the draftsman with the understanding that his work must conform to its requirements, a marked increase in the efficiency of the draftsmen will, in most cases, be noted. The checking list submitted herewith is given as an example for one special class of work. Different lists should be prepared for different classes of work. In making up such a list, one should guard against the mistake of trying to make this standard checking list as complete as an instruction book. To make it efficient and useful, it must be brief in every item, and must be used simply as a supplement to other necessary instructions. The sole object should be to instantly call to the mind of the draftsman the requirements of the standard practice. The list given below is for punch and die work drawings, and will, of course, vary according to the practice and working conditions of different drafting-rooms.

Standard Checking List—Punches and Dies

Design Approval:

1. Authorization, requisition, memorandum, blueprint, sketch or sample.
2. Yearly requirements.
3. Grade of tool.
4. Method of operation.
5. General and specific requirements of departments.
6. Harmony in design, compared with other up-to-date tools.
7. General design.

Assembly:

1. Views and projections.
2. Work to be easily placed in die.
3. Work to be easily removed from die.
4. Same gaging points on succeeding operations.
5. Parts to be readily machined and assembled.
6. Interference of moving parts, slides, etc.
7. Burr side of blank in proper relation.
8. Provision for grinding.
9. Stripping and knockout devices to be adequate.
10. Clearance for slugs and burrs.
11. Setting pins.
12. Safety pins for unsymmetrical blanks.
13. Punch height to clear work during forming operation.
14. Size of punch shank to be standard.
15. Relation of shut height to available presses.
16. Size of dowel pins and standard screws.

Details:

1. Views and projections.
2. Views of details placed in same relative positions as assembly.
3. Detail to check with assembly.
4. Easily machined.
5. Easily assembled.
6. Easily hardened without liability to check.
7. How fastened in place.
8. Scaling and calculating of dimensions.
9. Intermediate dimensions.
10. Overall dimensions.
11. Limits.
12. Size and location of holes.
13. Finish marks.
14. Grinding marks.
15. Detail number.
16. Name.
17. Number of pieces required.
18. Material.
19. Hardened.
20. Ground.
21. Forging.

Title:

1. Class and type of punch and die.
2. Part number.
3. Model number.
4. Scale.
5. Initials.
6. Drawing number.
7. Date drawn.
8. Date traced.

General Requirements:

1. Neatness and clearness.
2. Crowding of views, details and notes.
3. Lettering.
4. Lines.
5. Section-lining.

The different men in the drafting-room use all or part of this list, as required. The designer uses the section on "Assembly." The head of the division or department uses the sections under the headings "Design Approval," and "Assembly." The detailer uses the portion under the headings "Details," "Title," and "General Requirements." The tracer need pay attention only to the section of "General Requirements," after which the checker uses the complete list with the exception of "Design Approval." It is understood that before a list of this kind can be used successfully, detailed instructions in separate form must be given to the draftsmen, covering all the parts to which attention is called in this list.

* * *

Men who are absolutely convinced of the accuracy of their opinions will never take the pains of examining the foundation on which they are based.—*Buckle.*

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RELATIVE FIELDS OF THE BOARD AND STEAM DROP HAMMERS

BY H. TERHUNE*

It has been suggested that the steam drop hammer is rapidly replacing the board drop hammer. The writer wishes to state that after visiting practically all of the drop-forge plants and manufacturing plants making drop forgings, he is not of the opinion that the steam drop is replacing the board drop on the same class of work, but that the nature of the work at the present time has outgrown the limits of the board drop, which, even from a mechanical point of view, has always been placed at 3000 pounds falling weight.

In the Middle West and along the Lakes, where the bulk of heavy forging is done, drop hammers of from 2000 to 16,000 pounds falling weight are required. Here we find, perhaps, one and one-half board drop to every steam drop hammer, with a total falling weight much in favor of the steam drop; but from the western borders of Pennsylvania and New York to the Atlantic coast the conditions change almost as abruptly as does standard time, and we find about twelve and one-half board drop hammers to every one steam drop. The bulk of the board drops are from 800 to 1500 pounds and the steam drops from 2000 to 5000 pounds. Generally speaking, it is as difficult to convince people in New England of the merits of the steam drops as it is to do the same thing with relation to the board drops in the Detroit and Cleveland districts.

Each hammer has its advantages. The managers of the drop-forge shops say that a certain class of accurate work can be done more economically on a board drop than on a steam drop, provided that it does not require a hammer larger than from 1500 to 2000 pounds, and a number of plants that have been provided with all steam drop hammers have recently put in board drops to take care of this class of work. However, there are four or five drop-forge shops in the Middle West where nothing is considered except steam drop hammers for all classes of work.

Nearly everyone admits that the cost of operation and repairs is greater on the steam drop hammers, but at the same time about one-third more work can be done on these. The writer has failed, however, to obtain exact data as to the relative cost of operation and upkeep of the two types of machines. Some claim that these items are about double for the steam drop hammers, but this seems rather high.

The power required for board drop hammers varies considerably with the nature of the work. Very little power is required at the point of "pick-up" if the work is practically "die to die." A great deal more power is required when the work is very soft and there is no rebound; this is largely due to the small amount of kinetic energy in the driving pulleys, the rolls thus having to pick up a dead load from rest. When there is a good rebound, with the knock-off properly timed, the board will have practically the same upward velocity as have the rolls when they come together, and the ram is simply continued on its upward stroke by the rolls. Heavy flywheels would be an advantage, but makers of drop hammers would hardly consider them on account of the danger of the heavy overhanging weight on the end of the driving shaft. In several shops, however, they have been used for years without an accident, and in these places the manufacturers will consider no other construction.

It is rather difficult to find a better machine than the board drop hammer on certain classes of work, at least in cases, for example, where hammers of from 500 to 1500 pounds (or even up to 2000 pounds) are used, and the shop is driven by water power or natural gas at 12 cents per 1000 cubic feet, or even electric current at from one to one and one-half cents per kilowatt-hour, especially when coal is as high as in New England.

When the work is heavy and requires a great deal of breaking down, and there is considerable drawing and bosses to be forged, and even when light work is to be done having thin sections that cool quickly, such as gear blanks with thin webs, I-sections, etc., requiring quick sharp blows, the steam drop will make the best showing in nearly all cases.

At the present time the waste heat boiler mounted on the top of each heating furnace is receiving considerable attention. This boiler generates the steam for the hammer with little or no extra fuel other than that required for heating the work being forged. If the waste heat of each furnace were sufficient and could be utilized to generate enough steam for its own drop hammer, regardless of size, the board drop hammer would become obsolete on account of the superior economy of the steam hammer. At present, the relative advantages of each, however, depend, as we have seen, on many conditions, some of which are purely local in their character.

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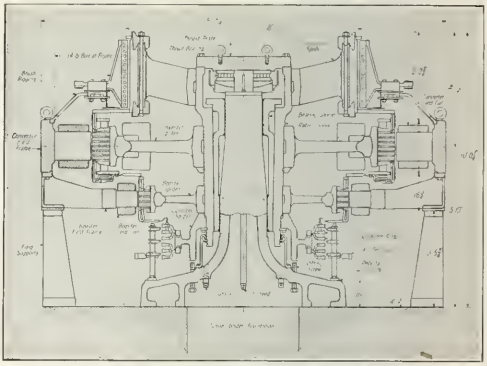
LARGE VERTICAL ROTARY CONVERTERS

Two 3000 K. W. vertical rotary converters have recently been built by the Westinghouse Electric & Mfg. Co. in its East Pittsburg works. These machines are of especial interest because they are the largest rotary vertical converters ever constructed. They were built for the New York Edison Co. The accompanying illustration shows a sectional drawing of these converters, some of the mechanical features of which are rather interesting and different from those hitherto used on ordinary electrical machines. The pedestal on which the armature rotates is made in one piece from a hollow steel casting. A much more rigid construction is possible in this way than with a steel pedestal provided with a flange on its lower end bolted to a cast-iron base. A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. This bearing rests on the plate having a spherical seat carried on the pedestal, so that perfect alignment is possible. The roller bearing can be easily taken out by removing the top plate of the machine. When it is necessary to remove the top plate, the weight of the rotating parts is carried by six 1¾-inch bolts which pass through the flange at the base of the pedestal. When the top plate is taken off these bolts are screwed up until they raise the rotating element a trifle and assume its weight.



Section through Large Westinghouse Rotary Converters

* * *

ARTIFICIAL RUBBER

A consular report states that a factory for producing artificial rubber has been established at Ymuiden, in Holland. It is stated that the company that has started this factory has succeeded in producing a substance having the qualities of rubber, and in addition, some advantages over genuine rubber. The principal ingredients of the product are said to be fresh sea fish with about 15 per cent of natural rubber, the resulting substance being as flexible and as elastic as rubber, but costing but one-sixth of real rubber. The low price of the product is caused partly by the use of the by-products, which can be employed as artificial fertilizers. It is stated that this artificial rubber can be vulcanized, that it is benzine-proof and that it can resist the effect of heat. The substance much resembles real rubber, but the slightly fishy smell betrays the chief ingredient. It is explained that this will be prevented by extracting the fat from the fish used. The development certainly is interesting, providing the claims, too, are not "fishy."

WATCH MOVEMENT MANUFACTURE—4

METHODS, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO., SOUTH BEND, IND.

BY DOUGLAS T. HAMILTON*

The final operations on a watch movement, such as jeweling, stem fitting, banking, dialing, balance truing, over-coiling, spring truing, finishing, timing and adjusting, are necessarily hand operations which require the attention of experienced workmen. The assembling operations are, of course, also accomplished by hand. Before the winding wheels, plates, bridges or other exposed portions of the movement are ready to be assembled, they are usually decorated by means of a tortoise shell lap charged with carborundum, held in a damaskeening machine. In addition to the operations mentioned, the methods used in making the dials will be dealt with in the following.

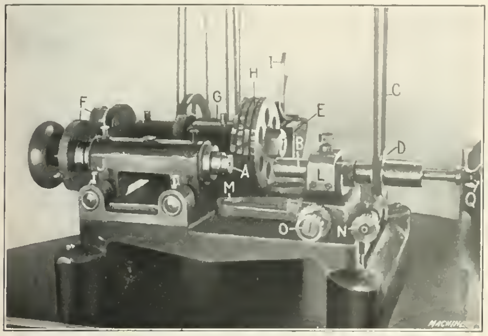


Fig. 40. Machine used in Damaskeening Winding Wheels, etc.

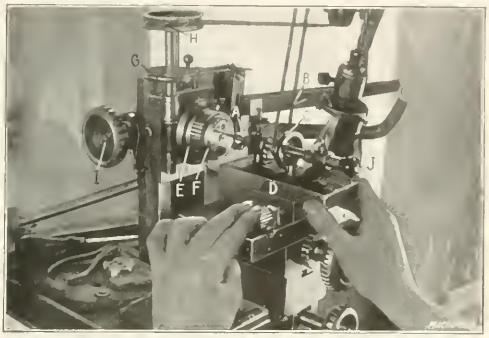


Fig. 41. Damaskeening Machine of the Upright Type for Decorating Bridges, Plates, etc.

Decorating Watch Movement Parts

To produce the decorations on the winding wheels, etc., the parts are held in the spring chuck *A* of the damaskeening machine shown in Fig. 40. The tortoise shell lap, which for the steel parts is charged with diamond dust, is held in the spindle *B*, the latter being rotated by a belt *C* running on pulley *D*. The work is rotated by the cam-shaft *E* through change gearing *F*, the former receiving power from grooved pulleys *G*, through a worm and worm-wheel.

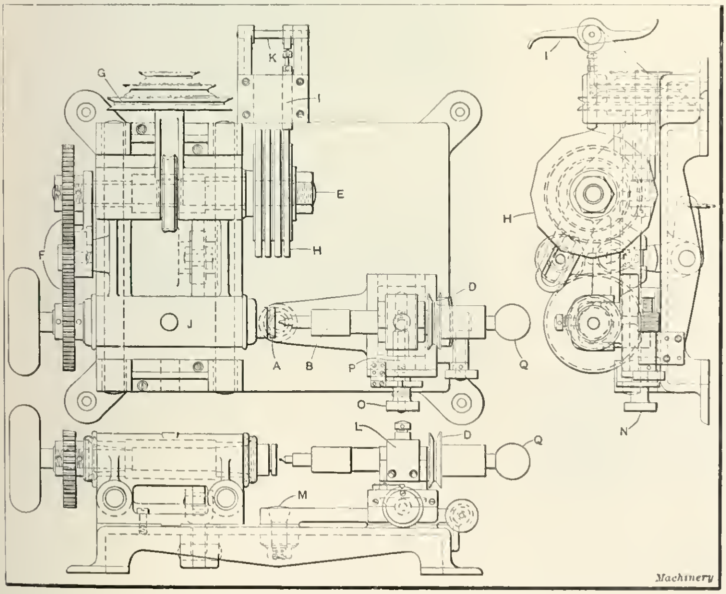


Fig. 42. Construction of the Damaskeening Machine shown in Fig. 40

The oscillating movements of the work required to produce the desired decorations are obtained from irregular faced cams *H*, which, through an adjustable pawl *I* transmit the required oscillating movement to the head *J*. As is shown in Fig. 42, this pawl can be slid back and forth on pin *K*, and thus be brought in contact with the irregular faces of the various cams. The entire head which carries the change gears and work is thus moved back and forth while the work is being rotated.

The head *L* carrying the spindle in which the diamond-charged lap is held is pivoted at a point *M*, and is made to move through an arc by operating knob *N*, which has a worm formed on its forward end meshing in a rack cut in the base of the holder. This adjustment of the spindle is necessary to change the angular position of the face of the lap in reference to the work, so that fine or wide "wavy" decorations can be produced. The head carrying the lap can also be adjusted laterally to conform to the diameter of the required circle by means of a knob *O* and screw *P*. The lap is kept in contact with the work by the operator pressing on knob *Q*.

Damaskeening Bridges and Plates

The bridges and plates are decorated in a machine which differs in construction to a considerable extent from that shown in Figs. 40 and 42. This machine is shown in Fig. 41 at work on the rear watch plate. As before, the decorating is accomplished with a tortoise shell lap, which in this case, however, is charged with carborundum. The lap is held in a spindle *A*, which is rotated at a high rate of speed by means of a belt *B* and pulley *C*. The table *D* on which the lap spindle is held can be tilted to an angular position, so as to change the width of the decoration. For large work, the table can be moved back and forth, and is provided with an index, so that all lines can be spaced the same distance apart.

Head *E*, carrying chuck *F*, which holds the work, can be given a variable oscillating movement by means of a worm and worm-wheel, the former being driven by a pulley *G* from the overhead works. The belt driving the worm is shifted by means of a foot lever, stops being provided to give the required arc of oscillation.

When irregular patterns are desired, irregularly-faced cam-strips retained on the rear of the machine are brought into play. These cams, through the medium of a follower, impart a forward and backward movement to the head, the latter being raised and lowered automatically by means of pulley *H*. This pulley is driven by a round belt from the overhead works, and by means of stops which shift the driving belt, its direction of rotation is changed to raise and lower the head. The head can also be moved back and forth by means of knob *I*.

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* Associate Editor of MACHINERY.

The variety of patterns which can be produced on this simple machine is very great. By using any one of the irregularly-faced cams, the outline of the pattern is altered, and by using the same cam, but changing the angle of inclination of the lap spindle, an entirely different pattern is produced. Various combinations of patterns can in this way be produced without special attachments. The lap, of course, is kept in contact with the work by the operator, who presses on the knob *J* with the palm of her hand.

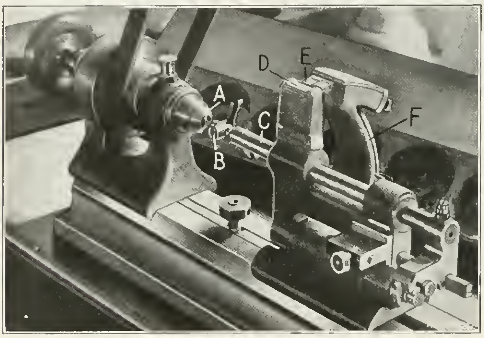

Fig. 43. Jewel "Letting-in" Machine and Caliper Rest for governing Diameter of Hole for Jewel

Fitting Jewel Settings and Jewels

The jewels, which act as bearings for the staffs, are not in all cases set directly in the plates and bridges, but are located in settings, the latter being retained in the plates and bridges. The machine used for producing the holes in the settings for the jewels is shown in Fig. 43. The setting is held in a spring collet *A*, and the boring tool in a holder *B*, provided with a shank fitting in spindle *C*.

A device called a "caliper rest" is used in connection with this machine for determining the diameter of the hole for the jewel. This caliper rest is shown in detail in Fig. 45. The jewel is placed between the two jaws *D* and *E*, and as arm *F* is cast rigid with the base, it follows that (when the jaws are together) arm *H*, which is pivoted at a point *G*, must be deflected when the jewel is placed between the jaws. As radius *R* is twice *r*, the spindle *C* of the machine which fits in the bushings *I* is moved out a distance equal to the radius of the jewel. Then, as the cutter is set directly on the center line or axis of the machine spindle, it will produce a hole (when cutting on one side only) equal to the diameter of the jewel.

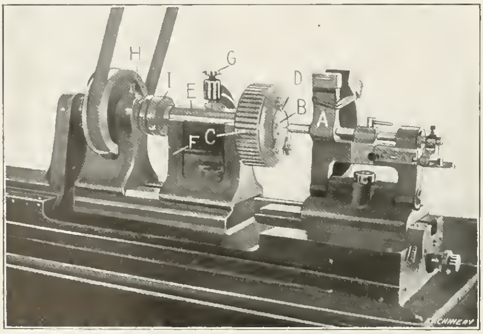

Fig. 44. "Cutting-in" Machine for Jewel Settings

The plate or bridge in which the setting is retained is bored out in the "cutting-in" machine shown in Fig. 44. This machine is also provided with a caliper rest *A* similar in construction to that shown in Fig. 45. The work is held in the quill chuck *B*, which is tightened onto the work by turning the corrugated ring *C*. This ring, in turn, operates a ring having cam grooves which draw in the dogs *D* to grip the work. This chuck is provided with a quill in which the spindle of the chuck rotates. The quill *E* is held by a clamp screw *G* in a U-shaped groove cut in the rest *F*. The spindle of the chuck is driven from pulley *H* by means of a clutch *I*. This method of holding and driving the chuck is conducive to greater accuracy, because vibration and wear are practically eliminated. The pull of the belt does not affect the alignment of the spindle, and the latter is free to rotate in the quill which is clamped rigidly in the rest.

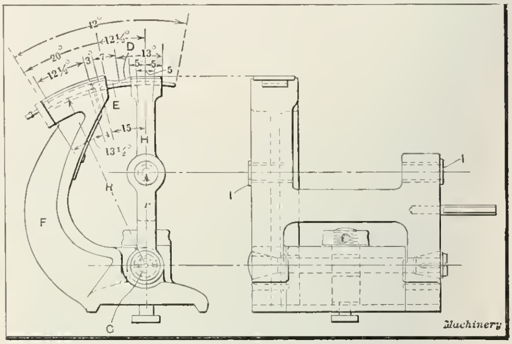

Fig. 45. Construction of the Caliper Rest shown in Figs. 43 and 44

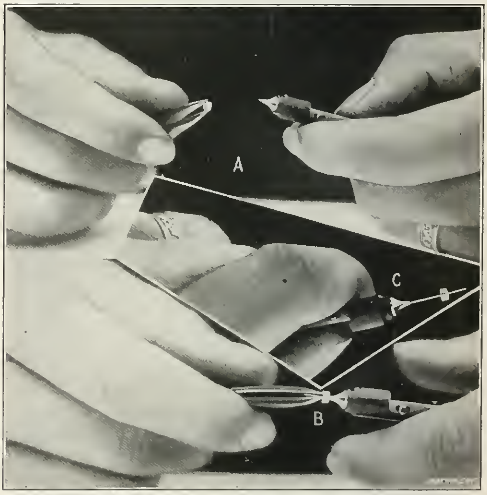

Fig. 46. Gaging the Holes in Jewels by Means of a Needle Gage

Another good feature of the quill chuck is that it can be removed from the machine and replaced with the assurance that it will always run true and be in perfect alignment. A chuck is also made for every different part, and is used only for that part, thus insuring interchangeability—one of the chief objects sought in modern manufacturing.

Polishing and Gaging Jewels

The jewels used for bearings in watches are obtained from Switzerland already drilled. It is necessary, however, to lap the holes and round the corners (making what is called an "olive" hole), so the staff will rotate in it with as little friction as possible. The jewel is held in a small speed lathe, the spindle of which is rotated at about 150,000 R. P. M. The polishing is accomplished by a lap made from peg wood—the same class of wood as is used for pegging shoes—charged with No. 6 diamond powder.

After lapping, the holes are gaged by means of a "needle" gage in the manner illustrated in Fig. 46. At *A* the gage is shown in position for inserting it into the jewel; at *B* the operator has forced the needle into the jewel, and is obtaining the correct reading on the scale; and at *C* the needle is forced out to the limit. The needle is slightly tapered and is set in a holder, and its position with reference to the scale gives the diameter of the hole in the jewel. It is absolutely necessary that the jewel be placed on the needle in the manner illustrated at *A* in Fig. 46, because of the slenderness of the needle. If it were attempted to put the jewel on the needle when the latter was in the position shown at *B* or *C*, a broken needle would be the result.

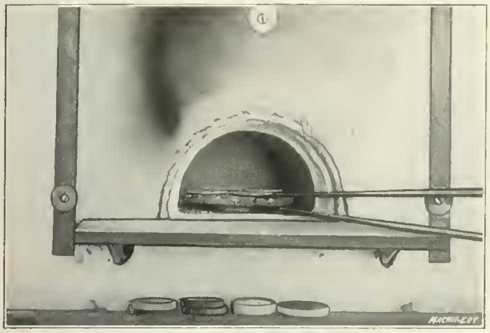

Fig. 47. Furnace for "Baking" the Enamel on the Watch Dials

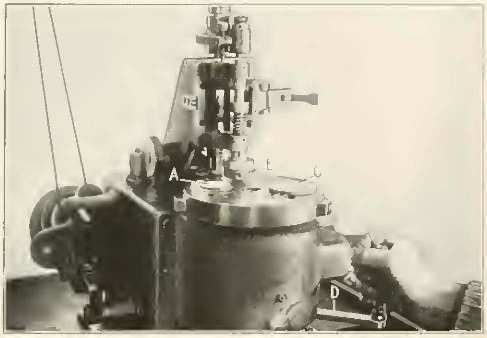

Fig. 48. Dial Printing Machine

Making Watch Dials

A watch dial consists of a copper disk or base upon which three or more layers of enamel are deposited. The first coat—known as the grip coat—is much harder than the top or last coat. The enamel used for watch dials comes from Germany. It is received in the form of lumps, which are broken up and put in a grinding barrel provided with a wedgewood lining. The grinding is accomplished by porcelain balls, which are put in the barrel with the lumps of enamel. After the enamel is ground it is sifted through bolting cloth—the same as that used in flour mills—two meshes of this cloth being used. The finely powdered enamel is used on the back of the dial—it being absolutely necessary that the enamel used on the front of the dial be of a uniform size of grain.

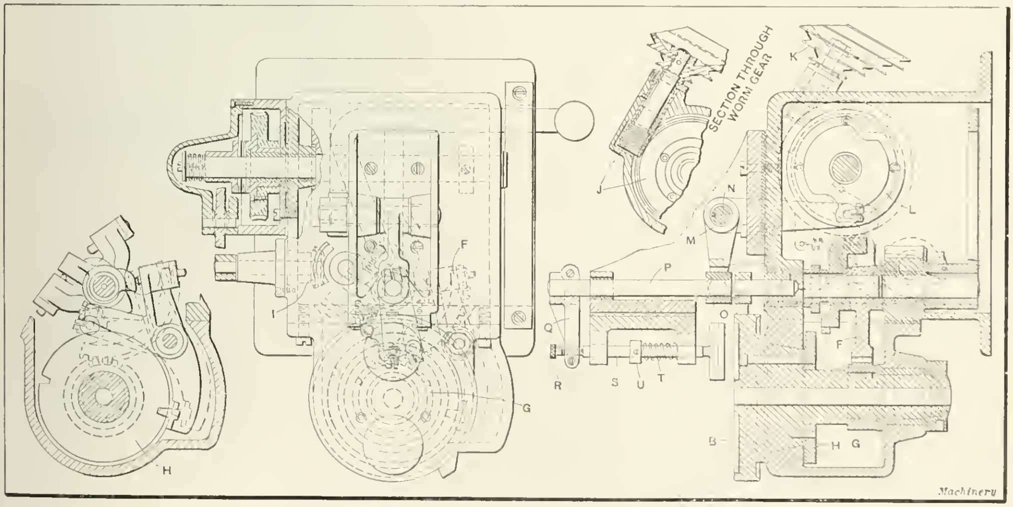

Fig. 49. Construction of the Dial Printing Machine shown in Fig. 48

After the copper bases have been blanked out in the punch press, the dial feet are riveted in. Small rings are then soldered around the base of these dial feet so that they will be held securely. In soldering the dial feet into the copper blank, the latter is bent out of shape, so it is necessary to flatten it on an ordinary flat die.

When the dials or bases have been prepared in the manner described, the copper bases are laid flat in a sieve tray, after they have been cleaned in acid, washed and dried. The tray containing the copper blanks is then taken to a sifting device which holds the ground enamel, the latter being sifted over the dials by means of a knocker, producing a slight vibratory movement of the container, thus spraying the enamel evenly over the copper blanks. After an even deposit of enamel has been sprayed on the copper disks, they are dried over a gas fire. Both the back and front of the copper disks are treated in this way. Then the front of the dial receives a second coat of a uniform thickness. After applying this coat, the enamel is fused in the gas furnace shown in Fig. 47, where the dials remain for about one minute. They are then taken out and allowed to cool off gradually.

The dials used on expensive watches are as a rule double sunk, that is, they are composed of various sized disks soldered together, that portion of the dial around the second hand usually being depressed. In such a case the enamel-coated disk is taken to a small grinding machine where that portion of the dial to be sunk is removed by means of a copper arbor coated with flour of emery, and located by means of a pilot fitting a punched hole in the dial. This emery charged arbor grinds away the enamel down to the copper on each side of the dial. The dials are now coated with paraffine wax, and an aluminum cup is placed around the ground ring in the enamel; then this is luted in place with wax. This aluminum cup is now filled with pure nitric acid, which eats or burns through the copper in about ten minutes.

While eating out the small copper disks with nitric acid, the dials are placed in a box-shaped container, provided with a rather ingenious arrangement to carry away the fumes of the acid. As is well known, nitric acid fumes, if in the vicinity of steel parts, will soon cause oxidation. Now, as the dial house is in close proximity to the factory in which the steel parts are made, the fumes of the acid would be carried to the other manufacturing departments and cause an endless amount of trouble. The device about to be described, which was devised by Mr. Charles T. Higginbotham, consulting superintendent, takes care of these acid fumes in a satisfactory manner.

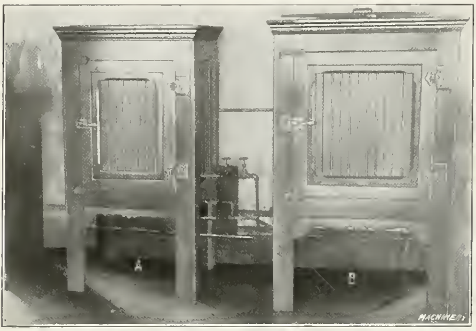

Fig. 50. Temperature Adjusting Cabinets

The arrangement consists of a funnel-shaped box through which the acid fumes are blown by means of an electric fan. This funnel-shaped box terminates in another box, where the fumes meet with a fine spray of water which descends in the shape of a fog, absorbing the nitric acid fumes and carrying them to the sewer.

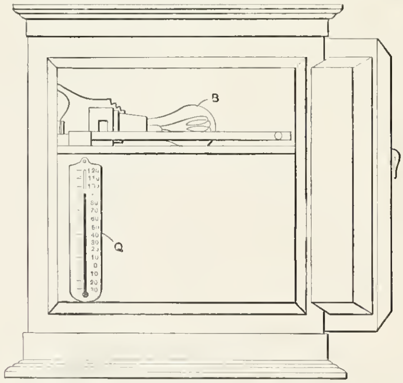

Fig.51

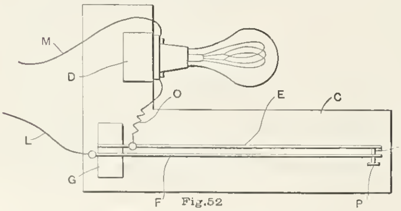

Fig.52

Machinery

Fig. 51. Interior Arrangement of the Temperature Adjusting Cabinet shown at A in Fig. 50. Fig. 52. Temperature Regulator

After burning out a portion of the copper disk, the hole is lapped with a copper lap coated with a putty powder made from oxide of tin. The sunken portion of the dial is then cemented in place with gum arabic and the parts are soldered together. The dials are next coated with shellac varnish to obviate scratching. There are a number of other minor operations on the dials before they are ready to have the characters stamped onto them, such as beveling the edge, drilling cross holes through the dial-foot pins, etc.

Printing the Characters on Watch Dials

The characters which were formerly painted on watch dials by artists are now put on by means of a transfer method, using a steel stamp in a dial printing machine. This machine is shown in Fig. 48, and in detail in Fig. 49. The dial to be printed is placed in a nest *A* held in the table of the machine. The steel stamp *C* fastened to the table has the characters cut in it (not in relief). This stamp is coated with fondant and the excess material removed, leaving the characters filled with the "paint." The operator, by means of handle *D*, now throws in the clutch, indexing the table to bring the steel stamp under the rubber transfer pad *E*, the latter being brought in contact with the stamp by means of a cam. The table is again indexed, bringing the dial under the rubber transfer pad, and the characters are stamped on.

The mixture used as a paint for printing the characters on the dial is composed of black enamel, which has been ground extremely fine and then mixed with oil of thyme. After the dials have been stamped they are coated with "under-glacé" and the dials black-fired. Before this latter operation, however, the dial has received two impressions in the dial printing machine, the first impression being allowed to dry before th second one is applied. The black-firing takes place in the gas furnace shown in Fig. 47.

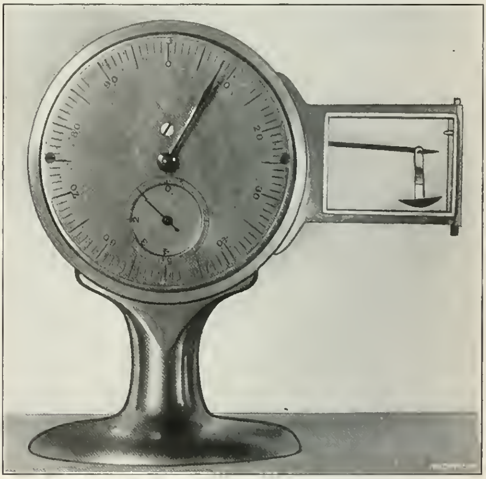
Fig. 53. Scales for Weighing Balance Screws

The machine used for printing the characters on the dial has some interesting mechanical features. It consists essentially of a table *B* on which the work and stamp are held. (See Fig. 49). This table is indexed or rotated by means of a sector gear *F* meshing with a pinion *G* keyed to the spindle of the table. An indexing dial *H*, provided with two notches in which an indexing finger fits, locates the table in the two positions. The sector gear receives its motion through bevel gears *I* and a worm and worm-wheel *J*, the latter being driven by pulley *K* belted to the overhead works.

The rubber transfer pad is operated by means of a cam *L* and bell-crank lever *M*, the latter being fulcrumed at *N*. The upper arm of this lever straddles a sleeve *O* which butts against a shoulder on spindle *P*. This spindle has an arm *Q* fastened to its top end carrying an adjustable screw *R* which comes in contact with the upper end of the spindle carrying the rubber pad. Spindle *S* is returned to the "up position" by means of a spring *T* working against collar *U* which is fastened by a set-screw to the spindle.

Assembling and Finishing Operations on Watch Movements

Upon completion, all of the small parts are turned into the stock-room from which they are sent out when needed. When the jewels have been burnished into their settings, the settings are put into the plates and bridges, and the latter are ready to be assembled with the various parts of the movement. Following this, the hair spring is trued, over-coiled and vibrated for strength. The balance is also trued up and fitted to the staff. Probably one of the most interesting operations performed on a watch movement in its final stages of completion, however, is that of temperature adjustment. After the watch movement has been completely assembled and tested, it is placed in the oven shown at *A* in Fig. 50. This is provided with a water jacket having a capacity of 40 gallons, and is heated by two 4-candlepower bulbs, which keep the water at a temperature of 90 degrees. The water jacket is used as a precautionary measure so that in case the electric current is turned off for a short time there will be no difference in the temperature.

The device used for heating this cabinet and keeping it at a uniform temperature is shown in Figs. 51 and 52. The door is made to fit closely and is provided with a door jamb set at an angle. The electric bulb *B* is wired to the electric circuit and also to the temperature controlling mechanism. This, as shown in Fig. 52, consists of a wooden base *C*, to which a block *D* is fastened to hold the lamp socket. Two bi-metallic bars *E* and *F* are let into a wooden block *G*. These bars are made from a strip of brass ½ inch wide by 0.060 inch thick by 12 inches long, to which a strip of steel 0.040 inch thick is soldered. The wires *L* and *M* lead from the switch of the electric wiring, while wire *O* connects the bar *E* with the lamp. The brass strips on these bars face each other. Contact is made by a platinum tipped adjusting screw *P* that comes in contact with the platinum facing *R* on bar *E*.

This device works on the same principle as a compensated balance. Heat expands the brass strips to a greater extent than it does the steel strips, thus bending the bars outward and breaking the electric circuit by separating the platinum faces. Screw *P* is used to adjust the contact at the proper point, so as to regulate the temperature. A thermometer *Q* is suspended with its bulb near the watches to be tested, so that a true temperature will be recorded. The watch movements are kept in this cabinet at a temperature of 90 degrees F. for 24 hours.

After the movements have been removed from cabinet *A*, Fig. 50, they are placed in the ice box shown at *B*. Here they are left for 24 hours at a temperature of 45 degrees F. They are taken out and the change in time noted. The adjustment for temperature is accomplished by changing the weight of the balance screws, and also their location in the rim, so as to equalize the expansion and contraction of the balance.

Weighing Balance Screws

The scales used for weighing the balance screws are shown in Fig. 53 and in detail in Fig. 54. The dial is provided with 100 graduations, each graduation equaling one ten-millionth of a pound avoirdupois. The lower dial hand registers 1 when the larger hand makes one complete revolution of the dial.

Referring to Fig. 54, it will be seen that this scale consists of a beam *A* pivoted at point *B* on a balance staff *C*, the pivots of which run in jewels. Attached to the staff *C* and to a pin in wheel *D* is a watch hair spring *E*. The main wheel *F* held on arbor *G* rotates the small needle *I*, which makes one complete revolution to every eight revolutions of the large hand *J*.

To weigh a balance screw, the glass door *K* is swung back and the screw deposited in pan *L*. Then the door is closed and the hair spring *E* wound up by means of knurled thumbscrew *M* and pinion *N*, until the tension of the hair spring overcomes the weight of the screw. The screw is then removed from the pan and the door closed, when the hands register the weight of the screw on the dial in ten-millionths of a pound avoirdupois. Flat spring *O* and thread *P* take up the back-lash in the gearing. So sensitive is this scale that the amount of lead deposited on a piece of paper when writing a name with a lead pencil is clearly registered on the dial.

A difference in weight in a pair of screws, located in the rim of the balance, of one ten-millionth of a pound equals a variation of one second an hour in a watch.

Final Inspection

In the making of the South Bend watch movement parts, over twelve thousand separate and distinct operations are required. Over one hundred operations are performed on the dial alone, while the completed watch has passed through four hundred and eleven inspections. After the watch movements have been accurately adjusted and timed they are, as a final test, run for six days in order to insure uniformity of rate. Even after a watch movement has passed through all of these inspections and has been packed ready for shipment it goes to a final inspector, who unpacks the movements and puts them through a final examination for the purpose of reducing to a minimum the chance of any defect.

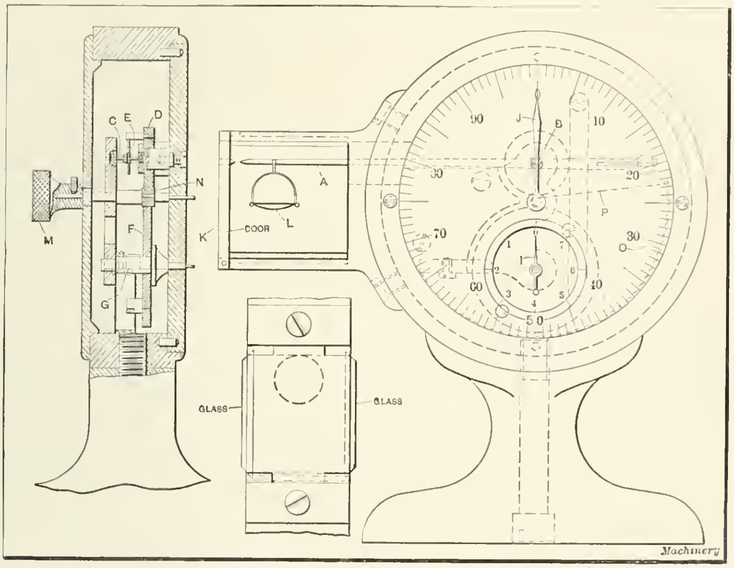

Fig. 54. Construction of the Balance-screw Scale shown in Fig. 53

* * *

A bill framed as a committee measure by the Patents Committee of Congress, and which covers the features of all the different bills that have been brought in during the present session of Congress relating to patent monopolies, contains the following features of special importance: It provides for compulsory licenses, which, however, will not apply to the original inventor, but only to those persons or corporations who acquire patents by purchase, and who in the past have often done so for the purpose of suppressing competition. It also provides that no purchaser, licensee or lessee of a patented article shall be liable for action for infringement of the patent because of breach of any contract of sale or license. The bill does not propose to take away any right of action, so far as the contract is concerned, but it does take away the rights that may now exist to bring an infringement suit growing out of a contract with regard to the use or sale of a patented article. It also proposes to so amend the Sherman anti-trust law as to make it clearly applicable to combinations and trusts in restraint of trade where patents are involved in the monopoly.

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OCTOBER, 1912

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THE REVIVAL OF BUSINESS

The fall season has opened with a heavy increase of business in iron and steel products, machine tools, accessories and kindred lines required in manufacturing, which makes the outlook bright; but the tendency to mark up prices higher than conditions warrant is a mistaken policy that will inevitably result in a setback.

The crops are large and the railroads have more freight than they can move, and there is already a car shortage which is likely to increase to serious proportions. So marked a revival of trade in a presidential election year is a phenomenon almost unequaled. The common notion that business must be dull every four years apparently has been exploded, and we sincerely hope that the quadrennial scare incident to the presidential election has been dispelled.

America's resources are too great and its business is based on too solid a foundation to be seriously disturbed by possible or impending changes in the political complexion of the government. Changes in economic policy are inevitable, and whatever the coming readjustment of the tariff schedule may be—for readjustment there will be, in some respects, whoever is elected—these changes will be made conservatively and with due regard to the welfare of the great industries that have developed during the past fifty years under a protective tariff.

* * *

THE TESTING OF MATERIALS

When speaking of the testing of materials for construction, one generally understands merely the testing, by suitable machines or other means, of the various qualities of a material. The scope of the work of the International Association for Testing Materials, however, is much greater than implied by this narrow definition of the testing of materials. It is recognized that it would be of little or no use, though we were ever so expert in the mere testing of materials, if we did not at the same time know exactly what was required of certain materials for certain service. We may, for example, be able to test the tensile strength, elastic limit, hardness, elongation etc., of the material entering into steel rails, but the information thus obtained would be of comparatively little value did we not at the same time know, with certainty, the requirements necessary for steel rails that have to stand the pounding of heavy engines on a sharp curve at high speeds. It is the object of the men interested in the testing of materials not only to devise means for carrying out the required tests, but also to settle upon the necessary specifications for materials to be used for different purposes, and to aid the makers of these materials, if possible, in obtaining the required qualities in them. The scope of the International Association for Testing Materials, therefore, is a very wide one. It embraces in its final analysis not only that part of the engineering science which deals directly with the study of materials, but also that which enters into the fields of design and manufacture. The work of the association is highly important to the engineering world, and the sixth congress of the association, held in New York City during the early part of September, tended to emphasize this fact. The great number of papers presented indicated the activity of the members, and the engineering world, in general, is to be congratulated upon the effective work being done.

* * *

MECHANICAL EFFICIENCY

The theory of the efficiency of machines is one of the simplest in applied mechanics, but it nevertheless seems to be one very often misunderstood and misapplied. The hundreds of inventors of perpetual motion machines are notorious examples of those who misunderstand it and the great principle of conservation of energy, but they may be classed as impractical men of little or no importance in the machine building world. There is another large class, however, whose ideas are embodied in machines built, sold and used with various degrees of satisfaction who are more or less hazy on certain fundamental principles. It is important that this class thoroughly understand the general principles which conserve power, reduce wear, and tend generally to promote the life and efficiency of machines.

A machine may be effective without being mechanically efficient, and again it may be mechanically efficient without being effective. This is an apparent paradox generally understood and appreciated. A worm-gear, as ordinarily made, is effective but not efficient, and on the other hand if highly efficient it fails to be effective as a brake—a most important consideration in some machines. In the case of machine tools, mechanical efficiency is ordinarily regarded as a minor matter, while accuracy, convenience of operation, adaptability, safety and pleasing lines are of paramount importance. But mechanical efficiency, aside from power saving, is important, nevertheless, as a mechanically inefficient machine wears rapidly and requires more lubrication to do its work than the efficient machine.

The efficiency of a machine is measured by the percentage of useful work available after transformation in the machine. The percentage of useful work is always less than one-hundred, is rarely over ninety-five in the simplest mechanisms, and is often less than ten. Efficiency is expressed by the formula: $E = \frac{W - w}{W}$, in which E is efficiency; W, the work put in; and w, the work delivered.

A stiff machine in which the train of mechanism is well supported is more efficient, other things being equal, than one having a weak and flexible train. Work is lost in bending the parts, especially when the action is intermittent. A reciprocating motion may be transmitted, for example, through a lever so weak and flexible that all the work put into the machine is lost in deflecting this member, thus producing molecular distortion and heat. Take, for example, a compressed air riveting machine of the alligator type. The stiffness of the levers is an important factor in its efficiency. A riveter having ample cylinder capacity might, nevertheless, be so weak in the levers that the toggle action would fail to produce the squeeze necessary to upset the rivets. The work that should be expended on the rivets is lost in friction of the pivots and in springing the levers which yield at the critical position so much that the necessary force to upset them is not developed. This machine would use as much compressed air as another of the same size but with stiffer mechanism which would effectively set the rivets. One is efficient and the other is totally inefficient.

Hence mechanical efficiency, while meaning the percentage of power available in terms of the power expended on a machine, should also mean that the machine is so designed that its parts are subjected to minimum wear, that a minimum amount of oil is required for lubrication and that no part is subjected to such high bending stresses at any point that it bends appreciably when transmitting the load required to do its work effectively.

* * *

SQUARE AND HEXAGON SOCKETS

The analysis of the stresses acting in square and hexagon socket safety set-screws by Mr. Myers in another part of this number, is an excellent example of practical application of mathematics to design. This is a case in which the strength of two members should be equal, if possible, but the proportions necessary for equal strength cannot be determined by simply adding here and taking off there. While the analysis is not rigid, it is sufficiently complete to answer practical requirements. It shows how the wrench socket may be so proportioned as to secure the maximum strength for both the wrench and the screw. Of paramount importance is the matter of durability when the hollow screw is employed for lathe chucks and other parts requiring constant manipulation. While it is shown that for pulley hubs and other machine parts the hexagon socket set-screw is best, as it can be so proportioned as to have greater strength than square socket set-screws of the same size, it is also shown that the square socket is better adapted for those situations in which it is subjected to daily use. Hence for lathe chucks, drill chucks, lathe dogs, etc., the square socket is preferable.

The superiority of this method of determining proportions of machine parts over mere guesswork and numerous tests is obvious. Tests, of course, are necessary to verify conclusions and make certain that the minor factors neglected in calculations are not of greater importance than assumed, but a comparatively small number of tests will suffice to verify a rational design; whereas, with rule-of-thumb or guesswork design those proportions necessary for maximum strength and efficiency are usually found only by a slow and costly process.

* * *

TABLES AND DIAGRAMS

There is considerable difference of opinion among mechanical men regarding the relative advantages and uses of tables and diagrams for recording data. Some engineers seem to prefer to tabulate all data coming under their observation, which may be useful in their practice, regardless of the fact that much of this information could be more conveniently shown in diagrams. Others have what might be called the diagram hobby, and apparently believe that all mechanical data that can possibly be given in diagram form should be put in that shape.

Both of these extreme types show a lack of appreciation of the true uses of tables and diagrams. There is, in general, a fairly well-defined field for each, and engineering data should be recorded partly by tables and partly by diagrams, according to which form best meets the requirements of the practical man. Whenever the matter dealt with has to do with parts, devices and objects made in certain specified sizes, once standardized, a table is most convenient. As an example, may be mentioned data relating to tap drills and other dimensions required in the use of pipe taps. Here a diagram is of little or no value, as there are but comparatively few standard pipe tap sizes, and all the dimensions relating to each of these sizes can be easily and conveniently tabulated with much greater exactitude than they could be put in diagram form; at the same time the chance of error in using a table is far less than in reading off a dimension from a diagram. The diagram, again, is most useful in cases where an indefinite number of combinations of values may exist, and where curves may be used to indicate the values to be found for any combination. An example of this kind is a horsepower diagram from which the horsepower that may be transmitted by gearing of different pitches and velocities may be found. In this case, tables would be entirely too voluminous, and could hardly contain all the possible combinations covered by a diagram of comparatively simple construction.

In a general way, therefore, the proper place for a table is where certain definite data are known and fixed and the values to be found corresponding to them can be conveniently put in plain figures. The diagram should be used instead in all cases where a great number of different combinations of two or more initial values are given, and where a tabulation would be entirely too voluminous to be practicable, both because of the time required for compilation and the inconvenience incident to its use. The diagram has in some cases another advantage—a curve may show the trend of certain functions, indicating the rising or falling values under certain conditions, etc. In this case, the diagram is especially useful in investigating work, when making tests, or when comparing the relative efficiency of mechanisms.

* * *

THE ONE HE GOT FROM HOME

BY A. P. PRESS

Bill was a first-class toolmaker, one of the very best we had in the shop, and the only fault we had to find with him was that nothing he ever did or saw us do—in fact, nothing in the shop or even in the whole country was so good as what they did "back home." What they did "back home" according to Bill's tell was certainly a wonder.

One day he got to talking to the boss patternmaker about extension bits.

"I tell you what, the extension bits we have 'back home' are way ahead of anything that you can get in this country, and the next time any of the boys go 'home' I am going to send and get one for you. I'm willing to pay for the bit, just to show you what they make over there."

Two weeks after that one of the boys in the shop made up his mind to take a trip to the old country, and when he came into the shop, after he got his ticket, Bill put it up to him to get him (Bill) an extension bit.

"Buy me the very best extension bit you can find, no matter what you pay for it, or who makes it, and bring it back when you come, and I will make it right with you."

"All right," and off he went.

Two months passed by, and one day he came in and asked for his old job, and as he was a "crackerjack" good man, we were glad to get him, and told him to come in in the morning.

When he came in the next day he brought in Bill's extension bit. It was in a box the same as they make "back home," and what it said on the label we are unable to tell as we only read and speak one language.

"There," said Bill, as he proudly took it out of the case, "there's a bit that is a bit. Look at that finish, and look at the way the blade is held in on the end."

"Say, but that is pretty good," said the boss patternmaker, "but at the same time it looks kind of familiar. What name is that on the shank? Hold on a minute. I can read that. Why that was made by the S. S. & S. Co., right up here in the next town."

"Well, Bill," said the boss patternmaker, "I want to thank you for that bit. Never mind if it was made only ten miles away, it has been to the old country and back again, and that is more than I ever expect to do, and I shall treasure it all the more for that."

This was the last of anything that we ever heard about "back home."

* * *

According to *The Foundry*, experiments have been made by the Crane Co., Chicago, Ill., which have shown that if iron borings are used in place of a portion of the gravel mixed in concrete, floors of this material can be successfully used in certain portions of foundries. Many foundrymen are interested in the use of concrete floors, but have generally found them unsatisfactory because molten iron will not lie on concrete on account of its porous and, therefore, generally moist condition. The mixture recommended consists of one part cement, three parts sand, four parts gravel, and one part of iron borings. It is stated that floors made from this mixture are perfectly safe.

CASEHARDENING AND CASEHARDENING PRACTICE*

A REVIEW OF METHODS IN THE BICYCLE, AUTOMOBILE BUILDING AND ALLIED TRADES

BY ROBERT H. GRANT†

A great improvement has been made in casehardening processes during the last few years. The advance was begun with the development of the bicycle industry, and the necessity for casehardened parts of the highest quality in automobile manufacture has been the cause of still further improvements in this field.

As an example of what can be accomplished by proper methods, consider the transmission gearing of an automobile. Who would think of throwing in the back-gears of a lathe or any other machine tool without first stopping the machine? In an automobile, however, this very thing is actually done, perhaps a hundred times a day, by a person who gives little thought to what he is really doing. Yet the gears stand up under this treatment because of being manufactured from special steels developed during comparatively recent years, and because of being heat-treated and casehardened by improved methods.

Principles of Casehardening

Casehardening is actually only an improvement on the old cementation process used in times past for making steel from wrought-iron. This process consisted of rolling the wrought-iron into thin strips and then placing it in boxes with some material containing a fair portion of carbon. These boxes were then heated to a very high temperature and the carbon was gradually absorbed by the iron.

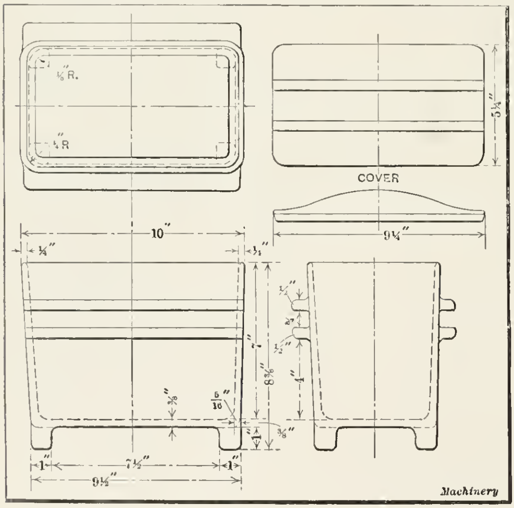

Fig. 1. Box for Casehardening, of Approved Design

In modern casehardening there are a number of different questions that must be taken into consideration. In the first place, the steel or material to be used must be considered. Another most essential thing is the casehardening furnace which must give a uniform heat. As oil has almost wholly superseded coal for heating casehardening furnaces, the changes in furnace construction have, of late, been considerable. The box constitutes another item which must be considered, as well as the material used in packing the parts to be casehardened. The methods used for hardening the parts after they have been carbonized is another question that must be dealt with.

Steel to be used for Casehardened Parts

As the casehardening process consists in adding carbon to the steel, it is necessary to use a material which will absorb the carbon without necessitating overheating or burning. The effect of carbon on steel is, in general, it may be said, to make it dense, and the denser the steel, the higher the heat necessary to open the pores through which it must absorb the carbon. A low carbon steel containing say from 0.15 to 0.20 per cent of carbon is, therefore, most suitable for casehardening. It should also be borne in mind when selecting the material that the casehardening process does not eliminate any of the impurities ordinarily found in iron, such as sulphur, phosphorus, etc., and hence a material as free as possible from these impurities should be selected.

Furnaces for Casehardening

In building or constructing a furnace for casehardening, the size of the work to be hardened should be the first consideration. It is far better to use a small furnace with a small box whenever possible. If the work varies in size, different sizes of furnaces may be used. Small furnaces require less fuel, and small work must be placed in small boxes as otherwise the pieces packed near the sides will be overheated while those in the center will not reach the required temperature. The furnaces should be made right- and left-hand so that they can be placed close together. Thick walls should be used to retain the heat. These walls should be supported by a substantial concrete foundation, so that they will retain their position and shape, even when subjected to a high heat. Large flues should be provided to carry away the smoke and gases.

The furnace should also be so constructed that as much as possible of the heat of the combustion gases may be extracted before they are discharged. The flues and all parts of the furnace should be easily accessible, and a door, the full width of the oven, should be provided so that the tiles can be taken out and the flues cleaned. A pressure blower with a light oil should be used with all the pipes accessible and placed, preferably, above the furnace. If, however, they are placed below ground, they should be arranged in compartments which can be easily reached if repairs are required.

The blower pipes should be run through the furnace so as to preheat the air used; if cold air is used directly it will reduce the heat in the furnace. The furnace fronts should be made in several parts to prevent cracking, with the door properly balanced and lined. A shelf should be provided, projecting at the front, for holding the boxes when they are taken out or put into the furnace. The smokestack should be made of sufficient height to produce a good draft.

Burners should be placed both at the front and rear of the oven and should be arranged in separate compartments, so that the heat will be uniform in the oven. The hot gases will then pass over the top of the compartment wall and strike the boxes on the top, after which they pass out through small openings in the corner of the furnace. They then take a zigzag course under the tiles and pass from there through a flue to the rear of the furnace. A large conduit should be provided just below the ground which will catch all the soot. This conduit should be provided with iron covers which can easily be taken off to remove the accumulation of soot.

The furnace should not be heated too quickly, as this is apt to crack the brickwork. The cooling should also be done gradually. After the work has been taken out and the heat shut off for the day, all the dampers should be closed to hold the heat. In this way the furnace will cool slowly and cracking or bulging out of shape will be prevented. In addition, it will be easier to heat the furnace the next morning, as it will have retained some of the heat.

When work is to be annealed, it should be placed in the furnace after the work to be hardened has been removed, and then the furnace brought to the proper heat. The material to be annealed can then remain in the furnace until the next morning with the furnace closed up and the burners turned off.

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* See also the following articles previously published in MACHINERY: "Casehardening," August, 1905, engineering edition; "The Casehardening Furnace," June, 1907, engineering edition, and the articles there referred to: "Casehardening Practice at the Juniata Shops of the Pennsylvania Railroad," July, 1910, engineering edition; "New Casehardening Methods," February, 1912, engineering edition; "Casehardening Temperatures," July, 1912, engineering edition. See also MACHINERY'S Reference Book No. 63, "Heat Treatment of Steel."

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A light oil should be used. It should have a high heating value and be comparatively free from carbon deposits, etc.

Boxes for Casehardening

The boxes for casehardening should not be made larger than necessary for the class of work being handled. They should be made from a malleable iron, as ordinary cast-iron boxes are not suitable on account of the fact that they are very porous and absorb the carbon of the carbonizing material. The boxes should also be provided with feet, as shown in Fig. 1, so that the heat can circulate all around them. The covers should be provided with ribs on the top to prevent excessive warping, and the sides should be ribbed so that a fork or grapple iron, as shown in Fig. 2, can be used for handling the boxes. The sides of the boxes should taper slightly towards the bottom so that the contents can be easily dumped out of them; they are also easier to cast when made in that way.

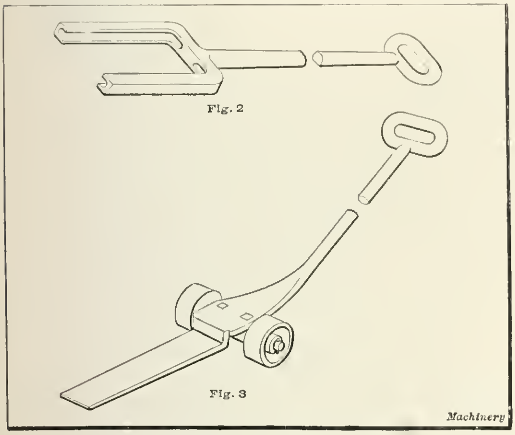


Fig. 2. Grapple Iron or Fork used for Handling Casehardening Boxes. Fig. 3. Truck for Handling Heavy Boxes

When very large boxes are required, they should, if possible, be provided with a hole through the center so that the heat can reach the contents from the inside, as well as from the outside. A box of this kind is shown in Fig. 4. For long work, such as shafts, tubing, etc., a wrought-iron pipe with a cap on each end provides an ideal box.

Local Hardening

In many cases it is essential that the piece of work be hardened at a certain place and that other parts be left soft. There are three ways in which this can be accomplished: First, by copper-plating and enameling; second, by covering the part which is not to be hardened by fire clay; and third, by using a bushing or collar to cover the part to be left soft.

In the first case the article should be painted with enamel where it is to be hardened, the enamel being baked after having been applied. The remainder of the piece that is to be left soft is copper-plated. In the second case, if the article to be hardened has a recess, such as a hole, slot, etc., this may be filled with clay. The third method is used when a shaft, for example, is only to be left soft for a short distance. A collar is then placed on the shaft, and this provides the easiest and least expensive means for accomplishing the purpose.

In the case where enamel and copper-plating is used, the enamel will burn away and allow the surface covered by it to absorb carbon and, hence, to be hardened, whereas the copper will stand a very high heat and prevent hardening of those portions that are covered by it. If the copper is burned off, it is an indication that the work has been overheated. The clay prevents the hardening of a portion of the work in the same way as does the copper. It is also of advantage when dipping the work, as it prevents the formation of steam pockets which are apt to warp or distort the piece. When a sleeve or collar is used, this should be made about one-half inch longer than the part which is to be left soft, so as to prevent carbonization near the ends of the collar.

Packing for Hardening

The packing room should, if possible, be separate from the room containing the furnaces, so that the packing can be done without the discomfort of the heat and dust. Tables on wheels, or trucks, provided with shelves of the same height as the shelf in front of the furnace and large enough to hold the required number of boxes for one furnace, should be provided, so that the packed boxes can be easily moved to the furnace and quickly placed in it. The work to be hardened should be classified according to its size and the percentage of carbon required, as it will take a higher heat for larger work, as well as for pieces which are required to absorb a higher percentage of carbon.

There are a great many different kinds of hardening materials, but the old-fashioned method of using ground bone can always be relied upon to give satisfactory results. During the last few years, however, the use of bone in various manufactures has increased so that the price of ground bone for casehardening purposes is almost prohibitive. Leather has become very extensively used for this purpose, it being first burned and then ground and graded.

A mixing bin is a great advantage in connection with the handling of the casehardening material. Some partly used bone and some new is then used to make a mixture suitable for the size of the pieces to be hardened. Large pieces require a richer material than smaller ones, as during the higher heat required for the larger pieces and the longer application of the heat, more of the carbonizing material will burn away.

When packing a box, first put a layer of the casehardening material on the bottom, the thickness of this layer depending upon the size of the pieces to be hardened. If the articles are heavy, they do not require such great care in packing, but if they are thin or long, or have a peculiar shape, greater care is required. It has frequently been stated that one piece should never be permitted to touch another when packing, but it has been found that this precaution is not necessary. If a box is properly sealed, the parts can touch each other without injury. Thin long pieces should, if possible, be placed in an upright position to prevent their sagging out of shape. Between each layer of pieces, casehardening material is packed according to the size of the pieces to be hardened. It has been found from experience that if there is not enough

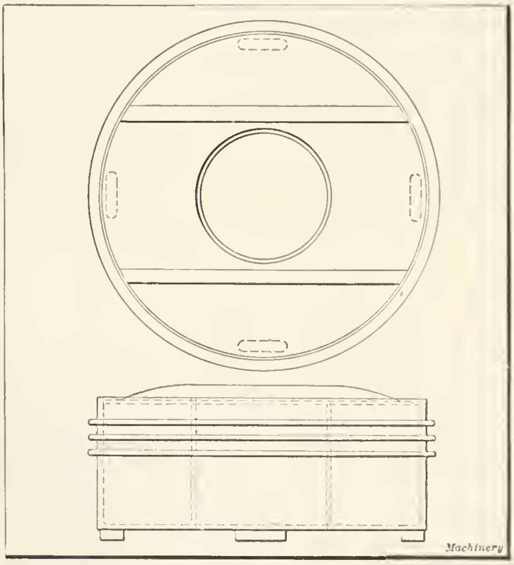


Fig. 4. Large Circular Box with Hole in Center for the Circulation of the Gases of Combustion

of the carbonizing material in the box, the work is liable to have soft spots.

About two inches from the top of the box, sheet steel strips about 1/16 inch thick should be laid and these should be covered with a layer of about one inch or more of powdered charcoal. Then the cover is placed on the box and the edges are sealed with fire clay. If there is any doubt about the length of time required for heating the pieces to obtain a certain depth of case, wire a couple of pieces together, allowing the wire to project out of the box. These pieces can then be taken out quickly and hardened, and, in this way, it can be ascertained whether the parts have been sufficiently carbonized. In casehardening very small work, it is advisable to wire the pieces together so that they can be taken out of the box at once; otherwise, they would have to be picked out with small tongs, as it is impossible to sift very small work in a screen because the mesh would have to be so fine that it would take a long time to do the sifting and the work would become too cold for hardening. If it is desirable to color the work, from one-third to one-half of the carbonizing material should be burnt leather.

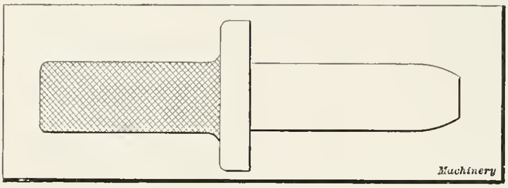


Fig. 5. Mandrel used when Hardening Collars, etc., on the Outside

The boxes should never be put into the furnace under a high heat, but should be placed in it when its temperature is from 800 to 900 degrees F. Then the heat should be slowly brought up to from 1500 to 1800 degrees F. In placing the boxes in the furnace, great care should be taken that the hot gases have an opportunity to circulate all around them. A pyrometer should be put in some convenient place and properly wired so that the heat in the furnace can be readily ascertained at any time. If there is a great deal of night work to be done, a recording pyrometer should be used as it gives the man in charge a record of the heats during the night.

By the aid of the pyrometer it has been found that it is necessary to have an expansion tank in order to get a constant air pressure, otherwise the pulsation from the blower will affect the heat in the furnace. This expansion tank should be situated so that the blower is connected directly with one end while the discharge pipe is connected at the opposite end. This will then act as a reservoir, producing a constant pressure. When oil is used for the heating, it is preferable to pump it from the storage tank in the ground to a stand pipe, which will insure a constant flow of the oil. The intermittent action of the pump, should the oil be used directly as it comes from it, is objectionable. There is also another advantage, in case the pump should have to be shut down on account of break-down. In that case, the furnaces could still continue to operate, as the stand pipe should hold a supply of oil sufficient for several hours. At night and on holidays the oil should be drained back into the storage tank in order to minimize the danger incident to its use.

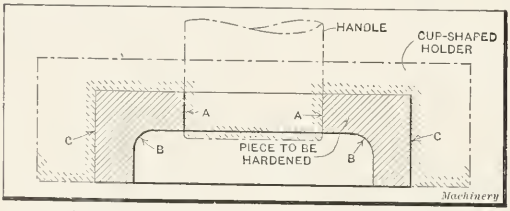


Fig. 6. Holder for Parts which are to be hardened locally

The supply pipe for the air should come from the outside and should be so arranged that the air passes through a fine wire netting, so as to prevent foreign substances from entering the blower.

On the outside of each furnace a card should be placed telling the kind of work that is in the furnace, when the work was put in, the heat required for it, and when it is to be removed. These cards can be kept as a record which will be of value when comparison is made with the depth of case obtained under any specific conditions.

Carbonizing, Reheating and Hardening

The heat required for casehardening is a great deal higher than that required for ordinary hardening. If, for example, the material to be casehardened was heated only to 1375 degrees F., which would be sufficient for the hardening of ordinary tool steel, the result would be very unsatisfactory. In fact, there would be no result at all. Small parts must be heated to at least 1575 degrees F., in which case sufficient depth of carbonized surface will be obtained in from six to eight hours. The time recorded as the correct one for casehardening should be taken from the time the boxes are heated clear through.

The correct way in which to caseharden is first to carbonize the material and then to allow the boxes to cool down with the work in them, after which they are reheated and hardened in water. The reheating refines the grain of the steel and prevents the formation of a distinct line between the outer hardened case and the soft core. If there is a distinct line between these two sections, the case is liable to flake off when the hardened part is subjected to severe stresses.

A still more refined method of casehardening is to repack the work, after it has been carbonized, in old bone, and after heating for two or three hours take it out and dip the pieces in the hardening tank directly as they come from the boxes. This will produce a very fine grain and in many cases prevent warping. If the work is large and it is required to toughen the inner core, it should be reheated to a higher heat than otherwise; then, after dipping, reheat again to 1500 or 1600 degrees F. according to the size of the work, and redip.

However, if the work to be hardened consists of bolts, nuts, screws, etc., it is satisfactory to dump them into water directly from the furnaces, without any reheating. A regular iron wheelbarrow with two pieces of flat iron placed across it lengthwise should be provided. On top of these bars is placed a sieve made from 1/8-inch wire with 1/4-inch mesh, about 18 inches square by 6 inches deep. This sieve should have a handle 6 feet long and 5/8 inch in diameter. The boxes are emptied into this sieve, and after sifting, the heated material is dumped into a tank of cold water which should be of sufficient size to prevent the water from heating too quickly. Care should also be taken in emptying the contents of the boxes into the water that they are not all dumped in one place, but scattered about in the tank. A constant flow of water should be available while the work is being hardened. The work should under no circumstances be removed from the furnace until the heat has been lowered, as the steel should be treated as tool steel after it is carbonized, and it would be injurious to the steel to harden it at the high carbonizing heat.

Gears and other parts which should be tough, but not glass hard, should preferably be hardened in an oil bath. There is then less liability of warping the work, and the hardened product will stand shocks and severe stresses without breakage. Cotton-seed oil is the best hardening medium to be used in this case.

After the work has been properly carbonized, the next operation in the case of all parts, except those mentioned as exceptions above, is to reheat. This may be done either as already explained, or it may be done in a regular muffle gas furnace in which the work can be put in rows on the tile. In this way the work can be heated very slowly, a new piece being put into the furnace to take the place of each piece as it is removed. Collars, etc., which are required to be hardened on the outside, but ought to be left soft on the inside, should be hardened on a mandrel, such as shown in Fig. 5, the diameter of the mandrel being from 0.001 to 0.003 inch smaller than the hole in the piece to be hardened. If the inside of the piece only needs to be hardened and the outside should be left soft, a cup-shaped holder, such as shown by the dash-dotted lines in Fig. 6, may be used. In this case the work will harden at *B* while it is left soft at *A* and *C*.

The hardening tank should be about 30 inches in diameter and 36 inches deep and have a constant flow of water from a pipe in the center about 6 inches below the surface.

Straightening the Work after Hardening

On account of the manner in which steel is rolled, drawn or forged, the density varies in different parts of the steel, and no matter whether the material is heat-treated or not, it will warp more or less when hardened. It is, therefore, necessary to provide apparatus for straightening the work. In straightening, it is necessary to bend the work about twice as much as would be required to merely keep it straight while the pressure is applied, as, on account of its elasticity, it will have a tendency to work back to its original form. Small rollers and shafts can best be straightened in a vise by having a three-point contact on the jaws. For large diameters a special straightener will be required. A surface plate placed to the height of a man's eye, and at a slight angle towards the light, provides the easiest means for testing work of this character while being straightened.

When there is a large quantity of rings to be straightened or trued up, a surface plate can be readily rigged up in the following manner: A solid strap is provided on one side and a compound lever on the other, adjustable to any place along the plate by means of a slot in the latter. By a slight movement of the lever the ring can be trued up. An indicator should be placed at the front of the plate so that the operator can try a ring to see at which points the ring is out, and also the amount necessary for making it round. In straightening washers or flat pieces of any kind, the hydraulic press provides the best possible means. It might be well to mention that washers or flat pieces should be ground by taking a small amount off each side alternately, as, otherwise, they will return to their original warped shape. Another precaution, relating to the grinding of cylindrical surfaces, is to use a copious supply of water, as otherwise the heat of the grinding operation will draw the surface, producing soft spots. These will appear to have been caused by improper casehardening, but as a matter of fact, they are wholly produced during the grinding operation.

* * *

ITALIAN NATIONAL AERO LEAGUE

A national "Aero League" has been formed in Italy and the raising of funds by public voluntary subscriptions has been started to build an aerial fleet of one hundred aeroplanes for the Italian government. A similar movement for collecting, by voluntary subscriptions, funds for the building of military airships has also been started in France; and the extent to which the military craze carries some of the European countries is further exemplified by the fact that in Sweden voluntary subscriptions are now being solicited for the building of battleships. A curious thing is that these movements meet with enthusiastic response, and that in Sweden, for example, millions of dollars have been collected within the space of a few months.

* * *

LIMITS ON GEARING

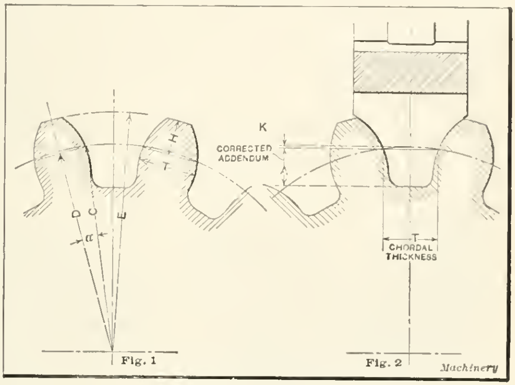
In an article in the *Machine Tool Engineer*, a supplement to the *Practical Engineer* (London, England), Mr. Francis W. Shaw gives the following table for allowable limits for spur gearing, the limits being based on the pitch of the gears:

Pitch	Center Distance	Pitch Diameter	Blanks, Outside Diameter
16	±0.002	−0 003 to −0.005	0.000 to −0.005
14	±0.003	−0.004 to −0.006	0.000 to −0.005
12	±0.0035	−0.0045 to −0.007	0.000 to −0.006
10	±0.004	−0.005 to −0.008	0.000 to −0.006
8	±0.005	−0.006 to −0.009	0.000 to −0.007
6	±0.006	−0.007 to −0.010	0.000 to −0.008
5	±0.007	−0.008 to −0.011	0.000 to −0.010
4	±0.008	−0.009 to −0.012	0.000 to −0.015

CHORDAL THICKNESSES AND ADDENDA FOR GEAR TEETH AND GEAR CUTTERS*

In measuring the thickness of gear teeth and gear cutters, it is necessary to make allowance for the curve of the pitch circle of the gear. In the ordinary 14½-degree involute system, eight cutters to a set are used, the cutters being laid out as follows: No. 1, for 135 teeth; No. 2, for 55 teeth; No. 3, for 35 teeth; No. 4, for 26 teeth; No. 5, for 21 teeth; No. 6, for 17 teeth; No. 7, for 14 teeth, and No. 8, for 12 teeth.

In the following article will be given formulas for finding the chordal thicknesses and what is called the "corrected" addenda, that is, the perpendicular distance from the chord at the pitch circle to the outside diameter of the gear as indicated at *H*, in Fig. 1. In the accompanying Data Sheet Supplement, tables are given for the chordal thicknesses and the corrected addenda for gear teeth and gear cutters. Let,



Figs. 1 and 2. Notation used in Formulas for Chordal Thicknesses and Addenda of Gear Teeth and Cutters

α = half the angle subtended from the center of the gear by one gear tooth (see Fig. 1),
N = number of teeth in gear,
T = chordal thickness of tooth at pitch line,
D = perpendicular distance from chord T to center of gear,
H = perpendicular distance from chord to outside circumference of gear,
C = radius of gear at pitch line,
E = outside radius of gear.

The formulas are as follows:

$$\alpha = \frac{90}{N}; \quad T = 2\,C \times \sin \alpha;$$

$$D = \sqrt{C^2 - (\tfrac{1}{2}T)^2}; \quad H = E - D.$$

In the case of the gear cutter (see Fig. 2), the chordal thickness is the same as that for the gear, but the corrected addendum of the gear cutter is different from the corrected addendum of the gear. The two dimensions, however, added together must equal the total depth of the gear tooth. To obtain the corrected addendum *A* of the gear cutter, we can, therefore, either subtract the dimension *H*, as found by the previous formulas, from the dimension for the total depth of the tooth, or we can take the dedendum for the particular pitch required from any standard table of gear tooth parts and subtract the dimension *K*, Fig. 2, which is found by the formula:

$$K = C\ (1 - \cos \alpha).$$

The values thus found are given in the tables entitled "Chordal Thicknesses and Addenda for Gear Cutters" in the accompanying Data Sheet Supplement. As these tables are calculated for both diametral and circular pitch and for all commonly occurring pitches in either system, they should prove of considerable value to persons engaged in gear cutting or in the making of gear cutters.

* * *

Rivets should never be used in direct tension, but bolts and nuts should be used instead.

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* With Data Sheet Supplement.

PRE-HEATING METALS TO BE WELDED BY OXY-ACETYLENE PROCESS*†

OBJECT OF PRE-HEATING, AND METHODS AND APPLIANCES USED IN THIS WORK

BY J. F. SPRINGER‡

The use of the oxy-acetylene torch for heating the work from the ordinary open-air or room temperature to that of, say, red heat, is a rather wasteful method. It is frequently more economical to do this pre-heating by some cheaper method and then to complete the heating with the torch. Various methods are used for pre-heating; as a rule these methods are comparatively simple. A number of examples will be described in the following.

In pre-heating a large cast-iron kettle, a charcoal fire was employed. The kettle weighed about 18,000 pounds and the metal around the crack, which was about two feet long, was several inches thick. The crack was in the bottom and so the kettle was overturned in order to make the crack more easily accessible. The pre-heating was then done from within the kettle, and, in this case, was not only economical but probably essential, as it would have been difficult to obtain the required amount of heat by the torch flame alone. Asbestos sheeting was employed to protect the operator from the heat radiation.

In repairing a break in a locomotive cylinder, Fig. 1, the pre-heating was also done with charcoal, a temporary oven having been built up of loosely laid bricks, as shown in Fig. 2. The fire was kept going for two and one-half hours, at which time a dull red heat was secured. This condition was maintained for six hours longer during the welding operation. It is often possible to use an ordinary blacksmith's forge for the pre-heating, and if a great many similar parts are to be handled, a special forge and bellows may be found of advantage. In addition to the use of charcoal, torches using illuminating, producer, or natural gas, oil, or gasoline, may be employed; in fact, any method for obtaining a large amount of heat, but not necessarily a high temperature, can be employed. In one case, in welding a break in a locomotive engine frame, a gasoline torch was employed for the pre-heating, the torch being applied throughout the welding operation. In cases of repetition work, special pipes and burners may be used.

In one plant in Europe, where tubing is manufactured with the aid of power-driven gas-welding machines, provision is made for the rolled but unwelded tube to pass through a muffle just before reaching the torch, so that the tube is bright red when passing under the torch. Sometimes the outer flame of the torch itself may be used for pre-heating. Thus the Edison Storage Battery Co. employs a machine (see MACHINERY, September, 1911, engineering edition, "Oxy-acetylene Welding and the Edison Storage Battery Can") in welding a straight seam on the containing cans of their batteries. The torch, the work, and the clamping devices are so arranged that the outer flame of the oxy-acetylene jet is divided into two long streamers. One of these impinges upon the seam several inches ahead of the place where it is reached by the working flame. It is possible that this arrangement was not provided with a view to pre-heating, but that is the effect, and a consequent economy in gas consumption is the result.

The use of the outer flame for pre-heating may come to be quite an important factor. A large quantity of heat is generated by this flame. In the machine referred to, the clamps arranged along the sides of the seam are beveled to afford access to the torch, the bevels being quite steep—about 60 degrees. The writer would suggest that similar clamping bars be formed in connection with regular hand-welding work, so as to provide a canyon-like working groove. In hand-welding larger sizes of tubing, it would also be practicable to provide a series of gas jets on a single supply pipe beneath the joint. In this way the edges could be pre-heated with cheap gas.

Pre-heating is often resorted to for reasons other than those of economy of gas consumption. It is used where the effects of expansion and contraction are objectionable. The rise of 2000 degrees in the temperature of a metallic body occasions considerable expansion in every direction. For example, a 12-inch steel bar will lengthen about 5/32 inch. It is easily seen that the sudden swelling and resultant shrinking of only a small part of the work may, at times, have disastrous results. Take as an example the spoke of a fly-wheel with a piece broken out. This piece just fits into its place. If we repair this by making the required grooves and then filling them with new metal, thus producing an apparently good weld, we will find that, upon cooling, a break will frequently occur in the weld or at some other point, due to the contraction. A similar case is met with in a crack in a casting. It is chipped out in order to obtain beveled edges for the flame, the faces are heated, and new molten material filled in. When the weld cools off, however, the new material is likely to shrink away from the walls of the crack.

Now what can be done to meet this condition? If we could uniformly heat the whole work within as well as without, we should probably have an ideal solution, but one of the great objects in oxy-acetylene welding is to localize the heating. We can, however, pre-heat a larger portion of the whole body than is required for the welding alone, and in this way distribute the stresses. In the case of the flywheel, the broken spoke, the adjacent spokes, and the intervening rim may be heated

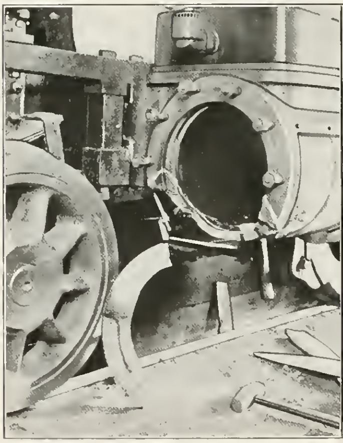
Fig. 1. The Broken Cylinder

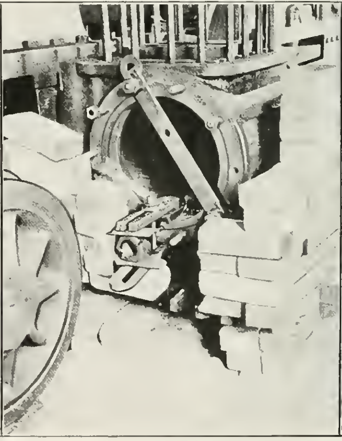
Fig. 2. Arrangement for Pre-heating

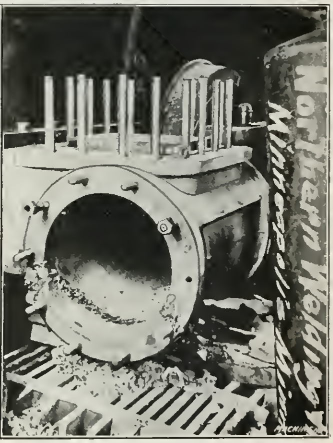

Fig. 3. After Welding, before Cleaning Weld

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* For further information on autogenous welding, see "Modern Welding Methods," MACHINERY, December, 1911, and the previously published articles there referred to.

† This article has been prepared with the cooperation of the Davis-Bournonville Co., New York, and is a chapter from a forthcoming book: "Oxy-acetylene Torch Practice."

‡ Address: 608 West 140th St., New York.

to a red heat, gradually diminishing toward the other parts of the wheel, so that the pre-heating itself does not introduce new stresses. When the new material for making the joints is filled in, the spoke is naturally longer than it will be at ordinary temperatures, and while there is a local contraction of the weld, there is also a general contraction of the whole spoke and those adjacent, which diminishes the effect. In the case of a cracked cylinder casting, the pre-heating of the metal beyond each end of the crack, if properly done, will ordinarily open up the crack so that when it is filled with new metal, the amount which is used will be sufficient, when the cylinder cools off, to fill the original space. Ordinarily, the walls of the crack should be held apart until the weld is completed, so that the width of the crack and the new metal will contract together. If the crack runs from a point within the periphery all the way to the edge it may be opened up by heating at a point a little further in than the beginning of the crack. The welding is begun at the inner end of the crack, working toward the edge.

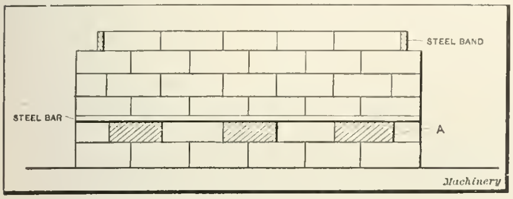


Fig. 4. Arrangement of Temporary Brick Furnace

The pre-heating should ordinarily be done rather slowly so as not to introduce sudden temperature changes and stresses. Slow heating is especially to be advised when there is a combination of thin and heavy parts. Similar remarks apply to the cooling, which should be slow to be safe; the cooling may be retarded by the use of asbestos sheeting or by packing the object in heated ashes or heated slacked lime.

When it is possible to pre-heat the entire casting, this seems to be the best way of taking care of expansions and contractions. Castings the size of which makes necessary special arrangements may be placed on a bed of fire-brick arranged with spaces between them. A temporary wall or furnace is then built around the whole, fire-brick being used for this also. These are arranged, of course, without the use of mortar, with very narrow openings between them, one method of constructing such a wall being shown in Fig. 4.

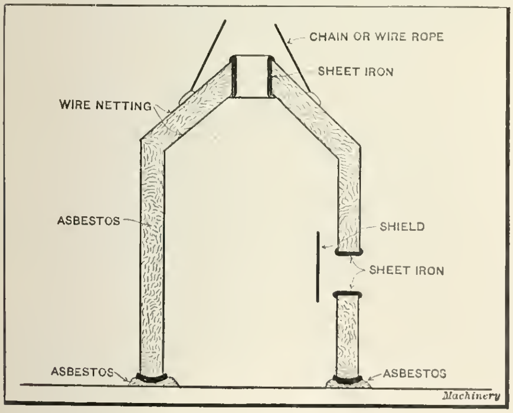


Fig. 5 Hood used for the Pre-heating Operation

Flat steel bars may be employed just above the separated course of bricks *A*. The top course may be held in place by a steel band. The object of the open spaces is to provide a draft. Charcoal is now filled in between the casting and the wall and the fire started. A sheet of asbestos is used as a cover. This cover should contain a number of holes so as to provide an exit for the gases.

Another method is to make a hood of a material that is a poor conductor of heat. Such a hood is shown in vertical section in Fig. 5. The walls consist of two sheets of wire netting with an intervening space filled with asbestos. A hole, the wall of which is made of sheet iron, is provided at the top. Another aperture also lined with sheet iron is provided on one side of the vertical cylindrical wall. The bottom of the hood is furnished with an annular base ring of sheet iron, the netting and sheet iron being joined by welding. Provision should be made for lifting and lowering the hood, so that it can be let down over the casting which is to be pre-heated. To make a tight joint with the floor, some loose asbestos may be used as a foundation for the hood. A kerosene or other torch may now be inserted through the aperture in the side. Some kind of shield may be used just inside of the side opening to divide the flame, so that, as far as possible, the casting will be encircled by it. Sometimes it is advisable to use auxiliary fires on shelves above the main fire at the bottom. This is especially to be recommended for tall castings, so that there will be no severe concentration of heat at one point. As already mentioned, the heating should be done slowly, the fires being started in a moderate way and gradually increasing in intensity. During the welding the hood must, of course, be raised, and when the welding is completed the hood may again be lowered into position in order to retard the cooling. The oil torch should be brought into service again for a short period. It may then be shut off and the openings of the hood covered. In this way, slow and even cooling is assured.

In general, after a welding operation, the casting should be reheated as soon as the welding is completed, and then covered with asbestos wool or scrap asbestos. The casting may also be buried in any of the materials ordinarily used for retarding the cooling of steel which is to be annealed. If the casting is of such a shape that it is not likely to crack, it may be cooled in the bed of charcoal in which it has been heated.

Cast iron may be pre-heated to about 700 or 1000 degrees F. Generally speaking, the higher the temperature of pre-heating, the less the danger of cracking when cooling. Aluminum castings should be pre-heated to about 600 or 700 degrees F., the heat if possible being maintained during the entire time of welding. To accomplish this, it is often advisable to cover the casting with asbestos and to leave only the working area exposed. Asbestos sheeting will be found satisfactory for keeping any class of work hot during the welding.

It may be of interest to refer to a specific case of welding performed by the Pullman Co. of Chicago. The bed of a hydraulic press was cracked; the casting weighed about 10 tons, and the crack was about 10 inches long and 26 inches deep. The material of the bed was cast steel. The casting was placed on supports of brick about 14 inches high and a fire of wood and charcoal was maintained during the night, with the result that when the welding was begun the metal was at a red heat. A No. 10 Davis-Bournonville tip was used with a soft steel welding rod, two workmen carrying out the work. The time consumed for the welding operation was about five hours. The necessary enlargement of the crack was made by the oxy-acetylene flame. The expense was estimated at $19.16, and the result of the welding was very satisfactory. As the gas cost of the Pullman Co. is extraordinarily low, for ordinary conditions the expense would, perhaps, be as follows:

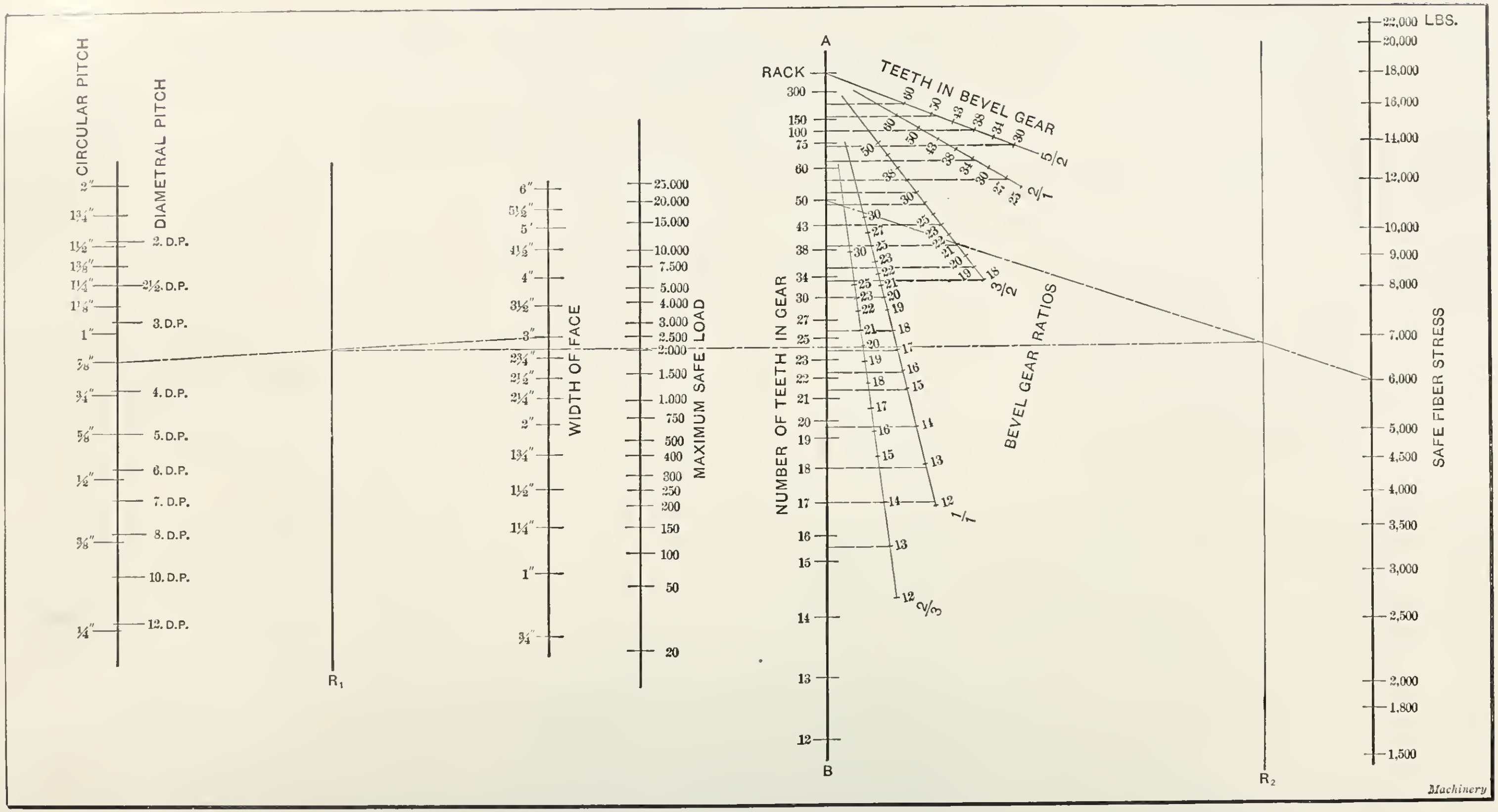
357 cubic feet of oxygen at 3 cents per cubic foot...	$10.71
143 cubic feet of acetylene at 1 cent per cubic foot..	1.43
Labor	7.40
Fuel for pre-heating and annealing................	4.00
	$23.54

The expense of replacing the casting by a new one would have been about $600.

* * *

An investigation of the melting points of tungsten and tantalum has been carried out at the University of Wisconsin, the measurements having been taken with especial care, using the optical pyrometer and a direct vision prism transmitting monochromatic light. The melting point of tungsten was found to be 3002 degrees C. (5435 degrees F.), and of tantalum, 2798 degrees C. (4982 degrees F.). These values are somewhat different from those generally accepted.

CHART FOR FINDING THE STRENGTH OF GEAR TEETH



Conditions of Drive	Pitch Line Velocity, Feet per Minute	Approximate Safe Fiber Stress, Pounds per Square Inch					
		Spur and Bevel Gears				Helical Gears	
		Cast Iron	Steel	Phosphor-bronze	Rawhide	Cast Iron	Steel
Without shock	Any	5000–8000	18,000–20,000	14,000–16,000	2500–3500	5000–8000	18,000–20,000
With shock	200– 800	3000–6000	14,000–18,000	9000–12,000	2500–3500	5000–8000	18,000–20,000
	800–1600	2000–4500	10,000–14,000	6000–10,000	2500–3500	3000–6000	14,000–18,000
	1600–2400	1500–3000	7000–12,000	4000– 7000	2500–3500	2000–4500	10,000–16,000

HOW TO USE THE CHART

Required to find the safe load for a cast-iron gear having 50 teeth, ⅞ inch circular pitch, and 3-inch face; assume the fiber stress to be 6000 pounds per square inch. Join the graduation for ⅞ inch circular pitch with that for 3 inches width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Then join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the maximum safe load scale gives the safe load, which for this gear is about 2050 pounds.

LOGARITHMIC CHART FOR FINDING THE STRENGTH OF GEAR TEETH[*]

BY H. T. MILLAR[†]

The accompanying illustration shows a logarithmic chart for the strength of cut gearing. The chart is based on the well-known Lewis formula. The method of using it is explained by the example shown in dash-dotted lines. Assume that it is required to find the safe load for a cast-iron gear having 50 teeth, the gear being of ⅞ inch circular pitch and having a 3-inch face. The fiber stress is assumed at 6000 pounds per square inch. To use the chart, join the graduation for ⅞ inch circular pitch with that for 3-inch width of face; also join the graduation for 50 teeth with that for 6000 pounds fiber stress. Join the points where these two lines intersect lines R_1 and R_2, respectively. The intersection of this joining line with the scale for the maximum safe load indicates that the safe load for this gear is about 2050 pounds.

The tooth form of a bevel gear is stronger than that of a spur gear of an equal number of teeth. The chart can also be used for bevel gears, as indicated. The increase in strength due to various cone angles is taken care of by the diverging lines marked with the ratio of the bevel gears. To use the diagram for bevel gears, follow the horizontal line from the actual number of teeth in the bevel gear to the scale *AB;* then use the number of teeth thus found on this scale for determining the strength, as already explained in the previous example. In using the chart for bevel gears the pitch selected must be the mean or average pitch and not the nominal pitch.

Some notes on helical gearing may be of interest, and may be found useful on account of the increased use of this class of gearing. The increased strength of helical gearing comes from two causes. The meshing action is more continuous, and, therefore, a high velocity is not so likely to induce shock. The contact between two helical teeth in mesh is very different. The line of contact is inclined across the face, beginning at the root and passing through the pitch line to the point. Considering, therefore, the tooth as a cantilever, the mean leverage of the load is less than with a straight cut tooth, where the load may have a leverage almost as great as the tooth depth. The angle of the tooth helix is usually so arranged that with a minimum width there is always contact at the pitch line of one of the teeth in mesh. In practice, it has been found that most double helical gears, especially pinions, fail through wear rather than through breakage, since in the usual case of helical gear reductions the circumferential speed of the gears is high. It is not wise to have a bearing pressure per inch of width very much higher than that given in the Lewis formula, unless the teeth are lubricated. It is also customary to select a fine pitch and a relatively wide face, say about six times the circular pitch, or 20 divided by the diametral pitch. When using the chart for helical gearing, the maximum safe load may be obtained by selecting a somewhat larger pitch than the actual one, and this pitch should be used for the graphical work.

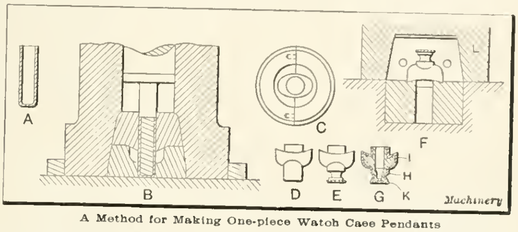
* * *

METHOD OF MAKING WATCH CASE PENDANTS

In the August, 1912, number of MACHINERY an article appeared entitled "Watch Case Manufacture," in which the making of a number of parts of watch cases is described. Little attention is given in this article, however, to the making of watch case pendants. It may, therefore, be of interest to show, in general outline, a method for making one-piece pendants as invented by Charles W. Butts of Sag Harbor, N. Y., and described in U. S. Patent No. 865,759, from which the accompanying description has been obtained. The principal object of this invention is to form a watch case pendant wholly of one piece from what is commonly known as "filled" metal or "gold-filled"; that is, gold covering a base metal, which latter must not be exposed after the pendant is formed.

The principle employed for accomplishing this result is to use dies of such a shape that when a straight tubular blank containing a core of a soft plastic metal is placed within the dies and pressure is brought to bear upon the blank and the core, the metal of the blank and core will flow into the cavities of the die and thus form a pendant of the desired shape. The pendant is then removed from the die, which is made in halves for this purpose, a central hole is drilled in it, and by means of rolls the lower part of the body of the pendant is depressed and a foot and bead are formed on it. The final over form of the foot of the pendant is obtained by placing the pendant, after the foot and bead have been formed, within a die made in halves and exerting pressure upon it. In this way it is possible to produce a pendant in one piece.

In the past, watch case pendants have generally been made in two pieces, the body and foot of the pendant having formed one piece, while the oval cap has been made in a separate part, these parts afterward being soldered together. Pendants made in this manner are not satisfactory, for the reason that, in forming the cap separate from the body of the pendant, the filling metal is necessarily exposed in some places; nor is an absolute uniformity in product possible when the pendants are made in two parts and afterward fastened together.



A Method for Making One-piece Watch Case Pendants

The accompanying illustration shows, in a general way, the methods for making the pendants in the manner described. At *A* is shown the blank from which the pendant is made. This blank has a tubular section and is closed at one end. It is made of a base metal covered with a precious metal. This blank is filled with a core of base metal and then inserted in the hole in the dies at *B*, which shows a vertical section through the dies used for forming the cap. The tube with its core of soft plastic metal is shown in the center of this illustration. By filling the blank with a core of base metal, the tubular blank is caused to flow more quickly and evenly into the cavities of the die, and, at the same time, the strain on the precious metal covering is relieved while the cap on the pendant is being formed. When the plunger descends upon the blank the core of metal of the latter is upset and forced to flow outward, thus preventing the wall of the blank from collapsing inward. When the plunger has reached the limit of its downward stroke, the walls of the metal blank will have been forced tight against the walls of the cavity in the die. A plan view of the lower die is shown at *C*. The die is made in two parts in order to make possible the removal of the formed pendant after the operation is completed.

At *D* is shown the appearance of the pendant after the blanks have been operated upon by the dies shown at *B*. The core, after this operation, of course, completely fills the blank, and a hole is then drilled through it, this hole being shown in the section at *G*. The blank is then placed between rollers or other suitable tools and the cylindrical part is spun and the foot and bead formed so as to give it the shape indicated at *E*. After the foot and bead have been formed on the lower portion of the body, the blank is inverted and placed so that the oval cap will rest within the depressions of the dies shown in section at *F*. The upper die is made in halves which, when placed together, give the foot and bead their final oval shape. This is accomplished by having the two halves of the die slightly apart at the beginning of the operation, but forcing them together by the block *L* as the operation proceeds, the outside of the die and the inside of blank *L* being conical in shape as indicated. A section of the pendant after this operation is completed is shown at *G*. The part *H* is cylindrical, while the cap *I* and foot *K* are oval in shape. The hole through the pendant is made, of course, in any suitable manner to fit the winding-stem of the watch.

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[*] See MACHINERY, January, 1908, engineering edition: "Variation of the Strength of Gear Teeth with the Velocity." See also MACHINERY'S Reference Book No. 15, "Spur Gearing," Chapter VI.

[†] Address: 150 Waterloo Road, Manchester, England.

It will be seen that the process briefly consists in the making of a one-piece watch pendant by first upsetting a cylindrical blank to form a non-cylindrical cap and a cylindrical base, using a core of soft plastic metal within the tubular blank to accomplish this, and then drilling the hole through the soft metal core. The base is then spun to form a cylindrical foot and bead, and finally the foot and bead are compressed into a non-cylindrical shape.

* * *

ALLOWANCES ON PARTS TO BE ASSEMBLED BY PRESSURE[*]

BY S. M. HOWELL[†]

The following article gives some data on the allowances for parts to be assembled by pressure. The subject is one of much importance in machine construction, and the data given has been secured by observation and personal experience in a large number of cases.

In making a press fit, the pressure at which the parts are assembled is estimated from the size and character of the job and the degree of tightness desired. In the case of very large work, the pressure may be limited by the capacity of the press. When the tonnage of pressure has been decided, the next step is to determine the allowance on the parts for the fit, that is, how much larger the fitted part should be than the hole into which it is forced, in order to enter at the required pressure. In plants where a special line of machinery is regularly manufactured, and the same parts are continually made, work to be assembled in this way is machined to dimensions which are known to be right from previous experience, and is usually fitted to gages; but in repair shops and other places where the work is of a more diversified character, the allowance must be determined in each individual case.

The "feel" of the calipers is, of course, a ready way of judging small variations of size, and is sufficiently reliable for many purposes, but when more definite results are desirable, a predetermined allowance, accurately measured, should be made. For this purpose an inside micrometer gage and a pair of outside calipers constitute a practical device.

In determining the allowance to be made in a given case, the governing conditions are the diameter and the length of the bearing, and to a greater or less degree also the character of the material and the smoothness of the surfaces of the fit. It is obviously impossible to accurately calculate the effect of varying degrees of hardness and other irregular conditions by means of mathematical formulas. In the majority of cases, however, the shaft or pin to be forced into place is of soft steel, and the receiving part is either of cast iron, or is a steel casting. The material is of average quality and the machined surfaces are slightly rough, the finishing cut having been taken with a moderate feed and without filing. Assuming these to be the conditions, the allowance to be made for the fit will, in a general way, depend upon the diameter and length of the bearing and the required tonnage. For finding the allowance, the following rule is applied:

Multiply the pressure in tons by 4.4, and divide the product by the product of the length and diameter in inches. The quotient is the allowance in thousandths of an inch. This rule may be given as a formula, as follows:

$$A = \frac{4.4P}{LD}$$

In this formula

A = allowance in thousandths of an inch,

D = diameter of hole in inches,

L = length of fit in inches,

P = pressure in tons.

As an example, assume that a pin is to be forced into a hole 4 inches in diameter, 6 inches long, the pressure being 40 tons. From our formula we find:

$$A = \frac{4.4 \times 40}{4 \times 6} = 7.3$$

Hence the proper allowance is 0.0073 inch.

As another example, assume that a shaft is to be forced into a hole 5 inches in diameter with a pressure of 60 tons; the length of the bearing is 8 inches. Then:

$$A = \frac{4.4 \times 60}{5 \times 8} = 6.6$$

Hence the allowance is 0.0066 inch.

The rule can be transposed so that we can find the required pressure when the allowance and the length of the bearing are known. In this case the rule will be:

Multiply the length by the diameter in inches, and multiply this product by the allowance in thousandths of an inch; divide this final product by 4.4.

The quotient will be the required pressure in tons. As a formula this rule becomes:

$$P = \frac{LDA}{4.4}$$

As an example, assume that a pin 2 inches in diameter is to be forced into a bearing 4 inches long, the allowance being 0.004 inch. What will be the required pressure in tons?

$$P = \frac{4 \times 2 \times 4}{4.4} = 7.3 \text{ tons.}$$

When forcing shafts into large rollers there is usually a short bearing at each end. In this case the shaft must be driven into both bearings at once, and the pressure required will be double that of a single bearing of the same length, or, in other words, in calculating the allowance, the length used in the formula must be equal to the sum of the length of the two bearings.

In small work where the parts are strong and it is required that they be tightly driven, an allowance of 0.002 inch per inch of diameter may be made, but care must be taken that the required pressure is not so great as to strain the material beyond its elastic limit; otherwise there is danger of damage to the work even if there is no visible distortion at the time of making the fit. In work of moderate size, an allowance of 0.001 inch per inch of diameter is usually made, but this is excessive for large diameters. In making a shrink fit, where the maximum tightness is required, a shrinkage allowance of 0.003 inch per inch of diameter may be used, provided the parts are strong enough to stand it.

A driving fit may be based upon an estimate of 10 tons pressure at the most, but the allowance should never exceed 0.001 inch per inch of diameter, and frequently must be much less. As a matter of fact, the allowance for light driving fits is often so small that it is best estimated by the "feel" of the calipers alone. If a hole is not true, but oblong, or tapers slightly, it should be calipered near the small end. In these cases, the parts will go together at a somewhat lower tonnage than if the hole were true.

The outside calipers used in this and other work requiring accuracy should have parallel chisel points about 1/16 inch wide, slightly rounded or dulled on the extreme edges. These points should be casehardened and smoothly finished. The inside pair may have one chisel point and the other point rounded or spherical. With calipers of this kind, a size may be transferred from one caliper to the other more easily and with greater certainty than if all the points were round or of an irregular shape which they might have acquired from use.

* * *

One of the Middle Western railroads—the Illinois Central—has appointed an official whose duties are practically that of a "courtesy expert." The official title is: "Inspector of Passenger Train and Station Service." His duties will be to see that passengers are enabled to make use of every convenience which the system affords, to suggest improvements for the comfort of the passengers, and to travel on passenger trains so as to ascertain in person the conditions of the service as far as it pertains to the comfort and convenience of the passengers.

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[*] For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Shrinkage and Press Fits in the Bradford Shops", August, 1911, engineering edition; "Shrinkage and Forced Fits", April and May, 1911, engineering edition; "Machine Shop Practice—Shrinkage and Forced Fits", July, 1909. See also MACHINERY'S Data Sheet Book No. 7, "Shafting, Keys and Keyways", pages 28, 29 and 31.

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THE MANUFACTURE OF BLUEPRINT PAPER

CHARACTERISTICS OF PAPER, SENSITIZING AND SENSITIZING SOLUTIONS

BY F. B. HAYS

The constantly increasing use of blueprints has caused the manufacture of blueprint paper to become an industry of considerable magnitude. The majority of people connected with engineering work have a fairly clear idea of the methods employed in making blueprints, and a few draftsmen and engineers understand the principles of coating the paper, but only a very small number have any conception of the methods and processes employed in producing large quantities of blueprint paper. The following article briefly describes the most general methods used. The machinery illustrated in the accompanying halftones is installed in the plant of the Indianapolis Blueprint and Supply Co., and is said to be the most modern and efficient type in use.

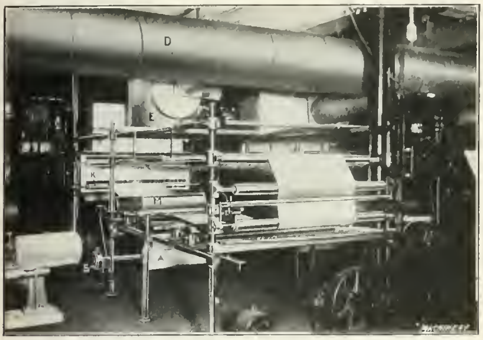

Fig. 1. Front View of Coating Machine and Dryer for Blueprint Paper

A special kind of paper is used in making blueprint paper. The principal requisites of this paper are: first, that it be free from wood pulp and the chemical impurities that are found in cheap papers such as newspaper stock, wrapping paper, etc.; second, that it be sufficiently tough to withstand frequent washing and rough handling; third, that it possess a fairly hard, and not too absorbent or coarse grained surface; and fourth, that it be properly sized on that surface which is to receive the coating. The size which gives the best results is a mixture of arrowroot flour and water. The flour is first mixed with a sufficient quantity of cold water to produce a thick paste, and then from forty to fifty parts of warm water is added.

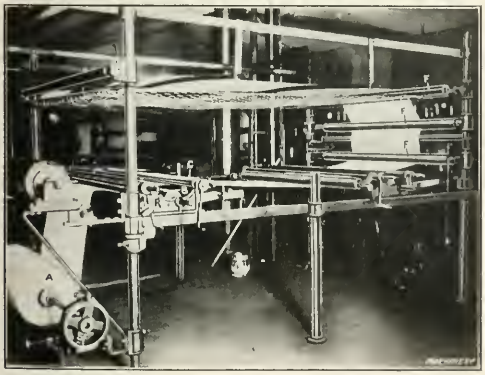

Fig. 2. Side View of Machine shown in Fig. 1

Sensitizing Solutions

The process of coating paper for blueprinting is termed "sensitizing," and it consists of coating the paper on one side with a solution that undergoes marked chemical changes when brought into contact with certain kinds of light and water. This process, although more or less complicated from a chemical standpoint, is very simple mechanically, provided only small quantities of paper are to be sensitized, but when done on a large scale special machinery and very skillful handling are required.

One of the oldest and most popular formulas for sensitizing paper that will print white lines on a blue background is: (A) Ammonia-citrate of iron, 20 parts; water, 100 parts. (B) Potassium ferricyanide, 16 parts; water, 100 parts. The sensitizing solution is made by mixing equal parts of (A) and (B) together, and filtering just before using. Another solution which gives good results, and which may be kept on hand for several months without deteriorating, is the following: (A) Ammonia-citrate of iron, 12 parts; water, 16 parts. (B) Potassium ferricyanide, 9 parts; water, 16 ounces. Mix together and filter one part each of (A) and (B), and add two parts of water just before using.

For coarse-grained, rough-surfaced papers, and silk and linen cloth, an excellent solution is obtained by the use of gum arabic. (A) Pulverized gum arabic, 1 part, dissolved in 20 parts water, and strained through muslin, combined with ammonia-citrate of iron, 5 parts. (B) Potassium ferricyanide, 4 parts, water, 20 parts. Equal parts of (A) and (B) are mixed before using. Fabrics must be washed and then sized in gelatine (hard gelatine dissolved in twenty parts water) before sensitizing.

Positive paper, or that which gives a blue line on a white background is produced in the same manner as negative paper, except that it is sensitized with different solutions. A number of mixtures may be used, but the two following are probably the most popular:

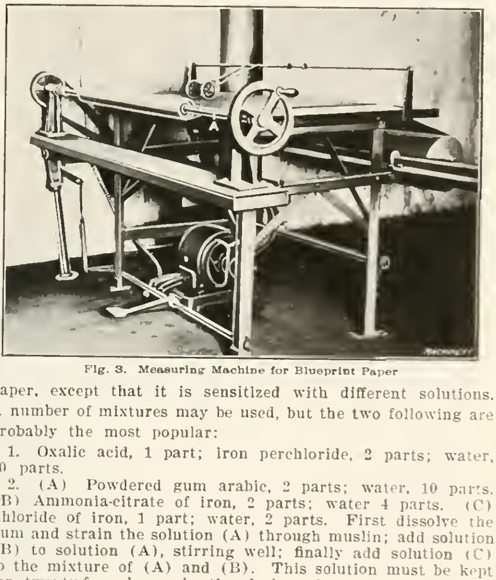

Fig. 3. Measuring Machine for Blueprint Paper

1. Oxalic acid, 1 part; iron perchloride, 2 parts; water, 20 parts.
2. (A) Powdered gum arabic, 2 parts; water, 10 parts. (B) Ammonia-citrate of iron, 2 parts; water 4 parts. (C) Chloride of iron, 1 part; water, 2 parts. First dissolve the gum and strain the solution (A) through muslin; add solution (B) to solution (A), stirring well; finally add solution (C) to the mixture of (A) and (B). This solution must be kept for twenty-four hours in the dark and must be frequently agitated before using.

Paper which produces positive black lines on a white background is sensitized and then developed. The sensitizing is a solution consisting of ferrous sulphate, 20 parts; ferric chloride, 45 parts; tartaric acid, 40 parts; water, 190 parts. The developing solution is a mixture of gallic acid, 15 parts; oxalic acid, 2 parts; water, 1700 parts. After developing, the prints are washed in running water.

In mixing any of the foregoing solutions, only distilled water should be used, and all operations should be carried out in a red or orange light.

Sensitizing the Paper

The coating of the paper with the sensitizing solutions and the subsequent drying and rolling is now done entirely by

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* Address: 107 W. Walnut St., Indianapolis, Ind.

machinery. Fig. 1 shows a general view of a machine for this purpose. The coating machine is shown towards the front and the drier in the background. The driving mechanism is shown on the floor in front of the machine. The air for the drier is received from a purifier and forced through pipe *D* and heater *E* into the drying oven. The general operation of the machine is as follows: The sized paper starts from the roll *A*, Figs. 1 and 2, and passes between two pulling rollers and over the celluloid coating roller *B*, Fig. 2. This roller is partially submerged in the coating solution placed in tank *R*, and as it revolves it carries a small film of the solution, which is absorbed by the lower surface of the paper. A glass bar runs along the edge of the tank, and a roller *C* presses the paper against this bar so that all excess solution is wiped from its surface and returns to the tank. This latter roller also regulates the pressure between the paper and the coating roller *B*. The bearings for roller *C* are placed in a rocker arm, so that it may be raised or lowered by means of a crank, thus decreasing or increasing the tension on the paper. Another retaining tank and a similar series of rollers is shown at the other end of the machine, and serve to administer the second coat of the solution. The rollers *F* are simply guide rollers, and the tubes above the machine prevent the paper from sagging and becoming strained between the guide rollers. All of the rollers are made of brass, except the coating roller which is made of celluloid, and are mounted upon ball bearings. They are driven from the main shaft by gears proportioned to impart the same lineal speed to each roll.

At *S*, Fig. 2, is shown a band brake which regulates the tension of the paper and also prevents it from unrolling from the spools when the machine is stopped. Upon leaving the coating machine the paper immediately enters the drier, where it runs upon rollers along the upper part of the drier to the extreme end, and returns upon rollers on the lower side, leaving at *K* and being wound upon the spool *M*, Fig. 1. Both the top and bottom of the drier are covered with steam coils, and the hot air forced into it thoroughly dries the sensitized paper before it is wound upon the spool *M*. The moist air is removed from the drier by a pipe at the back, which terminates at an exhaust fan on the outside of the building.

As it is necessary to keep the colored windows of this department closed because of the injurious effects of daylight upon the finished paper and the sensitizing solutions, air is artificially supplied by blowers and exhaust fans.

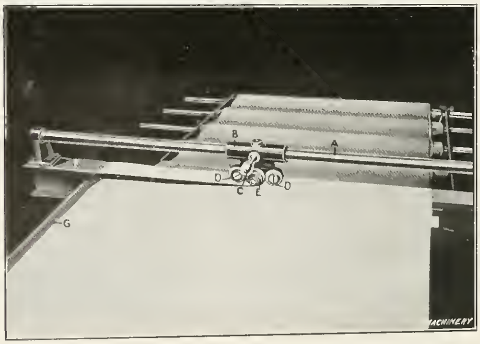

Fig. 4. A "Cutting-off" Machine

When the rolls of sensitized paper are removed from the coating and drying machines (each of which has a capacity of 1500 yards an hour), they are taken to the rerolling and measuring machine shown in Fig. 3, where they are rerolled into packages of desired length for the market. This machine consists of a "rolling" shaft *A* having a universal joint and driven through a friction clutch at the left from the motor beneath the machine; the clutch is controlled by a foot pedal. The operation of the machine is as follows: The operator places one of the large rolls of paper from the drier on the shaft at the back of the machine and starts it upon the "rolling" shaft *A* by means of the handwheel. This wheel has a jaw clutch connection with the shaft, so that it can be slipped out of connection with the shaft as soon as the paper is started, and the shaft driven by power through the clutch. As the paper passes over the table of the machine the registering device shown records the number of yards rerolled, so that the operator simply has to throw out the clutch and cut off the paper when the package has reached the proper size. The shaft *A* is then swung out on its universal joint and the roll slid off and sent to the packing department, where it is wrapped in light-proof paper and sealed up ready for the market.

Frequently orders for large quantities of short lengths of paper are received, and are handled by means of the mechanism shown in Fig. 4. This consists of four shafts, each inserted into a roll of paper, and supported by a steel plate on each end; a polished steel guide *A*; a steel I-beam support *F*, which is finished on the top and upper edges; two ball bearings *D*; a hardened tool steel cutter *E*; a handle *C*; and a body casting *B*. The paper is pulled from the rolls in four layers (one from each roll) and measured by means of a steel scale *G* on the edge of the table. The operator then pushes the cutter across the paper by means of the handle *C*, the ball bearings holding the paper rigidly in place while the cutter shears it off. The top of the beam *F* acts as a cutting table, and the finished edge serves as a sharpener for the circular cutter. Five hundred and eighty yard lengths of paper an hour are cut by this device. It is especially successful in handling tracing cloth and drawing paper.

Fig. 5. Section of Department for Sensitizing Solutions. Note that all Solutions are kept in Light-proof Receptacles

The principles involved in the chemistry of sensitizing paper for blueprinting were first discovered about 1725, but were not practically applied until 1835 when an English scientist, Sir John Herschel, developed the ferro-prussiate process, which is still used at the present day and which serves as a basis for all other blueprinting methods. Many new branches of industry have arisen since 1835, and practically all the methods of the old industries have been greatly changed and improved, but the principal chemical processes of making blueprints are virtually the same now as they were twenty-seven years ago. Great strides have been made in the mechanical methods of making, coating, and printing blueprint paper, but no improved simple and efficient chemical process has been developed for producing sensitizing solutions, or for incorporating them with the fabrics. What we need at the present time is a cheap, reliable, quick printing paper that will require neither developing nor washing after printing, and that will withstand rough usage and not fade a short time after printing. It seems reasonable to believe that such a paper could be produced at the paper mills by incorporating the sensitizer with the primer, provided a suitable sensitizing solution were discovered. Far more wonderful developments than this have been made in the chemistry of photography, but for some reason chemists seem to have entirely overlooked its sister subject, blueprinting. Let us hope that in the near future chemists will turn their attention to this matter, and that the chemical side of blueprinting will be greatly simplified and improved.

WIRE ROPES FOR LIFTING APPLIANCES[*][†]

AN INVESTIGATION INTO SOME OF THE MOST IMPORTANT CONDITIONS THAT AFFECT THEIR DURABILITY

The question of the durability of the parts of mechanical structures seems to be strangely neglected by all authorities. A designer has generally the choice of several formulas for calculating the mere strength of a given member, but usually he has to depend upon his own experience for the correctness of the proportions that will insure for it a reasonable length of life. The durability of wire ropes, in particular, is of great importance to all engineers, whether engaged in the design and manufacture of lifting appliances, or in their care and management.

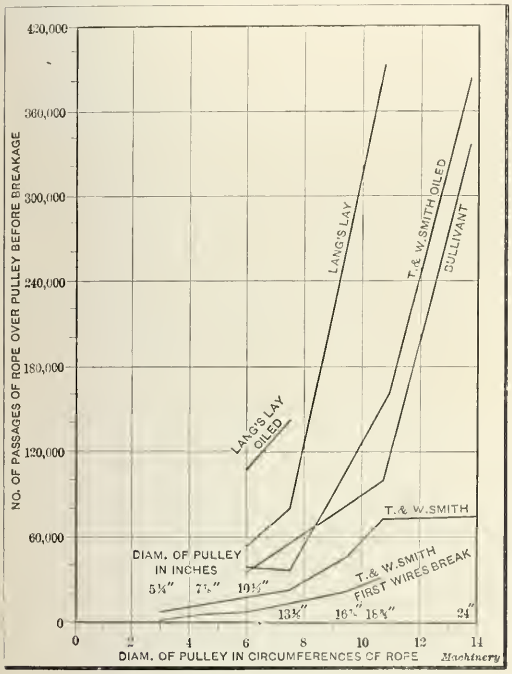

Fig. 1. Results of Experiments on the Durability of Wire Ropes

The two most important conditions appertaining to the manufacture and use of steel wire ropes that affect their durability are the quality of the material and the size of wire, and the diameter of the pulleys and arrangement of the ropes.

Quality of Material and Size of Wire

The wire used for lifting ropes is of crucible steel having a tensile strength varying from 80 to 130 tons per square inch. Although ropes made from material having a high tensile strength are of smaller diameter for a given load and a given factor of safety, this is not of great advantage to the crane designer. The stiffer character of the wire makes larger drums desirable, if the durability of the rope is to be considered, notwithstanding the fact that some rope-makers claim as an advantage for the stronger material that it does enable smaller pulleys to be used with a consequently lower cost of the working parts of the crane.

The ratio of the diameter of the individual wires to the diameter of the completed rope is an important factor. If the wires are too large, they are stressed considerably when passing over the pulleys, and accordingly the material is quickly fatigued and the wires break. Smaller wires, on the other hand, are more quickly worn through by rubbing against the pulleys and against their neighbors in the body of the rope. The stress in a wire due to bending round a pulley is directly proportional to the modulus of elasticity and to the diameter of the wire, and inversely proportional to the radius of the pulley; therefore, the radius of the pulley should be increased with an increase in the modulus of elasticity, if the same number of bends is to be endured by a stronger wire of the same diameter. Unfortunately, a theoretical calculation of the stresses induced in the wires of a rope by being bent over a pulley does not alone afford a reliable guide to the length of life to be expected from the rope, for consideration must also be given to the mutual wear that takes place among the wires.

Assuming, for the purpose of comparison, that two ropes are constructed of equal size, one from wires half the diameter of those in the other, then, for equal strength, the one rope will have four times the number of wires, and each of the wires will have one-quarter the cross-sectional area. According to the usual formula, the stress due to bending will be half as severe in the smaller as in the larger wires, when the ropes are bent over pulleys of the same diameter. If it be allowed that a reasonable figure for the estimated stress due to bending an ordinary rope over a pulley of a size usually adopted in crane design be, say, 30 tons per square inch, and that the stress due to the suspended load be 10 tons per square inch, then there will be a stress of 40 tons per square inch in the material each time the maximum load is lifted and released. The corresponding stresses in the rope of finer wires will be 15 tons per square inch due to bending, and, as before, 10 tons per square inch due to the suspended load, or a total of 25 tons per square inch.

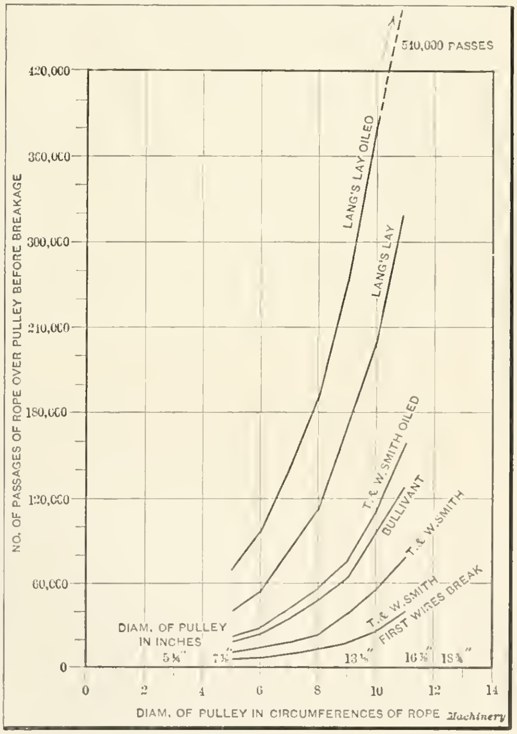

Fig. 2. Curves based on the Data in Fig. 1, covering the Conditions of General Overhead Crane Practice

There is, as yet, no agreement as to the exact effect upon endurance, of variations in the working stresses. It seems, however, to be reasonable to assume that a reduction in range of stress from 40 tons per square inch to 25 tons per square inch would increase the life of material such as ropes are composed of about 500 times. As no such improvement in the life of a rope has ever been experienced, or is to be reasonably expected, it must be taken for granted that abrasion is the principal factor in limiting the life of wire ropes, and, therefore, the effect of abrasion upon the suggested rope of finer wires must be considered.

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[*] Abstract of a paper by Mr. Daniel Adamson, read before the Belfast meeting of the Institution of Mechanical Engineers, Great Britain, July, 1912.

[†] See also the following articles previously published in MACHINERY: "Stresses in Wire Rope due to Bending," February, 1909, engineering edition; "Bending Stresses in Wire Rope," June, 1907, engineering edition. See also MACHINERY'S Reference Book No. 24, Chapter III, "Bending Stresses in Wire Rope."

When the rope of finer wires is passing over the pulley, there being four times as many wires in it, the pressure at each point of contact between the rope and the pulley and between the individual wires of the rope may be assumed to be one-quarter of what it is in the rope of larger wires. The wires being of half the diameter, the damage done to them by contact, even under this lower pressure, will be at least half that done to the coarser wires in the other rope, and this half damage done to a wire of one-quarter the sectional area will result in the cutting through of the wire in half the time, so that the effect of abrasion upon the rope of finer wires will be twice as great. If a smaller pulley be used for the rope of finer wires, as suggested by some authorities, the pressure at the points of contact and the stress due to bending will be proportionately increased, so that it may reasonably be expected that with a pulley-diameter bearing in each case the same proportion to the diameter of the wires, the life of the rope with fine wires will be one-quarter of that of the rope of coarser wires working over a pulley of correspondingly increased diameter.

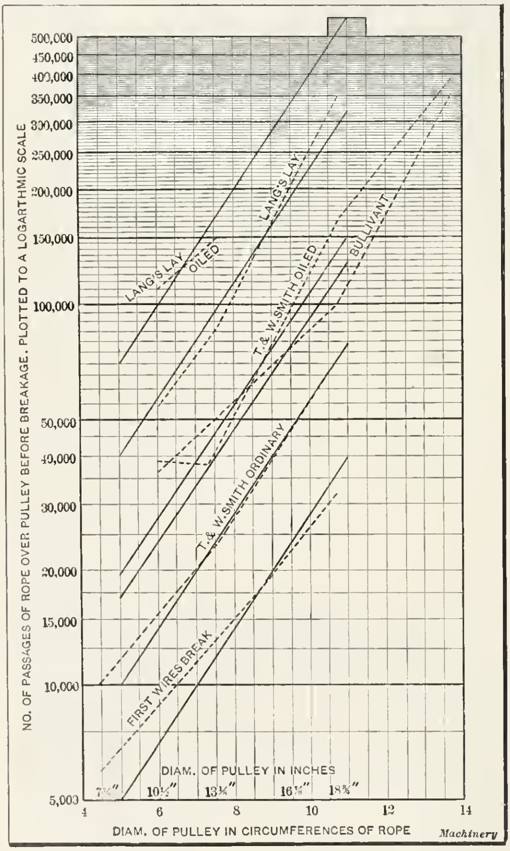


Fig. 3. Durability as affected by Diameters of Rope and Pulley

A German investigator (Ernst Heckel) refers to the very great surface pressures on the wires at the place of contact with the pulley (amounting in his opinion to as much as twelve tons per square inch) as a vital point in connection with the wear of wire ropes. This high pressure, accompanied as it must be by relative movement, even if quite small, readily accounts for the wear which takes place on the surface of the wires where they touch the pulleys or the other wires in the rope.

Diameter of Pulleys and Arrangement of Ropes

The lists issued by makers of wire ropes contain recommendations as to minimum sizes to be adopted, but no information is given as to the effect of using pulleys of different diameters. The author has felt for many years past the want of such information, but the experience of users afforded no reliable guidance, on account of the great difference in the conditions under which ropes work in different shops. In a paper read before the Manchester Association of Engineers by Mr. Matthews in 1902, he states that from 400 to 1700 lifts per crane per annum was the amount of duty required from certain cranes under his control, while the present author, in the discussion on Mr. Matthews' paper, mentioned from 32,400 to 43,200 lifts per crane per annum as representing his own experience in another class of work. Other important features that will affect the life of a crane rope are the average weight lifted and the average height of lift; cranes are generally occupied with loads much below their nominal capacity, but this will vary in different workshops, as will the proportion between the maximum height of lift available and the height most frequently attained by the hook.

Inquiries addressed to the users of cranes elicited varied replies; ropes working upon cranes of the same general design were found to last for periods of from two years to ten years and upwards, and one correspondent suggested that twenty years might be expected from ropes on cranes (of from five to twenty tons capacity) if damage from accidental causes could be eliminated. As might be expected, the ropes on foundry cranes have not so long a life as in erecting shops, the relative difference being perhaps as three is to five.

The most reliable and consistent information that the author has been able to discover is contained in a paper by Mr. A. S. Biggart, published in 1890 in the *Proceedings* of the Institute of Civil Engineers, Vol. CI, page 231. The experiments to which this paper refers were undertaken with the object of selecting the best form of rope to be employed in the construction of the Forth Bridge. The apparatus used by Mr. Biggart contained two pulleys, round which the rope under trial was passed, the lower pulley being weighted to give the required tension on the rope. The experiments consisted in passing the ropes, under a normal working load, to and fro over the pulleys until breakage ensued. Experiments were repeated with different diameters of pulleys and different makes of rope, and the accompanying diagram, Fig. 1, shows the life of different classes of rope as affected by the diameter of the pulleys.

The effect of oiling the ropes is shown by the diagram to be very beneficial, increasing the life of a given rope by two or three times. This is obviously due to the reduction of the cutting action of the wires upon each other. Experiments were also made to ascertain the effect on the life of a rope of running it over pulleys so arranged that the rope was subjected to reverse stresses, as shown in Fig. 4. The results obtained from this series of experiments showed that generally the life of a rope working under such conditions was only one-half that of a similar rope bent in one direction only.

Fig. 1 is based upon the actual figures tabulated in Mr. Biggart's paper, while Fig. 2 shows the present author's approximations as obtained by the simple method of drawing fair and regular curves through or near the points representing the results of Mr. Biggart's experiments over such a range of pulley diameters (measured in terms of the circumference of the ropes) as obtain in general overhead crane practice. Several interesting deductions may be drawn from a study of these figures. The time of breakage of the first wires of a rope in the lowest curve is only recorded for one make of rope, but comparing it with the second curve, which shows the time of breakage of whole ropes of the same make, it will be seen that when the first wire breaks, the rope may be assumed to have passed through one-half of its life, and as no one knowingly works a rope until it breaks entirely, the breakage of even a few wires is a sign that a rope should be carefully watched and replaced by a new one at an early opportunity.

The effect of varying the proportions of diameter of pulley to diameter of rope is one of the most important features to be noticed. Speaking generally, Mr. Biggart's experiments show that increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will double the life of the rope. This is approximately correct for all the varieties of rope and conditions experimented with, and may therefore be taken as equally correct for all the varying conditions under which cranes are worked. It is very remarkable that so simple a rule should evolve from such numerous and varied experiments, and the author hopes that its statement in this form will be of some value to designers. That it is sufficiently correct for all practical purposes may be readily seen by referring to Fig. 3 where the ratios of pulley diameters to ropes are plotted as abscissas to a linear scale, while the durability of the ropes is represented by ordinates drawn to a logarithmic scale.

These conclusions enable one to express a definite value for the effect upon the durability of ropes, of the various arrangements of pulleys that are commonly adopted in overhead cranes, some of which are illustrated in Figs. 5 to 11. Assuming that Fig. 6 (in which the ropes make three bends in working, namely, one at the upper drum and one on each side of the lower pulley, *i. e.*, at entering and leaving) is the arrangement most frequently adopted in practice, and representing the anticipated life of the rope under these conditions by 100, then the relative lives of the ropes in each of the other arrangements indicated are as shown in Table I.

TABLE I. COMPARISON OF ANTICIPATED LENGTH OF LIFE OF ROPES ARRANGED AS SHOWN IN FIGS. 5 TO 11

Fig. No.	No. of Bends	Relative Life of Rope
5	1	300
6	3	100
7	3*	75
8	7	43
9	11	27
10	7*	37½
11	11*	25

* Including one reverse bend which is twice as effective in wearing out the rope.

If it be desired to design each of the above arrangements of pulleys so that the ropes shall have equal durability, then the ratio of the drum diameters to rope circumference (if the law indicated by Figs. 2 and 3 is to be relied upon) must be increased as shown in Table II.

TABLE II. REQUIRED INCREASE IN DIAMETERS OF ROPE DRUMS (MEASURED IN TERMS OF CIRCUMFERENCE OF ROPE) REQUIRED TO GIVE EQUAL DURABILITY

Fig. No.	Increase over Diameter called for by Fig. 6
7	1 Circumference of Rope.
8	2½ Circumferences of Rope.
9	4 " "
10	3 " "
11	4 " "

It is quite usual for purchasers to specify in their inquiries that the diameters of the pulleys and drums must bear a certain relation to the diameter of the rope, but the author wishes now to emphasize the point that this stipulation is not sufficient in itself without some consideration being also given to the arrangement of the rope and pulleys.

If the generally accepted ratio of seven circumferences, or twenty-two diameters, of the rope for the diameter of the barrel be assumed as suitable for the drum and pulleys arranged as in Fig. 6, then the diameters for the other figures, to give equal durability, should be as shown in Table III.

TABLE III. RATIO OF DIAMETER OF PULLEYS AND DRUMS TO CIRCUMFERENCE OF ROPE TO GIVE EQUAL DURABILITY

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference
5	4 to 1
6	7 to 1
7	8 to 1
8	9.5 to 1
9	11 to 1
10	10 to 1
11	11 to 1

To make the comparisons quite fair between the different arrangements, it must now be pointed out that owing to the increased number of falls of rope adopted in Figs. 8 and 9, the size of the rope may be reduced as shown in Table IV, while retaining the same factor of safety.

TABLE IV. RELATIVE ROPE CIRCUMFERENCE ALLOWING FOR SMALLER ROPES DUE TO INCREASED NUMBER OF FALLS

Fig. No.	Number of Falls	Relative Rope Circumference
5	2	140
6	4	100
7	4	100
8	8	70
9	12	57
10	8	70
11	12	57

Combining the figures given in Tables III and IV will give drum and pulley diameters as shown in Table V.

TABLE V. DRUM AND PULLEY DIAMETERS RESULTING FROM A COMBINATION OF TABLES II AND IV, AND STILL ASSUMING THAT 100 REPRESENTS THE CONDITION IN FIG. 6

Fig. No.	Ratio of Pulley and Drum Diameter to Rope Circumference according to Table III	Relative Circumference of Rope as per Table IV	Resultant Pulley and Drum Diameter assuming Fig. 6 = 100
5	4	140	80
6	7	100	100
7	8	100	114
8	9½	70	95
9	11	57	90
10	10	70	100
11	11	57	90

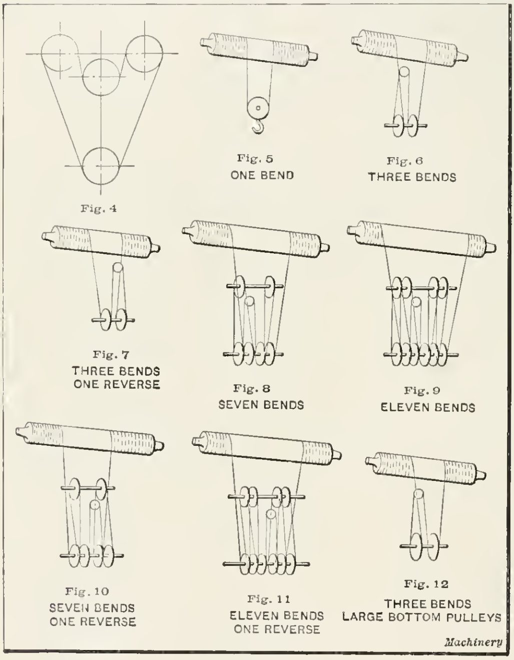
The noticeable feature in the last table is that whether two, four, or six falls are adopted, the diameter of the drum and pulleys should remain about the same, if the ropes are to have equal durability. A recent text-book upon the subject of crane design states (as an advantage of a large number of falls of rope) that the proportionately larger pulleys and barrel will insure *long* life for the ropes, but the author hopes that he has made it clear that very large proportions are necessary to insure a *reasonable* life for ropes on cranes with many falls of rope. Reference to Table V shows also the increase that should be made in the diameter of the drum and pulleys if a reverse bend occurs in the run of the rope.

Another important detail in crane design may now be referred to. In Fig. 6, as already mentioned, the ropes make two bends at the lower pulleys to one at the drum, and therefore, if the lower pulleys are made of the same diameter as the drum they will be responsible for two-thirds of the wear and tear of the rope. Now it is usually difficult to increase the diameter of the working barrel or drum of a crane, because to do so affects the ratio of the gearing and also requires a much larger framework with a corresponding increase in the cost of manufacture; but, if it is agreed, as a result of Mr. Biggart's experiments, that increasing the diameter of the pulley over which a loaded rope passes, by an amount equal to twice the circumference of the rope, reduces the evil effects of bending the rope round it to one-half, then a simple means of improving the durability of crane ropes is immediately at the disposal of the designer, namely, to increase the diameter of the pulleys in the blocks, leaving the drums of the original size, as indicated in Fig. 12. This change can usually be effected without serious alteration of the design, and may even be carried out on existing cranes. The result of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope will be that the effect of the double bend round the lower pulley is halved, the resultant effect of the three bends will be equal to two only, and the relative life of the rope will be increased by 50 per cent; or the drum diameter might be reduced by an amount equal to 1.2 times the circumference of the rope with a corresponding reduction in the size of the framework of the crab or winch, while still retaining a relative life for the rope equal to that in Fig. 6. In this case the diameter of the lower pulleys would only require to be about one circumference of the rope larger than the original size of Fig. 6.

In making the foregoing comparisons of diameters of drum and pulleys with different arrangements of rope it has been assumed that the hook is raised to the full height available at each lift. This, however, is not the case in actual practice, the majority of loads not being raised one-half this height. This consideration brings to light another great advantage of the design in Fig. 12 as compared with any of the others.

Where, as is usually the case, the average height of lift in a shop does not reach half the maximum available, then that portion of the rope which passes under the lower pulley does not reach the upper drum, and accordingly is only subject to the wearing action of the two bends at the lower pulley. If, therefore, the effect of the bends at the lower pulley is reduced to one-half, by the proposed increase in diameter of the pulley, then the actual life of the rope will be doubled, instead of only being increased by 50 per cent, as was first assumed.

Where there are more than two falls of rope, as in Figs. 8 and 9, the effect of increasing the diameter of the pulleys by an amount equal to two circumferences of the rope is also very marked, reducing the effect of the seven bends in Fig. 8 to that of four and a half, with corresponding increase in the lift of the ropes. This shows up the fault of those designers who adopt large drums (in order to obtain the great length of rope entailed by high lifts) and are yet content to make the pulleys of small sizes, when they could enormously increase the durability of the rope by the adoption of larger pulleys at little extra cost.



Figs. 4 to 12. Various Arrangements of Drums and Pulleys in Lifting Appliances

When the rope makes a reverse bend at the barrel as in Figs. 7, 10, and 11, the barrel ought to be increased in diameter to counteract the effect of the reverse bend. Thus, if in each of these cases the diameters of the drums were made larger by an amount equal to two circumferences of the rope, the durability of the rope would be equal to that in Figs. 6, 8, and 10, respectively.

Some Continental makers point out, very rightly, the desirability of making the compensating pulleys of reasonable size. The motion over such pulleys is apparently considered as negligible by some designers (judging by the forms of construction adopted), but this point of view overlooks the movement of the rope due to the swinging of the load, and the repeated bending of the rope at the same place over a small radius has an appreciable effect upon the durability of the rope.

Although the deductions laid down here appear too simple to need elaboration, a glance at the designs of many modern cranes shows that neither the designers, nor the purchasers, are aware of the importance of the principles involved; otherwise we should not see modern cranes with reverse bends in the ropes, and as many as eight plies of rope to carry the load on cranes of only 15 tons capacity.

The qualities of wire used vary considerably, and this, together with the heat-treatment in manufacture and the care taken by the makers in testing and examination, are questions that makers of ropes are in a better position to discuss than users. The "lay" of the strands and the lubrication of the rope when in use have each a considerable effect upon durability, and some guidance on these points may be obtained from Fig. 3, where "Lang's lay" is shown to have more than double the life of ropes of ordinary "lay," and ropes that are oiled last more than twice as long as when this precaution is neglected, as already mentioned. The superiority shown by "Lang's lay" naturally gives rise to the question as to why it is not exclusively used, and the answer the author has obtained from rope-makers is that such ropes must be very carefully handled to avoid "kinks," and they are also found to be more liable to "spin."

* * *

STATE TRADE SCHOOL OF BRIDGEPORT

The State of Connecticut maintains two trade schools, one of which is located in Bridgeport. The purpose of the Bridgeport school is to teach the methods of machine making, cabinet making, pattern making, drafting, machine shop practice, toolmaking, printing and plumbing.

Several plans of instruction are followed, such as day school, continuation school, and half-time school. In addition, there are vacation and evening schools. The day school course extends over two years, comprising 104 weeks of 49 hours each. The continuation school gives four hours instruction per week to apprentices employed in local factories. Each student is paid his regular wage scale by the factory while in school, and the time is employed in educational work to supplement the training he is receiving in the factory. The half-time school takes care of apprentices who alternate between the shop and the school, being employed at the factory one week and sent to the school the next. The school time is applied on their apprenticeship and the apprentice time is applied on school hours.

Each day of instruction received on the machine shop course is made up of 6½ hours shop work, one hour drafting, ¾ hour applied mathematics, ¾ hour applied science and mechanics. Shop lectures and inspection trips are given at times. In the continuation school the four hours are divided into drafting, 2½ hours, and trade mathematics, 1½ hour. In addition, the teacher occasionally visits the factories so as to keep in touch with the specific needs of each pupil. The students in the half-time school spend half of their time at their trades and the other half in school. They are rated as regular day students and receive the same instruction. Each student must finish one year of regular school training before being entered in this school. There is no charge made to students from any part of the State of Connecticut, nor are there any entrance requirements, save that the students must be fourteen years of age. The school is under the direction of Superintendent Frank L. Glynn.

* * *

HORSEPOWER AND KILOWATT

The British Association for the Advancement of Science adopted, as early as 1873, 746 watts as the equivalent of the British and American horsepower, and 736 watts as the equivalent of the metric or Continental horsepower. In a circular recently issued by the United States Bureau of Standards, it is stated that in all future publications of this bureau the former value, 746 watts, or 0.746 kilowatt, will be used as the exact equivalent of the English and American horsepower. For scientific work, it is quite important to have the horsepower thus standardized by being expressed in the so-called "absolute" system of measurement, because the common definition of 550 foot-pounds per second is scientifically correct only at a certain latitude and altitude, on account of the fact that the pound-weight, as a unit of force, varies in value as g, the acceleration of gravity, varies. The horsepower when expressed as 746 watts is equal to 550 foot-pounds per second at 50 degrees latitude and at sea level.

BALANCING AUTOMOBILE ENGINE FLYWHEELS

One of the essential points to be observed in the manufacture of a smooth-running and efficient automobile engine is to put all the moving parts in perfect balance. In the following is described the method employed by the White Co., Cleveland, Ohio, maker of high-grade automobiles and motor trucks, for balancing the flywheels used on its engines.

The first operation called the "static balance test," is carried out in the manner illustrated to the right in Fig. 2.

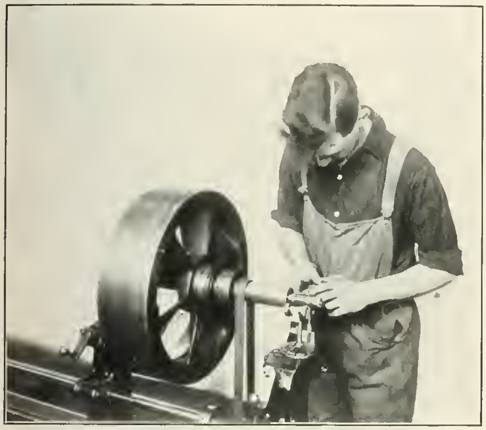


Fig. 1. The Final or Running Balance Test accomplished on a Norton Balancing Machine

Here the flywheel to be balanced is held on a hardened and ground arbor, the latter being located on knife-edges which form an integral part of the balancing stand. The stand has four legs, rigidly braced. When balancing, the operator lets the flywheel oscillate, watching it until it comes to rest. That part of the wheel which is heaviest, of course, always goes to the bottom. A piece of putty is then put on the inside of the rim opposite the heaviest side, and the flywheel is again tried and more putty added, if needed, until a close approximation to a perfect balance is obtained.

The next operation consists in removing the required amount of material from the heavy side of the rim to secure the proper balance. This operation is shown in the center of Fig. 2. The operator places the flywheel on a fixture which is tilted at an angle and is provided with a stud for holding it. The material is removed with a twist drill from that portion of the rim diametrically opposite the chunk of putty. To ascertain the amount of material to remove, the putty is placed on a scale, as shown in the foreground, and the drillings are collected and put on the other pan of the scale. A sufficient amount of material is removed to balance the putty.

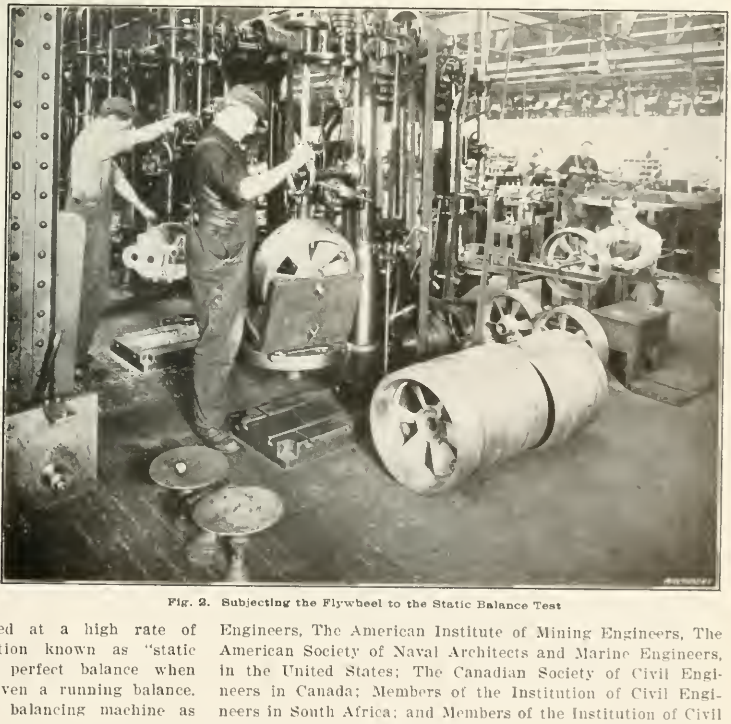


Fig. 2. Subjecting the Flywheel to the Static Balance Test

In the balance test just described, the flywheel is not rotated at a high rate of speed, but is put into the condition known as "static balance." To insure its being in perfect balance when the engine is running, it is next given a running balance. This is accomplished on a Norton balancing machine as illustrated in Fig. 1. The flywheel is again placed on an arbor, the extreme ends of which run on four pairs of rollers, and is rotated by a belt as shown in the illustration.

In order to see where the flywheel is out of balance, the small end of the arbor is coated with red lead, and as it is rotating the operator brings a copper pencil, held in a swinging member, in contact with the arbor. The points on which the pencil bears heaviest indicate the side of the rim from which it is necessary to remove material to make the flywheel balance properly when in service. From the foregoing it will be seen that by following this procedure a flywheel is obtained which aids in producing the much-desired smooth-running automobile engine.

D. T. H.

* * *

LORD KELVIN MEMORIAL WINDOW SUBSCRIPTION

The engineering societies of the United States are receiving subscriptions for a memorial window to be erected in Westminster Abbey, London, to the memory of the late Lord Kelvin, the distinguished scientist and engineer. Lord Kelvin, formerly Sir William Thomson, was the inventor of the first successful receiving galvanometer for ocean cables, which is a marvel of sensitiveness. His work in the development of testing and recording apparatus for cables made submarine telegraphy a great success. The general committees formed to carry the plan into effect embrace representation from eight engineering societies in England, Ireland, Scotland, America, Canada, Victoria, South Africa and South Australia, and its chairman is William Cawthorne, Unwin, London. The societies represented are: The Institution of Civil Engineers, The Institution of Mechanical Engineers, The Institution of Electrical Engineers, The Institution of Naval Architects, The Iron and Steel Institution, The Institution of Mining and Metallurgy, The Institution of Mining Engineers, The Northeast Coast Institution of Engineers and Shipbuilders, all of England; The Institution of Civil Engineers of Ireland; The Institution of Engineers and Shipbuilders in Scotland; The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Electrical Engineers, The American Institute of Mining Engineers, The American Society of Naval Architects and Marine Engineers, in the United States; The Canadian Society of Civil Engineers in Canada; Members of the Institution of Civil Engineers in South Africa; and Members of the Institution of Civil Engineers in South Australia.

DOGS AND DRIVERS FOR LATHE WORK

A REVIEW OF THE VARIOUS DESIGNS OF DRIVERS FOR WORK HELD BETWEEN CENTERS

BY H. E. WOOD

The lathe dog constitutes such an important part of the equipment of a machine shop, and there are so many different types of these devices in use, that it may be of interest to mechanics to follow the writer in a brief review of the most commonly used designs. Many of the lathe dogs shown in the following have been made for special purposes. It may appear that they are not of great utility, but in emergency cases, under special requirements, they have been found useful. A brief reference will be made to each of the lathe dogs shown. The illustrations show clearly the construction, and there is little need for a detailed description.

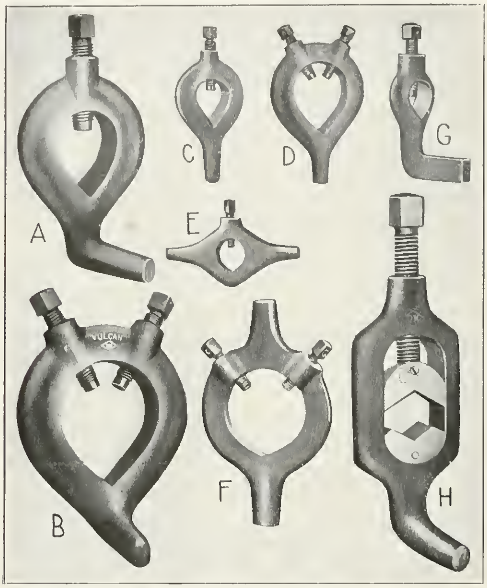


Fig. 1. Miscellaneous Examples of Lathe Dogs

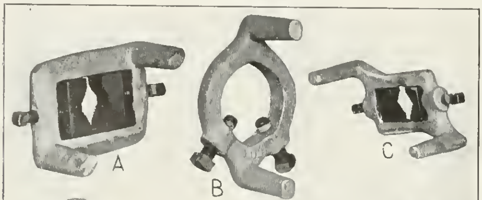


Fig. 2. Lathe Dogs of Special Construction

At *A* in Fig. 1 is shown one of the most commonly used lathe dogs—that with a bent tail and a single screw. At *B* is shown the same type of dog, but having two screws. At *C* is shown what is called a straight-tail dog with one screw, and at *D* the same dog with two screws. When these latter dogs are used, a stud driver, of course, is employed to drive against the tail. At *E* and *F* are shown double-tail dogs with one and two screws, respectively. At *G* is shown a dog which, although similar to that shown at *A*, has a flat tail with parallel sides. This type of dog is used in the milling machine rather than in the lathe, the flat tail making it convenient to secure it with a set-screw when used in the milling machine.

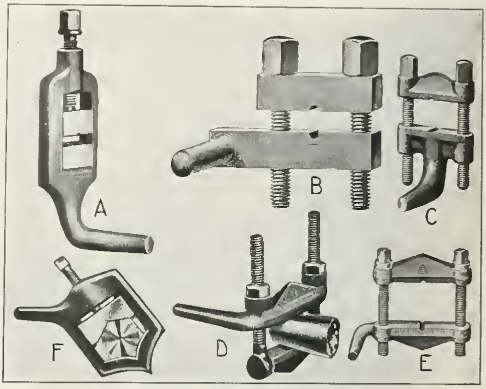


Fig. 3. Die Dog, Clamp Doge, etc.

A dog somewhat different from those previously shown is illustrated at *A* in Fig. 3. This is called a die-dog because of its similarity to a thread-cutting die. At *H* in Fig. 1 is shown the so-called "O. K." design of dog. The design of these two dogs is intended to prevent the binding screws from marking the work. At *A*, *B* and *C*, Fig. 2, are shown three double-tailed dogs designed by the Fitchburg Machine Works, which are especially adapted to the Lo-swing lathe made by that company. The prime object of double-tailed dogs is to equalize the pulling strain on the dog on both sides of the center. This relieves the work of undue side strain. At *D* in the same illustration is shown a type of dog called an open-side dog because of the opening at one side which permits of the dog being put onto the work after it is placed on the centers. At *E* is shown the Brinton patented dog which can be slipped on and off the work while it is on its centers, and at *F* is shown a type of dog made in two parts. This dog is adjustable for size, as indicated, there being three possible positions of the lower part within the upper. It is patented by Mr. Richmond Parsons. At *B* in Fig. 3 is shown a very common type of clamp dog, and at *C* the same type of dog with bent tail. At *D* is shown another dog of similar type, but in this design the lower jaw can swivel so as to accommodate tapered work. At *E* is shown still another type of the clamp dog class. At *F* in Fig. 3 is shown a type of patented dog made by the Western Tool & Mfg. Co. Fig. 4 shows what is called a reduction dog.

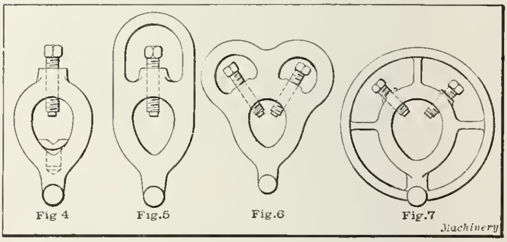


Fig. 4. Adjustable Dog Figs. 5 to 7. Safety Dogs

Figs. 5, 6, and 7 show three types of dogs with protected screws. It is rather difficult to guard the set-screw on the lathe dog properly so that it cannot cause injury to the operator, but these illustrations indicate what can be done. Fig. 8 shows a somewhat unusual type of double-tail dog provided with inserted shoes to assist in the holding of the work. This dog is patented by Mr. William L. Reid. Fig. 9 shows an elaborate type of what is usually termed a hold-back dog. Its object and the manner in which it is used is clearly shown in the engraving, it being used on work where one end runs in a steadyrest, to hold the work against the lathe center. The springs back of the faceplate give the required elasticity to the entire tool. This device eliminates the use of the belt-lace or lashing process which is more or less unhandy. This lathe dog was patented by Mr. Milton B. Hill. In Fig. 10 is shown a "homemade" type of dog. The cross-bar is forked where it fits over the side bars. Fig. 11 shows a dog with corrugated jaws, jointed as indicated. This dog is very convenient for certain purposes. Fig. 12 shows a popular type of driving dog. Dogs of this kind are usually made to suit immediate requirements. Fig. 13 shows a peculiar form of adjustable chain dog. This dog has a capacity for a wide variety of sizes according to the length of the chain. Fig. 14 shows a similar kind of dog patented by Mr. Hugh Elmer Clark, the claim for this dog being that it is easily attached to and detached from the work without removing the latter from the centers.

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* Address: 56 Fifth St., Newark, N. J.

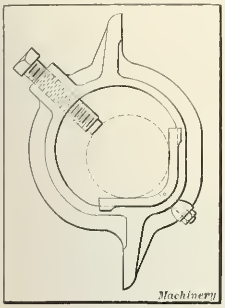


Fig. 8. The Reid Lathe Dog

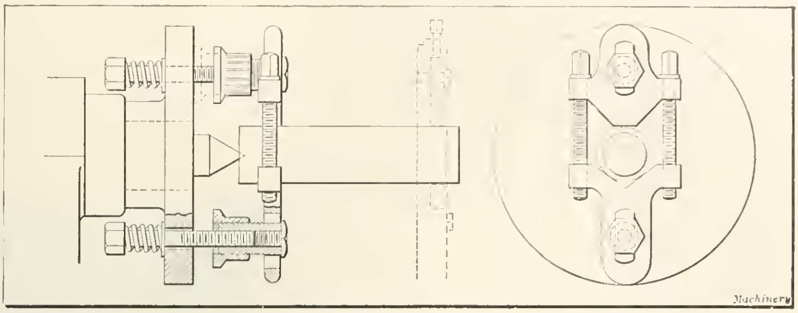
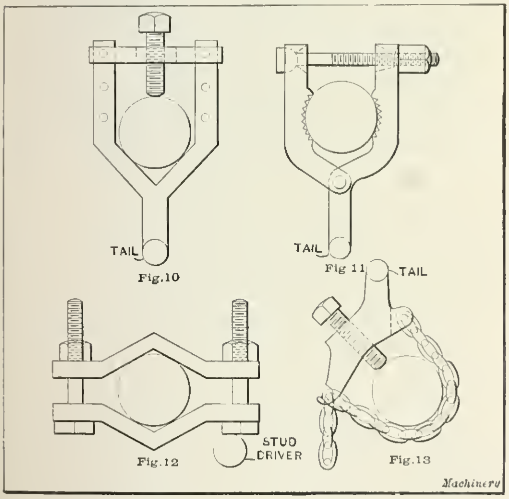


Fig. 9. The Hill Hold-back Dog



Figs. 10 to 13. Miscellaneous Dogs of Special Construction

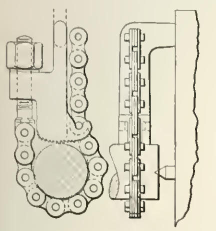


Fig. 14. The Clark Chain Lathe Dog

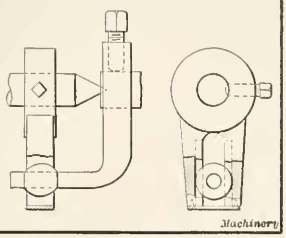


Fig 15. The Hill Improved Type of Dog

In Fig. 15 is shown a dog which is more especially adapted for the milling machine, and which is intended for taper work when it is necessary to have a radial and transverse movement and at the same time have no backlash in the rotating direction. This dog is patented by Mr. Milton B. Hill.

Fig. 16 shows a dog specially designed for use when producing a large number of pieces of the same size. This dog is termed a faceplate dog, principally because it is secured to the faceplate of the lathe. It is patented by Mr. Adam Tindel. Fig. 17 shows a dog which operates without screws. It is quick-acting, but can drive in one direction only. This design is patented by Mr. Thomas C. Thompson. Fig. 18 shows a dog especially devised for driving work which has irregular surfaces of any sort. It is patented by Mr. Louis Goddun. Fig. 19 shows a lathe dog which can be tightened without a wrench. It is patented by Mr. Frank L. Osgood. It can be attached to and detached from the work without removing the latter from the lathe. Fig. 20 shows a very simple but strong and efficient dog which can also be attached to and removed from the work while the latter is held between centers. Fig. 21 shows a number of types of clamp dogs. The one at *A* has brass-faced clips to protect finished work from being marred. The dogs shown at *E* and *F* are also provided with soft jaws for protecting the work. Those shown at *D*, *E* and *F* are intended to be self-balancing dogs for grinding machines.

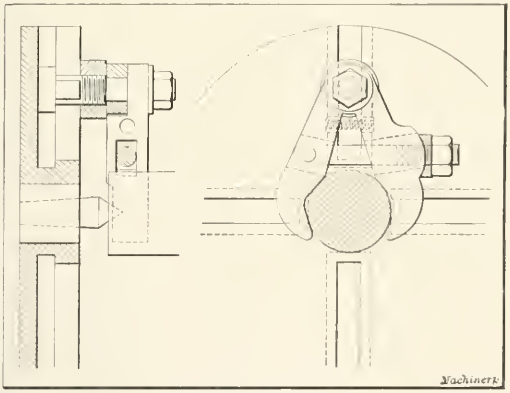


Fig 16. The Tindel Lathe Dog

In addition to the devices illustrated, there are shown in the following some devices which can hardly be classed as dogs, but which are merely makeshifts used in place of dogs. Fig. 22 shows a very common method of driving a piece of lathe work, the device consisting of two V-blocks clamped onto the work with an ordinary C-clamp. In Fig. 23 the clamp is used with its screw directly on the piece being turned. It will be noticed that the center line of the screw is a trifle in front of the center line of the work and that there is a block behind the work. This arrangement has been adopted in order to insure that the screw will not work off the shaft. The use of a stud driver in the faceplate of the lathe is, of course, necessary when these methods are employed. Fig. 24 shows another commonly used method where either a wooden or iron parallel clamp is screwed onto the shaft or work.

Fig. 25 shows a cheap makeshift which is often resorted to. This dog consists simply of a piece of scrap iron with a hole through it, large enough to take the work for which it is wanted. Fig. 26 shows another makeshift consisting of a common collar with an extra set-screw in it and a hole drilled for a piece of round iron driven into the collar and used as a tail. Fig. 27 shows a threaded lathe dog with a split hub and binding screw. When work is threaded on the end, the diameter of the thread being the same as that in the dog, the latter can be screwed onto the work and clamped by the binding screw so as to drive the work without injuring the thread. Fig. 28 shows another type of dog with a threaded hole in it. This dog is intended to be placed on the ends of studs or pieces made in the screw machine, or on any piece not having a center. Fig. 29 shows another cheap, "homemade," open-side, adjustable dog. This type is made from a round piece of cold-rolled steel, bent as shown. Three pin-holes are drilled through it so as to receive the pin which holds the head, which is adjustable from one position to another. Fig. 30 shows a simple method of driving a piece of work, the dog consisting merely of a piece of flat iron bent over to suit the work, with a bolt for binding as shown. Fig. 31 is another type consisting merely of a piece of flat iron, bent as required and drilled and tapped for a set-screw. Fig. 32 is especially intended for use on finished work, when one wishes to avoid any marks which might be made by the lathe dog.

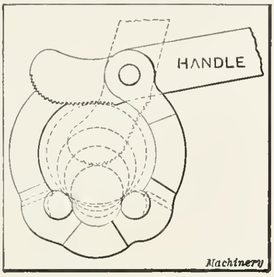


Fig. 17. The Thompson Lathe Dog. which operates without Screws

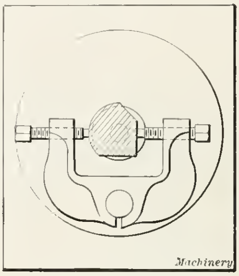


Fig. 18. Lathe Dog for Irregularly Shaped Work

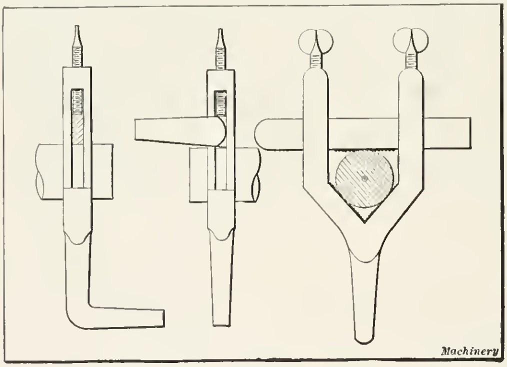


Fig. 19. The Osgood Lathe Dog

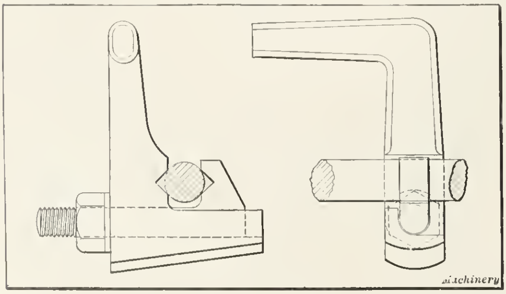


Fig. 20. Type of Open Dog

There are, of course, innumerable devices that have been made for special purposes, but those shown are typical and indicate what may be done. In addition there are, also, of course, a number of drivers used on faceplates for driving chucked work not held between the centers. These, however, are not strictly lathe dogs, and as they are often made to suit special requirements and have hardly any common characteristics, they are not dealt with in this connection.

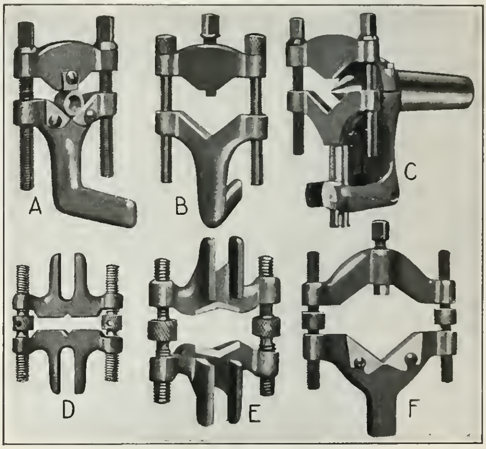


Fig. 21. Hill Clamp Dogs

In Fig. 33 is shown a safety lathe dog which has been brought out by Elmer J. Michaud of South Windham, Conn. Every machinist who has operated a lathe realizes the danger incident to the use of the ordinary lathe dog with its unguarded set-screw, which tends to catch in the clothing, especially when filing. This lathe dog is so shaped that it provides a guard, the tail of the dog being curved around in front of the set-screw on the leading side, thus affording protection. It can be clearly seen that this feature does not interfere with loosening or tightening the set-screw.

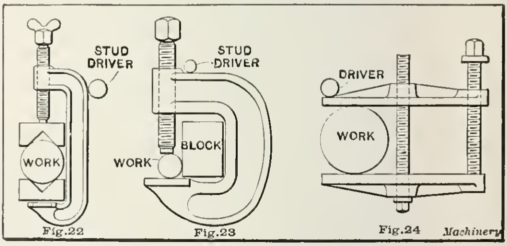


Fig.22 Fig.23 Fig.24

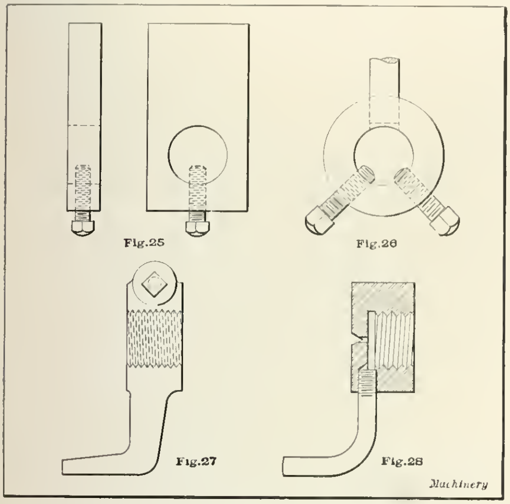
Figs. 22 to 24. Makeshift Dogs

* * *

A method of accurately shaping very small dies, punches and other tools to an irregular form, developed by the watchmakers of Switzerland, employs a projectoscope or magic lantern as a magnifier. The shape required is drawn carefully to a scale of, say, fifty times actual size. The tools are made to size and shape as nearly as possible by common methods and are finished by stoning off the high parts which extend beyond the limits of the drawing when projected on it by the lantern. The inaccuracies are thus multiplied fifty times and the spots that do not coincide with the drawing are stoned off by a specially devised grinding rig that is controlled by the toolmaker, the tool being worked down without removing it from the lantern.

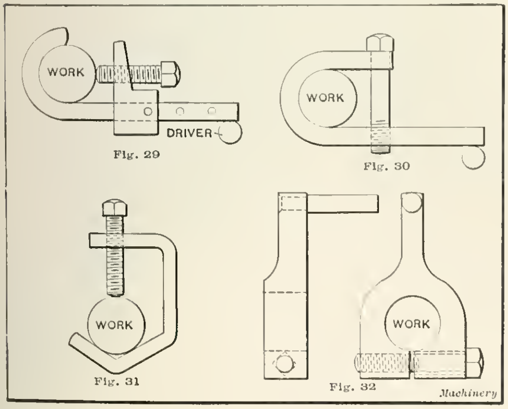
CONGRESS OF INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

The sixth congress of the International Association for Testing Materials was held in the Engineering Societies Building, New York City, September 2 to 7. Twenty-four nations were represented in the congress, the various foreign governments, as well as engineering societies here and abroad, having sent delegates. The object of the society is to further the progress of engineering by augmenting the knowledge relating to materials, by devising proper means and methods for the testing of materials, by drawing up specifications for materials for various purposes, and, in general, by providing standardized and uniform methods of engineering practice, in as far as the properties of materials of construction are concerned.



Figs. 25 to 28. Other Examples of Makeshift and Special Dogs

The congress was divided into three sections: one on metals, with a sub-section on cast iron and special steels; one on cement and stone; and one on miscellaneous materials. One hundred and fifty-three papers formed the program for the sixth congress. These papers related to hardness testing, to wear tests of steels, impact tests, corrosion tests for pipes, endurance tests, tests relating to magnetic and electric properties and properties of metals at high temperatures, tests on steel rails, cast iron and special steels, as well as tests on non-ferrous metals and alloys. Other papers relating to the investigation of new testing methods, micrography and micrographic researches, nomenclature of iron and steel products, as well as a considerable number of papers relating to cement, stone, paints, timbers, oils, road materials and rubber, were also presented.



Figs. 29 to 32. "Homemade" Dogs of Simple Design

The International Association for Testing Materials meets every three years in a congress devoted to the presentation and discussion of technical papers along the lines outlined. The last congress was held at Copenhagen, Denmark, in 1909. The preparations for the sixth congress have been in the hands of the American Society for Testing Materials, which is affiliated with the International Association. The social features included an informal reception under the auspices of the American Society for Testing Materials, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the American Institute of Mining Engineers, on Monday, September 2, and an excursion on the Hudson River to the military academy at West Point on September 4. On September 5 there was a reception tendered to the foreign members by the American Society of Civil Engineers. For those of the foreign members who desired to see something of America and its industrial development, a special excursion hotel train was arranged after the adjournment of the convention, making a week's tour, visiting Washington, Pittsburg, Buffalo and Niagara Falls.

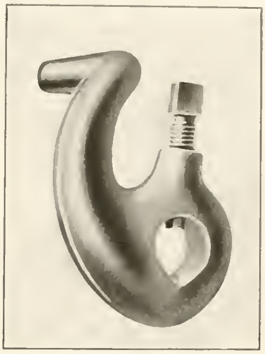


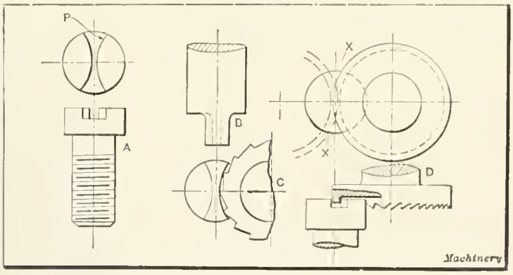
Fig. 33. Michaud Safety Dog

Before adjourning the congress elected as the new president of the International Association, Prof. N. Belelubsky of St. Petersburg, Russia, professor emeritus of the Institute of Engineers of Ways of Communication. The next international congress of the association will be held in 1915 in St. Petersburg.

* * *

UNUSUAL FORM OF SLOT IN FILLISTER-HEAD SCREW

An unusual form of slot in fillister-head screws is illustrated in a recent issue of the *Mechanical World*. This form of slot is used by an English firm and is claimed to have the advantage of providing a screw slot that is not likely to be injured; it also provides for a strong form of screw-driver. In the illustration *A* shows the screw, *B* the screw-driver, *C* the cutter used for milling the screw-driver, and *D* the annular cutter employed for milling the slot in the screw head. It is evident that two milling operations with this cutter are required for each slot. In addition, an ordinary plain cutter must be run through in order to remove the piece *X*, which otherwise would remain at the ends of the slot. The screw head is strengthened in this way, it is claimed, because the pressure of the screw-driver is received in the direction of the arrow *P*, in which there is a better backing of metal to withstand the pressure. The slot is, in fact, of the same shape that an ordinary plain slot tends to assume after it has been used for some time.



Form of Screw-driver, and Screw-head Slot and Method of Producing it

CHARACTERISTICS OF WROUGHT-IRON

A REVIEW OF KINDS, USES, PECULIARITIES, AND METHODS OF TESTING

BY A. L. HAAS*

Wrought-iron has, to a very large extent, been superseded by mild steel. Nevertheless, a large field remains where its resistance to fatigue and the ease with which it can be welded renders it valuable. Where reliability is of prime importance, no other material is superior to it.

Yorkshire iron of the best quality is still made in large quantities. There is no finer commercial grade of iron to be obtained anywhere than the iron known as Lowmoor or Farnley. The iron made in Staffordshire is of a lower grade, and it is this quality of iron that is threatened with extinction by mild steel. The cost varies, of course, with the quality, the best Yorkshire iron demanding twice the price of low-grade Staffordshire iron.

There are some articles for which wrought-iron is always used, for example, crane chains, lifting hooks, locomotive draw gears, etc. Years ago marine engine shafting was invariably made from wrought-iron. The firm of Blair, of Stockton on Lees, one of the earliest makers of marine engines and one of the most conservative firms at the present time, still makes (or, at least, until very recently did make) its shafting from this material. It is a well-known saying on the Northeast coast that no ship with Blair engines has ever been known to break down at sea from a fractured shaft. Two leading makers of steam fire engines still use Lowmoor plate for their boilers. These boilers are subjected to a heavy duty in spite of their small size. In locomotive practice Lowmoor iron rivets are still used for the boilers.

Pieces of Wrought-iron having been subjected to the "Rams Horn" Test

Corrosion of Wrought-iron

The resistance of wrought-iron to corrosion is remarkable, in spite of any statements to the contrary based on short periods of comparative tests. At Delhi, in India, there is a monumental column of this material which is over one thousand years old. The writer is informed on good authority that in various humid parts of India native-made iron, whose origin is too far back to be definitely known, is still seen fully exposed to weather conditions. At the Epping church, near London, there are some exposed iron hand-rails, one hundred and fifty years old, the section of which has not been diminished below the margin of safety during this period. This iron was probably smelted and puddled in small quantities, using charcoal for fuel, from particularly high-grade and easily reduced ore.

Corrosion in iron takes place in layers on account of its fibrous structure. The make-up of an iron bar can be compared with that of a wire rope, the spaces between the wires being filled with a silicious matter, which latter is naturally more or less weather- or corrosion-proof. In the instance of the hand-rails at the Epping church, the structure is plainly apparent, as corrosion has left the rails knotted like the trunk of an old tree. The pitting characteristic of steel is absent in this ancient iron.

It is a fact admitting of no controversy that the use of mild steel for ship plates has reduced the life of the hulls by one-half, and a similar reduction in life has accompanied the adoption of mild steel for boilers. The writer has personally observed steel deck plates around hatches which were originally ⅜ inch thick, that in a fourteen-year old steamer had been reduced to a thickness of 1/16 inch over a considerable area. The same vessel had to have the entire engine and boiler room tank (top, floors and intercostals) renewed after the same period. The original 7/16-inch plate could in a great many places be perforated with a good blow from a sharp scaling hammer.

On the other hand, an old steamer called the *Dodo*, which used to ply regularly between Cardiff and Spain, and which was provided with one of the earliest iron hulls ever built, was 65 years old in 1900. It is still running, and, hence, is now 77 years old. A fireman who sailed in her, and subsequently with the writer, said that he was afraid to break coal in her lower bunker or to scrape up dust with his shovel, using undue violence, for fear he would break through the bottom. A similar steel hull would have been in the ship breaker's hands in half that length of time. In fact, wooden hulls last longer than these do. A collier trading between Newcastle and London was sold for a coal store hulk at the youthful age of 150 years. In many ports scattered throughout the world old British wooden ships converted into stationary hulks can frequently be seen.

Present-day Tendency to Reduce First Cost and Increase Cost of Upkeep

It seems to the writer that the present-day tendency is to reduce the first cost, increase the cost of upkeep, and decrease the length of service without corresponding advantages, by the use of newer materials. Of course, circumstances alter cases, and there are instances where economy is of no account. There is a works in the Birmingham district in England which was recently taken over by an up-to-date concern. In these works there was a beam engine built by Bolton & Watt, which must have been about eighty-five years old. It was found advantageous to run this antique engine as the sole means of power. The engine cost nothing and the new concern built its furnaces with boilers mounted over them, and hence obtained, as one might say, for nothing, easily twice the amount of steam that could be used. The economy of modern engines, or of producer gas, is of no interest to this firm. The fuel has to be burned anyway, and the waste of steam is of no moment.

One of the largest users—as distinguished from producers—of wrought-iron, who employs this material exclusively in the articles of his manufacture, has a strong belief that there will come a revival in its use; yet this man does not belong to the old school, but is a live, prosperous man under fifty. Could some newer process of puddling be devised to produce larger quantities at a single operation, the use of wrought-iron would certainly be extended and its price reduced.

Peculiarities of Wrought-iron

In testing wrought-iron some peculiarities have come to the writer's notice. Best Yorkshire (Lowmoor and Farnley) if nicked ⅛ inch deep around, say, a 1-inch bar, with a sharp set, and broken short over the anvil with a single blow, shows a curious fracture. The bar breaks dead short and square. The fracture is coarsely granular, resembling badly burned steel, only the granular structure is coarser. The bar nicked on one side only, and carefully bent with the nick a couple of inches from the edge of the vise or anvil, shows a beautiful gray, silky, fibrous structure, free from crystals and perfect in every way. Only the best Yorkshire iron shows this peculiarity, which to the writer's knowledge has never been satisfactorily explained.

Some peculiarities have been noted in connection with the welding of wrought-iron. The lower grades make an apparent weld at almost a melting temperature, as well as at low heat. With the better grades of iron, however, this cannot be done, and a heat between closer limits of temperature is necessary. Hence, this kind of iron needs a careful and competent blacksmith, and he must give closer attention to his work than with the cheaper grades. A burned weld and a partial shut cannot pass even a cursory glance, as would similar welds in common grades of iron. Another point with regard to welding is that the less the iron is worked at the weld, the better the job. The writer has seen welds that have been reduced several tons in tensile strength by a smith unversed in this part of the art, unnecessarily working the weld at a comparatively low heat to make a good looking job.

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Testing Wrought-iron

When mild steel is tested the strength "with" and "across" the direction of rolling is nearly equal, and for ordinary purposes of design can be so assumed. With wrought-iron, however, this is not the case. In bending tests, also, the angle through which the iron can be bent with safety varies considerably, according to whether the bending is "with" or "across" the grain. The accompanying tables give a summary of the characteristics of wrought-iron, these tables being the results of long experience with this kind of material.

TABLE I. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON BARS

Sectional Area	Yorkshire Iron		B B Staffordshire		B B B Staffordshire		Staffordshire	
	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent	Tensile Strength, Tons	Elongation in 10 Inches, Per Cent
1 square inch and under.	23	26	24	20–23*	23	23–25*	24	23
Above 1 square inch, under 4 square inches....	22	24	23	22	23	24	24	22
Above 4 sq. inches, under 8 square inches...	22	22	22	20	22	23	22	20
Above 8 square inches..	21	21	21	20	21	20	21	20
Channels, Angles, Tees.	22	21	22	15	23	15	22	15
Rivets..................	23	26	23	24	23	25	23	24

* Lower elongation: Rounds and squares 9/16-inch and under; flats 7/16-inch in thickness and under. Higher Elongation: Rounds and squares 5/8-inch and over; flat ½-inch in thickness and over, up to 1 square inch in area.

A number of wrought-iron pieces which have been tested in the manner that was commonly used years ago, and which still survives in some quarters, are shown in the accompanying halftone. Tests of this kind are known as "rams horn" tests, and are intended to indicate both the forging qualities of the iron and the closeness of the piling. A hole, 1¼ times the size of the bar or the thickness of the plate, is drifted hot from the solid, leaving the same distance clear from the end or the side. The metal between the hole and the end of the bar is split with a sharp set from both sides and turned over as indicated in the engraving, the name of the test being derived from the appearance of the pieces after the bending is completed. When flat plates are tested, one horn is turned sideways and the other forward. Sizes up to two square inches in sectional area can be tested in one heat, but usually two heats are required. A second hole of the same size is drifted lower down the bar at right angles to the first. The test specimen, when cold, should show no defects, the piling should not split, and the surface of the "rams horns" should be free from red-short cracks. A clean fire, an experienced blacksmith, and considerable speed are required in order to make a satisfactory test, especially in the common grades of iron.

TABLE II. TENSILE STRENGTH AND ELONGATION OF WROUGHT-IRON PLATE

Grade of Iron	Tensile Strength	Elongation in 8 Inches, Per Cent
Yorkshire.........	With grain, 21 tons Across grain, 19 tons	With grain, 20 Across grain, 12
Staffordshire BB ..	With grain, 21 tons Across grain, 18 tons	With grain, 10 Across grain, 5
Staffordshire BBB.	With grain, 22 tons Across grain, 18 tons	With grain, 12 Across grain, 7

The only physical test bearing a direct relation to the prices and quality of iron is the reduction of area at the point of fracture, when broken in a tensile strength test. In good iron this reduction of area should be 40 per cent. Two pieces of iron, one of which is twice as expensive as the other, will often have the same tensile strength and elongation, but the reduction of area will indicate which is the better iron. The best Yorkshire bar iron has been known to have over 60 per cent reduction of area, and usually it exceeds 50 per cent, but a cheap grade of bar iron rarely reaches 30 per cent. Good Staffordshire iron should have approximately 40 per cent reduction of area.

TABLE III. COLD BENDING TESTS OF PLATE, ALL QUALITIES

Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)	Thickness of Plate, Inches	With the Grain, through Angle (in Degrees)	Across the Grain, through Angle (in Degrees)
1 and 15/16	20	7½	½	42½	17½
⅞ and 13/16	22½	10	7/16	50	20
¾	25	10	⅜	60	25
11/16	27½	12½	5/16	70	30
⅝	30	12½	¼	90	40
9/16	35	15	3/16	100	60

The inner radius of the curve at the bend not to exceed 1½ times the thickness of the plate.

Chain made from Wrought-iron

As welded chain is one of the principal uses for which wrought-iron is still exclusively employed, a few remarks relating to the welding of chain of this kind may be of interest. In the making of high-grade crane chain, the value of the reduction of area cited above is clearly shown in the tests of the finished chain. The elongation of a good sample under tensile test bears a direct relation to the reduction of area obtained from the bar iron from which it is made. The greater the reduction of area in the bar, the greater the percentage of elongation in the finished chain.

TABLE IV. SPECIFICATIONS OF DRIFTING TESTS

Description of Iron	B B Staffordshire	B B B Staffordshire
Rounds up to 3 inches in diameter	Drift with grain to 1¼ times diameter, and across grain equal to diameter	Drift with grain to 1½ times diameter and across to 1¼ times diameter
Squares up to 3 inches side	Drift with grain equal to side of square, and across equal to ¾ times side	Drift with grain to 1¼ times side, and across equal to side
Rounds and squares over 3 inches diameter of side	Drift to ⅛ diameter or side	Drift to 1¼ times diameter or side
Flats up to 6 inches wide and under 1 inch thick	Drift to 2½ times thickness at a distance from edge equal to thickness	Drift to 2¾ times thickness at a distance from edge equal to thickness
Flats up to any width over 1 inch thick	Drift to 2 times thickness at a distance from edge equal to thickness	Drift to 2½ times thickness at a distance from edge equal to thickness

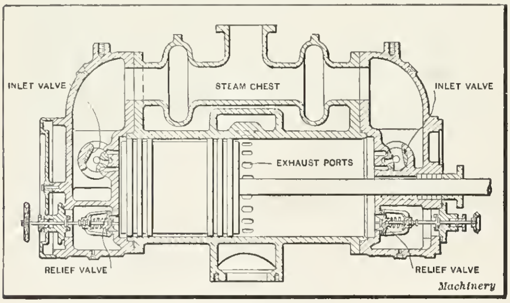
A well made chain under tensile test never breaks in the weld, but always at the end of the link which is not welded, or at the side. A break at the weld proves poor workmanship, no matter what iron is used. If the chain is of the best quality of iron, and the workmanship is first-class, the chain should stiffen under the breaking stress so that it becomes solid like a piece of bar iron. This stiffening under a breaking load is a certain indication of quality. Chains made from a common grade of iron do not stiffen. The stiffness is such that in good chain the end of the test piece can be held in the hand, and the test piece holds its own weight without movement or bending. If, when in use, a chain sling is found to lack freedom of movement, even to a slight degree, it should be discarded instantly because of the danger attached, as the chain must have been at some time overstressed.

A practical example of the value of annealing can be obtained from a wrought-iron chain by anyone. A link of such a chain of a good class of iron, say a sling chain, known to be in need of annealing, can easily be broken by a single blow of the hammer, with the link held vertically on the anvil. The fracture is coarsely crystalline and the break is sharp and nearly square. After proper heat-treatment the next link can be flattened or maltreated in almost any manner short of actually cutting it, but it will not break.

* * *

THE UNIFLOW STEAM ENGINE

The difference between the temperature of the live steam admitted to an engine cylinder and that of the exhaust leaving it makes the cylinder walls, cylinder head and piston act as reservoirs of heat which alternately fill and discharge at every stroke. The greater the ratio of expansion, the greater the difference in temperatures at the beginning and end of the stroke, and hence the greater the heat loss. This heat loss is commonly attributed to "initial condensation," but this phenomenon is simply the evidence of heat being imparted to the cylinder to raise it to the temperature of the incoming live steam. The abstraction of heat from saturated steam immediately causes condensation, which is followed by evaporation and cooling as the pressure falls.



Longitudinal Section of Uniflow Steam Engine Cylinder

The superior economy of the multiple-cylinder engine is due to the fact that the range of expansion is divided between two or more cylinders and the temperature difference in each cylinder is not so great as in a simple engine working to the same number of expansions. In other words the high pressure cylinder is hotter than the intermediate, and the intermediate is hotter than the low-pressure. If the whole range of expansion was effected in one cylinder its temperature would be an average between that of the live and exhaust steam.

In theory, the greater the number of cylinders, the higher the efficiency, but mechanical losses set a practical limit to the number of cylinders, four being as many as it is profitable to use. It is in this respect that the turbine is at a great advantage over the reciprocating engine. The zones of temperature can be graded by very small differences, thus reducing losses from heat interchange to a minimum. The Parsons turbine is really an expansion nozzle, hot at one end and relatively cold at the other.

Much ingenuity has been expended on steam engine design to reduce the heat losses in simple engines and make their performance approach more nearly in economy that of multiple-cylinder engines. One of the simplest and most effective cylinders is that of the so-called "uniflow" engine, patented in 1886 in Great Britain by Mr. L. J. Todd, and developed by Prof. Stumpf of Charlottenburg, Germany. This type of simple engine has recently been taken up by an American engine builder who claims that he can develop a horsepower on 24½ pounds steam non-condensing, and on 13¼ pounds condensing at 100 per cent load. At 100 per cent overload the consumption rises to 30 pounds and 14½ pounds, respectively.

The principle of the uniflow type of steam engine is that of admitting the steam at the ends of the cylinders as in all Corliss engines and exhausting at the center, thus causing no reversal of steam flow in the cylinder. The cylinder barrel is slightly more than two times the length of the stroke, the excess being in the width of the central exhaust port or ports and the clearances between the piston and cylinder heads. The increased efficiency is due partly to non-reversal of flow, the admission ends thus remaining hotter, but chiefly to reduced time of exhaust. In the common type of engine the cylinder walls are exposed to the exhaust temperature for about ninety per cent of the time required for the return stroke, whereas in the uniflow engine the exhaust period is much less.

On the return or exhaust stroke the steam remaining in the cylinder after the outer edges of the ports are passed by the piston is trapped and compressed in the clearance space to live steam pressure. This feature of the cycle, while apparently economical, is not so, thermodynamically, for the reason that the power required to compress has been generated in a comparatively low efficiency cycle and the resulting available energy in the compressed steam is far below that required for its conversion. But mechanically this feature is unavoidable for two reasons, the first being the very structure of the uniflow type, and second the need of cushioning effect in the cylinder to check the reciprocating parts and prevent shock and noise, a common requirement, of course, of all reciprocating piston engines.

* * *

RATHENAU GOLD MEDAL

The Allgemeine Elektricitäts Gesellschaft (A.E.G.) of Berlin has notified President Arthur Williams of the American Museum of Safety, New York, that the Rathenau gold medal has been placed at the disposal of the museum for award annually for the best device or process for safeguarding life and limb or promoting health in the electrical industry. The competition is open to every country in the world, the only condition being that the device or process must be exhibited at the American Museum of Safety in New York City. This is the first time that a high European honor has been given to an American institution and indicates the standing of the American Safety Museum among European scientists.

The Rathenau medal is well known in the European scientific world. It was presented to Dr. Emil Rathenau, president and founder of the Allgemeine Elektricitäts Gesellschaft, the greatest European electric company, on the occasion of his seventieth birthday, with the felicitations of the Kaiser for his services in the field of electro-technics. (He was the man who introduced incandescent lighting into Germany). One medal will now be cast each year from the original die for the American Museum of Safety to award.

* * *

THE USE OF WASTE STEAM

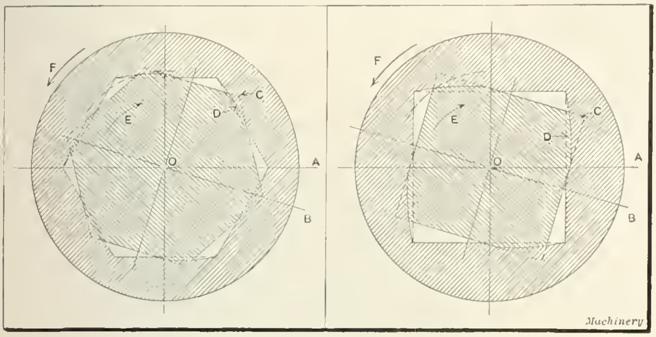
The use to which steam which formerly went to waste has been put at the Indiana Steel & Wire Co., Muncie, Ind., indicates what could be done to increase the efficiency of the steam plant in many industrial plants. In the power plant of this company two 22 by 42 inch Corliss non-condensing engines operate a series of wire-drawing benches. Each engine carries a load averaging from 370 to 400 H. P., and operates continually with the exception of Sundays and holidays. Up to two years ago electric power was purchased from an outside source to drive the machines for making wire fencing, wire nails, etc., but at that time it was decided to utilize the exhaust steam from the Corliss engines to generate this electric power. A 600 K. W. mixed-pressure Curtis turbine was installed and the exhaust steam from the two Corliss engines used to drive this turbine, which, in turn, exhausts into a condenser maintaining a vacuum of 28 inches. In case the engines are shut down, the mixed-pressure turbine automatically cuts in sufficiently high pressure steam to continue to run. The turbine now carries the entire motor load of 600 H. P., using steam that was formerly allowed to go to waste.

SQUARE VS. HEXAGON HOLLOW SET-SCREWS

ANALYSIS OF STRESSES, AND COMPARISON FOR WEAR AND STRENGTH

BY JOHN S. MYERS*

Since hollow set-screws have come into vogue, supplying a long-felt need of the manufacturer with humanitarian instincts, a controversy has arisen as to the respective merits of the square and the hexagonal form of hole, which presents an interesting problem. It is the object of this article to investigate analytically the relative claims to superiority of the two forms.



Figs. 1 and 2. Illustrations showing the Effect of Wear in the Case of a Hexagonal and a Square Wrench and Socket

Any mechanic knows that the corners of an ordinary hexagonal nut are more easily bruised and rounded off than the corners of a square nut, when using an open-ended or monkey wrench. Especially is this the case when, under dire stress of circumstances, one is compelled to use a wrench which does not fit properly, or a monkey wrench with a weak back. Nevertheless, hexagonal nuts have almost entirely superseded square ones in machine construction, for, as it seems, good and sufficient reasons. However, when we consider the case of a socket wrench, the answer to the question as to which form of nut would burr up easiest is not so apparent, for with the hexagonal nut we have six obtuse corners in action, against four square corners on the square nut; whereas, with the open-ended wrench, there are but two corners under pressure in either form. The case of the square versus the hexagonal nut, even with a socket wrench, is, however, considerably different from the case of the hollow set-screw; for, with the same size of bolt the distance across the flats of the square nut is equal to that of the hexagonal one, whereas, with the hollow set-screw, the distance across the corners is the limiting feature.

Comparison for Wear

In Fig. 1 we have a hexagonal inner member driving in the direction of arrow *E* against a resistance of the outer member in the direction of arrow *F*. It is assumed that the corners of the inner member have been worn as at *C*, and the faces of the outer member as at *D*, permitting a relative angular rotation *AOB*. Fig. 2 represents a square inner member with an assumed wear sufficient to permit of an angular displacement *AOB*, equal to the similar angle in Fig. 1. Comparing the two, it is seen that the square form would have to be worn much more than the hexagonal to permit of equal angular looseness, so that, unless the pressure on the corners of the square is sufficiently higher than that on the corners of the hexagon to offset this advantage, we would expect the square form to wear longer than the hexagonal.

Arbitrarily assuming the distance across the corners for the two forms to be equal, the depth of the two inner members to be equal, the torsional moments delivered equal, and the driving forces to be concentrated upon the extreme corners, as represented in Figs. 3 and 4, we may proceed as follows:

For the square form (Fig. 3) F acts at a lever arm $l = \frac{C}{2\sqrt{2}}$ (1)

The turning moment of the four forces is

$$T = 4Fl = 4F\frac{C}{2\sqrt{2}}$$

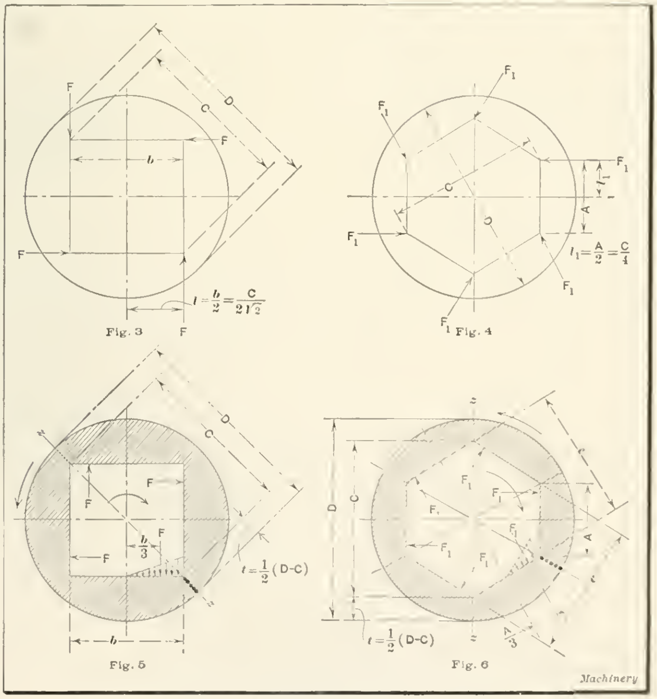
$= FC\sqrt{2}$, from which

$$F = \frac{T}{C\sqrt{2}} = 0.707\frac{T}{C} \qquad (2)$$

For the hexagon (Fig. 4), $l_1 = \frac{C}{4}$ (3)

The torsional moment is $T = 6F_1l_1 = 6F_1\frac{C}{4}$, or

$$F_1 = \frac{2T}{3C} = 0.667\frac{T}{C} \qquad (4)$$



Figs. 3 to 6. Diagram for Analyzing Relative Strength and Wearing Qualities of Square and Hexagon Hollow Set-screws

From (2) and (4), $\frac{F}{F_1} = \frac{0.707}{0.667} = 1.06$. (5)

This indicates that, under the assumed conditions, the total pressure (not the unit pressure) on the corners of the square is 6 per cent higher than that on the corners of the hexagon.

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Comparison for Strength

Comparing the square and hexagon for torsional strength, we have the torsional section modulus of the square as:

$$Z_{ps} = \frac{C^3_s}{12} \qquad (6)$$

and for the hexagon:

$$Z_{ph} = 0.1353\ C^3_h. \quad \text{(See table.)} \qquad (7)$$

When $C_s = C_h$, the ratio of relative strengths is:

$$\frac{Z_{ph}}{Z_{ps}} = 0.1353\ C^3_h \times \frac{12}{C^3_s} = 1.62 \qquad (8)$$

or, when of equal distances across the corners the hexagon is torsionally 62 per cent stronger than the square.

If we equate $Z_{ps} = Z_{ph}$ and solve, we have:

$$C_s = 1.175\ C_h \quad (9) \qquad \text{or, } C_h = 0.851\ C_s \quad (9a)$$

which indicates that, for equal torsional strength the distance across the corner of the square form should be 1.175 times the same dimension for the hexagon, or, viewed the other way, the distance across the corners of the hexagon need only be 0.851 times the same dimension of the square.

Now, for $C_s = C_h$ we have, from (5), the total pressure on the corners of the square 1.06 times that on the hexagon, while in (8) the hexagon is shown to be torsionally 1.62 times stronger than the square; hence, if both are stressed to their full strength, the pressure on the corners of the hexagon is $\frac{1.62}{1.06} = 1.53$ times the similar pressure on the square (10).

In the case of the hollow set-screw, however, the outer member is of equal (if not of greater) importance than the inner member. The ideal condition would be to have both members of equal strength. Investigating in this direction, we have for the torsional section modulus of a circular section with a square hole (Case V in table):

$$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \qquad (11)$$

For the square inner member (Case II in table):

$$Z_p = \frac{b^3}{3\sqrt{2}}. \qquad (12)$$

Equating these, we have:

$$\frac{b^3}{3\sqrt{2}} = \frac{\pi D^3}{16} - \frac{b^4}{3D}. \qquad (13)$$

Now let $b = xD$; then:

$$\frac{x^3 D^3}{3\sqrt{2}} = \frac{\pi\ D^3}{16} - \frac{x^4 D^4}{3\ D}, \text{ or } \frac{x^3}{\sqrt{2}} + x^4 = \frac{3}{16}\pi \qquad (14)$$

From (14) we have $x = 0.74$, or $b = 0.74D$. (15)

But $b = \frac{C}{\sqrt{2}}$, hence:

$$\frac{C}{\sqrt{2}} = 0.74D \text{ or } C = 1.046D. \qquad (16)$$

The significance of Equation (16) is that it is impossible to make a square inner member of torsional strength equal to the round outer member, because the distance across the corners of the square becomes greater than the diameter of the outer member thus splitting it up into four separate sections.

Treating the hexagonal form in a similar manner it is found that, for the inner and outer members to be of equal strength, we would have:

$$C = 0.912D \qquad (17)$$

Just how thin the metal over the corners might be made without destroying the continuity of the section, and thus entirely upsetting the conditions upon which the theory of torsion is based, is problematic. It would, however, seem impracticable to give C as large a value as indicated by (17).

Proportion of the Inner to the Outer Member and their Relative Strengths—The Square Form

The problem now resolves itself into one of how large the inner member may be made without danger of rupture in the outer member at the corners. Referring to Fig. 5, the pressure against the sides of the square is maximum at the advancing corner and may be assumed to diminish uniformly to zero at the center of the side. The center of pressure on each face is then at F, at a distance of 1/3 b from the center, and the torsional moment of the four forces is:

$$T = \frac{4Fb}{3}. \qquad (18)$$

Taking the depth of the square hole as equal to b, the area of material resisting rupture at the corner, as at z, is:

$$a = tb = \frac{D - C}{2} b, \text{ and, since } C = b\sqrt{2}, a = \frac{D - b\sqrt{2}}{2} b \qquad (19)$$

With a unit stress of S this area is capable of resisting a force of:

$$F_s = a\ S = \frac{D - b\sqrt{2}}{2} b\ S \qquad (20)$$

Now, for simplicity of treatment as well as safety, we will consider the entire force F in Fig. 5 as concentrated upon this area a. We then have $F = F_s$, and, by substituting the value of F_s as given by (20) for F in (18) we have:

$$T = \frac{4\ b}{3}\left(\frac{D - b\sqrt{2}}{2}\right) b\ S = \frac{2}{3} b^2\ S\ (D - b\sqrt{2}) \qquad (21)$$

This equation represents the extreme torque of the outer member without causing rupture at the corners.

The torsional strength of the inner member is:

$$T = Z_p\ S = \frac{S\ b^3}{3\sqrt{2}} \qquad (22)$$

Equating (21) and (22) we have:

$$\frac{2}{3} b^2\ S\ (D - b\sqrt{2}) = \frac{S\ b^3}{3\sqrt{2}}$$

from which

$$b = \frac{2\sqrt{2}}{5} D = 0.566\ D \qquad (23)$$

$$\text{or } C = 0.800\ D \qquad (23a)$$

Equations (23) and (23a) represent the largest size of square inner member that can be used without danger of rupture of the outer member at the corners.

Substituting the value of b as given by (23) in (12) we have:

$$Z_p = \left(\frac{2\sqrt{2}}{5} D\right)^3 \div 3\sqrt{2} = \frac{16}{375} D^3 = 0.0427\ D^3 \qquad (24)$$

which is a measure of the torsional strength of the square form of the inner member.

If we divide the result of Equation (24) by the torsional section modulus of a solid circular section (Case I in table) we have:

$$\frac{16D^3}{375} \times \frac{16}{\pi D^3} = 0.2173. \qquad (25)$$

This indicates that a square inner member may approximate 22 per cent of the torsional strength of a solid circular section of a diameter equal to that of the outer member.

Proportion of the Inner to the Outer Member and their Relative Strengths—The Hexagonal Form

Investigating the case of the hexagonal form of inner member in a similar manner (see Fig. 6), we have first that the torsional moment of the six forces F_1 is:

$$T = 6F_1\frac{A}{3} = 2F_1A. \qquad (26)$$

Assuming the depth of hole to equal e, the area resisting F_1 is $a = e\frac{D - C}{2}$, and since $e = A\sqrt{3}$,

$$a = A\sqrt{3}\frac{D - C}{2} \qquad (27)$$

The force that this area is able to resist is:

$$F_1 = a\ S = \frac{\sqrt{3}}{2} A\ S\ (D - C), \text{ or, since } C = 2A$$

$$F_1 = \frac{\sqrt{3}}{2} A S (D - 2A) \qquad (28)$$

Substituting this value of F_1 in (26) we have:

$$T = \sqrt{3} A^2 S (D - 2A) \qquad (29)$$

The torsional strength of a hexagon (see Case III in table) is:

$$T = Z_p S = \tfrac{5}{8} \sqrt{3} A^3 S \qquad (30)$$

Equating (29) and (30), and reducing gives us:

$$A = \tfrac{8}{21} D = 0.381 D \qquad (31)$$

From (31) we have $C = 0.762 D$ (31a); or $e = 0.66 D$ (31b).

Equations (31), (31a) and (31b) represent the various dimensions of the largest size of hexagon that can be used without danger of rupture of the outer member at the corners.

The torsional section modulus of a hexagon (Case III in table) is:

$$Z_p = \tfrac{5}{8} \sqrt{3} A^3 \qquad (32)$$

Substituting the value of A from (31) in (32) gives:

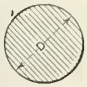
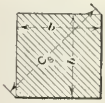
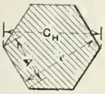
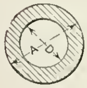
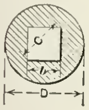
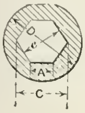
$$Z_p = \tfrac{5}{8} \sqrt{3} (\tfrac{8}{21} D)^3 = 0.0598 D^3 \qquad (33)$$

Equation (33) is the measure of the torsional strength of the hexagonal form of inner member. If we divide this by the torsional section modulus of a solid circular section, as given in Case I of the table, we have:

$$0.0598 D^3 \times \frac{16}{\pi D^3} = 0.3048 \qquad (34)$$

which indicates that the hexagonal inner member may develop approximately 30 per cent of the strength of a solid circular section of a diameter equal to the outer member, as against 22 per cent for the square form of inner member. Stated in another way, the hexagonal form is 0.3048 ÷ 0.2173 = 1.4, or 40 per cent stronger than the square form for equal sizes of the outer member.

PROPERTIES OF SECTIONS

Case	Section	Polar Moment of Inertia I_p	Polar Section Modulus Z_p	Remarks
I		$I_p = \frac{\pi D^4}{32} = 0.098 D^4$	$Z_p = \frac{\pi D^3}{16} = 0.196 D^3$	
II		$I_p = \frac{b^4}{6} = 0.1667 b^4$	$Z_p = \frac{b^3}{3\sqrt{2}} = 0.236 b^3 = \frac{C^3_s}{12}$	Taking Case II as an inner member for Case V and making $b = 0.566 D$, the inner member would be the weakest and the section modulus for II is $Z_p = 0.043 D^3$
III		$I_p = = \frac{5\sqrt{3}}{8} A^4 = 1.0825 A^4$	$Z_p = \frac{5}{8}\sqrt{3} A^3 = 1.0825 A^3$ $= \frac{5\sqrt{3}}{64} C^3_h = 0.1353 C^3_h$ $= \frac{5}{24} e^3 = 0.2083 e^3$	Taking Case III as an inner member for Case VI and making $e = 0.66 D$, the section modulus for III is $Z_p = 0.06 D^3$
IV		$I_p = \frac{\pi}{32} (A^4 - D^4)$ $= 0.098 (A^4 - D^4)$	$Z_p = \frac{\pi}{16} \left(\frac{A^4 - D^4}{A}\right)$ $= 0.196 \left(\frac{A^4 - D^4}{A}\right)$	If the inner section of diameter D is to be of a torsional strength equal to the outer hollow member, make $D = 0.82 A$ or $A = 1.22 D$
V		$I_p = \frac{\pi D^4}{32} - \frac{b^4}{6}$ $= 0.098 D^4 - 0.167 b^4$	$Z_p = \frac{\pi D^3}{16} - \frac{b^4}{3D}$ $= 0.196 D^3 - 0.333 \frac{b^4}{D}$ With an inner member the largest probable safe value of b is $b = 0.566 D$, from which $C = 0.8 D$	If the inner section were to be of strength equal to the outer section it would be necessary to make $b = 0.74 D$ or $C = 1.046 D$, which is impossible, since C would be greater than D
VI		$I_p = \frac{\pi D^4}{32} - \frac{5\sqrt{3}}{8} A^4$ $= 0.098 D^4 - 1.0825 A^4$	$Z_p = \frac{\pi D^3}{16} - \frac{5\sqrt{3} A^4}{4D}$ $= 0.196 D^3 - 2.165 \frac{A^4}{D}$ With an inner member the largest probable safe value of e is $e = 0.66 D$, from which $C = 0.762 D$	If the inner section were to be of strength equal to the outer section, make $A = 0.456 D$ or $C = 0.912 D$. This leaves the material very thin at the corners.

Unit Pressure on Driving Faces—The Square Form

Considering the pressure to be distributed as indicated in Fig. 5, with the depth of the inner member equal to b, we have the unit bearing pressure on the driving faces at the corners of the square as

$$P_s = \frac{F}{b \times \frac{1}{2} b} \times 2 = \frac{4F}{b^2} \qquad (35)$$

From (18) we have $F = \frac{3T}{4b}$. (18a)

Substituting this value of F in (35) gives us:

$$P_s = \frac{4}{b^2} \times \frac{3\,T}{4\,b} = \frac{3\,T}{b^3} \qquad (36)$$

Now substituting in (36) the value of *b* as given by (23) we have:

$$P_s = 3\,T\left(\frac{5}{2\sqrt{2}\,D}\right)^3 = 16.573\,\frac{T}{D^3} \qquad (37)$$

In (24) we have the section modulus of the square member, which, multiplied by the stress *S*, gives:

$$T = 0.0427\,D^3\,S \qquad (38)$$

Substituting this value of *T* in (37) we have:

$$P_s = \frac{16.573}{D^3} \times 0.0427\,D^3\,S = 0.708\,S \qquad (39)$$

Equation (39) gives the unit bearing pressure on the corners as about 71 per cent of the torsional stress in the inner member, which is a very safe bearing value, and indicates that the inner member would fail by twisting rather than by crushing at the corners.

Unit Pressure on Driving Faces—The Hexagonal Form

Treating the hexagonal form of Fig. 6 in a similar manner, with depth of inner member equal to *e*, we have for the unit bearing pressure at the corners:

$$P_h = \frac{F_1}{e \times \frac{1}{2}\,A} \times 2 = \frac{4\,F_1}{e\,A} \qquad (40)$$

Now $e = A\sqrt{3}$, and, from (26), $F_1 = \dfrac{T}{2A}$; then:

$$P_h = \frac{4\,T}{2\,A \times A\sqrt{3}\,A} = \frac{2\sqrt{3}}{3}\;\frac{T}{A^3} \qquad (41)$$

From (31), $A = \dfrac{8}{21}D$, then:

$$P_h = T\,\frac{2\sqrt{3}}{3} \times \left(\frac{21}{8\,D}\right)^3 = 20.886\,\frac{T}{D^3} \qquad (42)$$

From Equation (33) we have, for the strength of the hexagon:

$$T = 0.0598 D^3 S \qquad (43)$$

Substituting this in (42) gives us:

$$P_h = \frac{20.886}{D^3} \times 0.0598\,D^3\,S = 1.249\,S \qquad (44)$$

Equation (44) gives the unit bearing pressure at the corners as about 25 per cent higher than the torsional stress in the inner member, which is about in the same relation as the ultimate tensile and shearing strength, so that this bearing pressure is not too high.

When both forms are developing their full respective strengths we have, from (44) and (39), the ratio

$$\frac{P_h}{P_s} = \frac{1.249}{0.708} = 1.76 \qquad (45)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 76 per cent higher than on the corners of the square; so that, if tested to destruction, we would expect the corners of the inner member and the internal faces of the outer member to be much more distorted in the case of the hexagon than in the case of the square.

When both outer members are of equal size and transmit equal torques, we have from (42) and (37) the ratio

$$\frac{P_h}{P_s} = \frac{20.886\,T}{D^3} \times \frac{D^3}{16.573\,T} = 1.26 \qquad (46)$$

or, under this condition, the unit pressure on the corners of the hexagon is about 26 per cent greater than that on the corners of the square.

Conclusions—Comparison of the Two Forms of Set-screws

1.—With the distance across corners equal and the depth of inner members equal for the two forms:

a.—The hexagonal form is torsionally 62 per cent stronger than the square. See Equation (8).

b.—Under the same conditions, and considering the total driving forces as concentrated at the extreme corners,* this force is 6 per cent higher for the square than for the hexagon, if delivering equal torques. See Equation (5).

2.—For equal torsional strength the distance across the corners of the square should be 1.175 times the similar dimension for the hexagon. See Equations (9) and (9a).

3.—It is impossible to have the inner member of torsional strength equal to the outer member, because the outer member would rupture at the corners. This impossible but desirable condition is more nearly attained with the hexagon than with the square. See Equations (16) and (17).

4.—With the depth of hole equal to the distance across the flats of the inner member:

a.—We may, for the square form, make $b = 0.566D$, or $C = 0.8D$. See Equations (23) and (23a).

b.—For the hexagonal forms we may make $e = 0.66D$ or $C = 0.762D$. See Equations (31a) and (31b).

c.—These proportions will prevent rupture at the corners when the full torsional strength is developed.

d.—When so proportioned the square member develops 22 per cent and the hexagonal member 30 per cent of the strength of a solid circular member of diameter *D*. See Equations (25) and (34).

e.—The hexagonal form is thus 40 per cent stronger than the square form for equal sizes of the outer member.

f.—The unit bearing pressure on the driving faces is 71 per cent of the unit torsional stress for the square, and 125 per cent of the unit torsional stress for the hexagon. See Equations (39) and (44).

g.—When subjected to equal torques, with equal sizes of outer member, the unit bearing pressure on the driving faces is 26 per cent higher for the hexagonal than for the square form. See Equation (46).

5.—The hexagonal form is thus shown to be superior for strength, or for equal strength to be smaller, hence more compact.

6.—The square form is superior in wearing qualities because of less unit bearing pressure on the driving faces.

7.—Hence, the proper field for the hexagonal form is for parts not requiring much adjustment, such as set-screws in collars, wheel-hubs, etc., while the field for the square form is in parts requiring frequent adjustment, such as the screws in lathe and drill chucks. Use the hexagonal form for compactness and strength; the square form for wearing qualities.

* * *

TESTING STEEL FOR AUTOMOBILE PARTS

The careful tests to which the products of the G. Derihon Co. of Liege, Belgium, are put, explain the high standard which this firm has reached in the manufacture of automobile parts subjected to high stresses and shock. Since 1904 this firm has employed the Fremont drop test, and the results obtained have been very satisfactory. At the Derihon shops a test piece is taken from every piece out of which an automobile part is forged, and this test piece is forwarded to the customer together with the part ordered and a record of the results of the test. Thus, when sending out an order of twenty-eight steering levers, the company accompanies it with a list of twenty-eight tests. This increases the cost per lever by approximately five cents, but it gives an absolute certainty that the piece will stand as much as it is expected to. This policy makes it necessary for the firm to test from ten thousand to twelve thousand pieces per month, and on account of the experience thus obtained, it is interesting to note some of the conclusions arrived at by this firm with relation to the method of making these tests. For the drop test the firm uses test specimens 10 by 8 millimeters (25/64 by 5/16 inch, approximately) with a one-millimeter nick (3/64 inch approximately). If test pieces of larger dimensions are used, they are not likely to reveal minor defects. While brittleness in steel is often a local condition, it would be none the less objectionable and dangerous in the completed machine detail. As an indication of what can be accomplished by a commercial shop testing department and by taking advantage of the knowledge obtained from the tests made, it may be mentioned that at the outset the Derihon firm had to reject, for brittleness, from 20 to 40 per cent of the pieces tested, whereas during 1911 the total number of rejected parts averaged 0.3 per cent. This result has been obtained entirely from the fact that the testing of the steel has enabled the firm to apply proper heat-treatment to its steel products. In the opinion of M. Derihon it is possible to make all steels of good quality non-brittle. The whole question is simply one of heat-treatment, different steels, of course, requiring entirely different treatment in order that satisfactory results may be obtained.

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* This is an arbitrary assumption. The writer believes the distribution of forces to be more nearly as shown in Figs. 5 and 6.

RECIPROCATING STRAIGHT-BLADE SAWING MACHINES[*]

DEVELOPMENT OF HACKSAW MACHINES, WITH SPECIAL REFERENCE TO BRITISH PRACTICE

The material presented in the following has been gathered with the idea of setting forth the merits of the straight-blade reciprocating saw for metal work, as compared with those of the band saw and the circular saw. The latter types have been developed to approximately the same degree of efficiency which has been attained in other types of machine tools, while many reciprocating saws remain in essentially the condition in which they were first placed upon the market. The author believes that the Millers Falls Co placed the first hacksawing machine upon the market. This machine is shown in Fig. 1, from which it will appear that its design is of a character hardly suitable to modern shop conditions. Fig. 2 shows the next hacksaw machine that was introduced. This is a more elaborate and heavier type than the preceding, and the old hacksaw frame has given way to a stronger design.

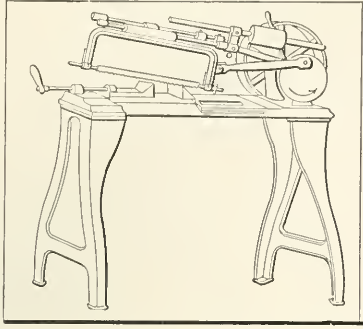
Fig. 1. The Star, the First Type of Hacksaw Machine.

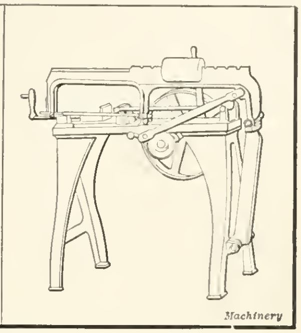
Fig. 2. The Simplex, another Early Type

Another very early pattern of hacksaw was the Eureka, shown in Fig. 3. This machine was made by G. Thompson, Son & Co. It is designed along far better lines than the preceding types, having a solid base and provision for guiding the saws. The thrust is in a direct line, and the upper guide is made to extend in such a way that it admits of a large variation in the length of blade used. The long blade, similar to a band saw, is coiled up and brought out for use as the working part becomes worn. This coil contains about twenty-five feet.

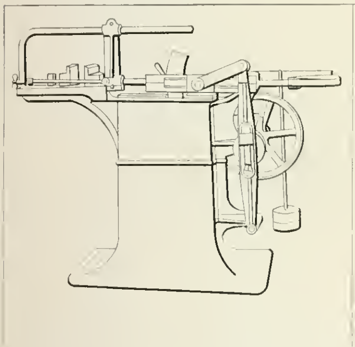
Fig. 3. The Eureka Hacksaw Machine.

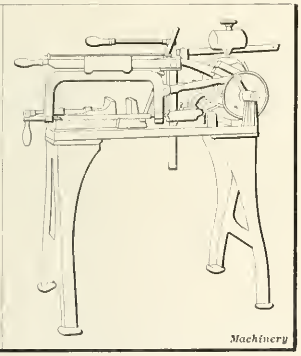
Fig. 4. The Milford Machine, an Improved Type

The Milford saw, shown in Fig. 4, is a still more carefully designed tool. It is fitted with a quick return and a clutch device for lifting the blade free of the work on the idle or return stroke. It has a gear drive of 4 to 1 and an automatic stop. In the author's opinion, these four designs are a fair illustration of the progress of the original type of hacksawing machine up to a recent date.

Messrs. Herberts of Manchester, England, were the first firm who seriously took up the matter of improving the design of hacksaw machines. The object was to make a stronger machine which would be capable of working more rapidly and of taking larger sections. They have made saws of a capacity hitherto commercially unknown, the largest being capable of taking 18 by 30 inches. Among other improvements they introduced an automatic feed for the work, and an eccentric motion was given to the fulcrum of the saw frame, as shown in Fig. 5. This made it possible for the fulcrum of the saw frame to be moved around slightly at intervals of 20 strokes, thus putting the saw at a different angle to the work. In this way it was working on a comparatively small surface at all times and was thus capable of handling larger sections. Such saws were capable of cutting a 4-inch bar in twenty minutes, as compared with an hour taken by the earlier types of machines. The only disadvantage of this method lay in the strain placed upon the saw blade after each move of the eccentric. The author believes that his firm was the first to use a stronger and better blade, and they were aided in this by the Sterling Co., who used tungsten steel.

Messrs. Holroyd & Co., of Milnrow, England, also introduced an excellent machine for rapid work with the same object in view that Messrs. Herberts had. In the Holroyd machine the bar was slightly turned around at intervals of several strokes instead of altering the angle of the saw. The advantage of this system lay in the fact that as the bar was continually turning around, it was difficult for the saw to run out, and the work would be approximately as true as that produced in a cutting-off lathe.

Advantages of Hacksaw Machines

The advantages of hacksaw machines as compared with other types are briefly as follows: First, the cost of the machine and blades, is comparatively low and the blades can be brought to any temper to suit the work. Second, a hacksaw will cut to any depth that the frame which holds it will permit; extra depth does not necessitate extra cost of blades as in the case of the circular saw, where the bosses limit the depth of cut to approximately 1/3 the diameter of the saw. It may also be mentioned in this connection that a circular saw is necessarily fairly thick and exceedingly difficult to get quite hard. Circular saws are also liable to break if hardened beyond certain limits. Third, in the case of band saws it is frequently necessary to cut the blade in order to thread it through the work, and, like the circular saws, it is almost impossible to get them quite hard. Fourth, another advantage of the straight blade over the circular saw or lathe cutting-off machine lies in the narrowness of the cut, say 1/16 inch instead of ¼ inch.

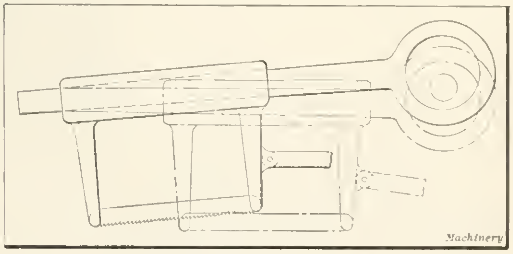
Fig. 5. Eccentric for tilting the Saw

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[*] Abstract of a paper by Mr. Charles Wicksteed read before the Belfast meeting of the Institution of Mechanical Engineers, July, 1912.

This difference in the width of cut makes a great saving possible when working on such expensive materials as high-speed steel. Fifth, the power taken by a hacksaw is about one-fourth of that taken by a circular saw.

When once convinced that the straight-blade sawing machines had as great advantages as their competitors, it did not take long to discover the principles on which the blades must be made and operated. These may be briefly outlined as follows: First, the blade must be kept absolutely firm and perfectly square with the work. Second, it must be strong enough to stand all the weight that the teeth will take without breaking. Third, the blade must be made of the highest possible quality of steel with the best cutting edge that is practicable. Fourth, the machine must be well designed and work without spring or vibration. Fifth, since the pressure on the blade must be considerable, a reliable release on the return stroke must be provided. However, the results of experiments by the author have shown that unless the weight was heavy it made little difference whether the blade was released on the return stroke or not, but where a heavy weight is used, the blade will be quickly destroyed unless this precaution is observed.

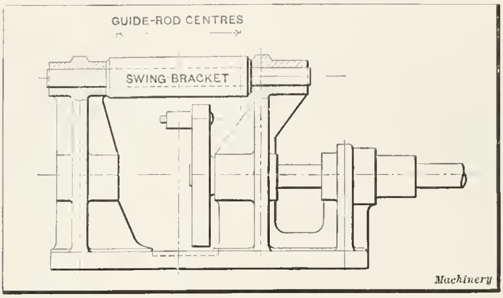


Fig. 6. Arrangement of Bearings for Guide Frame, viewed from the Back

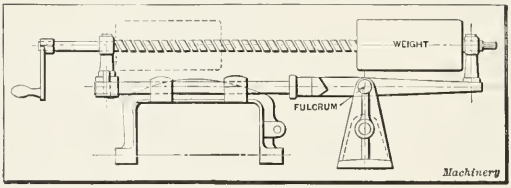


Fig. 7. Method of adjusting Position of Weight

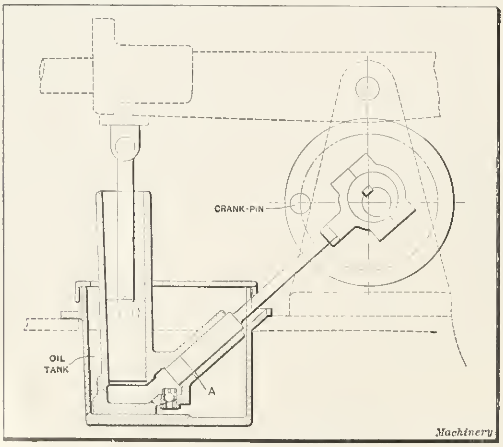


Fig. 8. Pump and Ram used to lift and lower the Saw at End of Stroke

Taking the points just mentioned into consideration, it will be evident that the blades have not been developed to this high standard without the expenditure of a great deal of effort on the part of the manufacturers. These improvements may be briefly outlined as follows: First, for ordinary work, a coarse pitch tooth, not less than 10 to the inch, has been found most suitable. Such teeth cut better, clear themselves better, and give a better opportunity for side clearance which is especially necessary in the deep blades used on heavy machines. Second, to make the teeth strong enough to take all the weight that they will stand, it is not necessary to do any special tempering. If the teeth are properly hardened, the back of the blades will also be of the proper hardness. Third, additional strength must be obtained by increasing the depth and not the thickness of the blade. An increase in thickness means a corresponding increase in the amount of power required to drive the machine. Theoretically, the thinner the blade can be made the better. This is limited, however, by difficulty experienced in hardening deep thin blades in such a way that they are absolutely straight. Deep blades are also more difficult to work and still keep the proper clearance. The blades used by the author vary from ¾ inch to 2 inches in depth and from No. 19 to No. 16 wire-gage in thickness. Fourth, the greatest weight that a tooth will take without injury must be ascertained and the blades then made strong enough to carry it. A weight of 210 pounds is about right for a 6-inch machine, and enables the machine to use practically the full capacity of the blade up to a 4-inch round bar. As the machines become larger, the proportion of weight is increased. Thus a 15-inch machine requires 700 pounds on the saw to get the full capacity of the blade when working on a 10-inch surface.

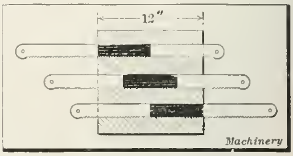


Fig. 9. Diagram showing how Saw is freed of Swarth

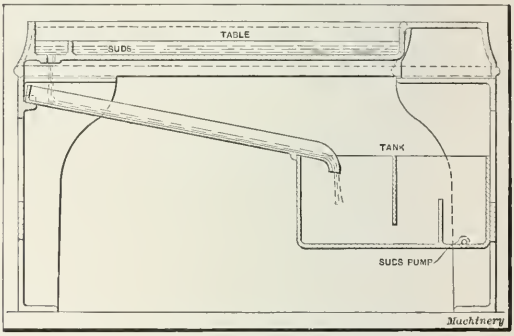


Fig. 10. Arrangement of Tank and Pump Connections

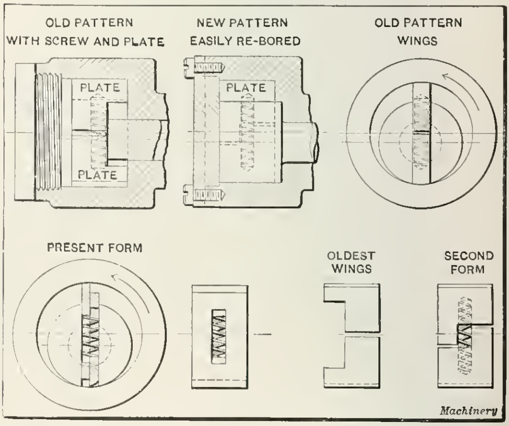


Fig. 11. The Type of Lubrication Pump used

Design of Machines

After having said this much about blades, it is hardly necessary to point out that corresponding improvements were required in the machines that drive them.

One of the greatest faults in early types of hacksaws is found in the fact that the guide frame was almost universally pivoted on the crankshaft. Narrow bearings were usually employed, thus giving some play to begin with, which was constantly increased by wear. Hence the design lacked the first essential of a good machine. The loose guide allowed the saw to run out, to produce bad work, and to break the blades. To avoid these fundamental defects, the author applied a guide frame which is pivoted on independent bearings of the type shown in Fig. 6. These bearings have no other work to do than to guide the frame, and there is practically no wear. The machine is of rigid construction and the bed is of sufficient width to provide a bearing for the bar on both sides of the saw. The guide bars are placed far apart and all bearings are of ample proportions and bronze-bushed. The weights have been correspondingly increased so that a 6-inch machine weighs 550 pounds and a 15-inch machine 2500 pounds. Such weights are necessary to make the machine perfectly firm and free from vibration.

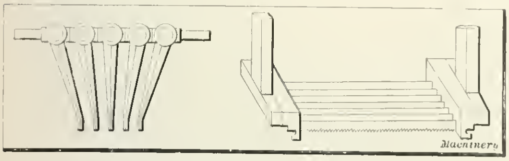


Fig. 12. Two Styles of Saw Racks used on Multiple Machines

The additional weight used on the blade made it necessary to adopt a convenient method of varying it according to the requirements of the work. This is done by means of a sliding weight on a bar which runs from the extreme end of the frame to a point well behind the fulcrum of the spring bracket. In the heavy machines this weight is adjusted by a quick pitch screw, the arrangement being shown in Fig. 7. Having such a heavy weight to deal with, it was next necessary to provide means to protect the machine from breakage in case the blade should break. A reliable release was also required on the return stroke of the blade. The latter is a difficult thing to provide for by purely mechanical means, as the plane of the saw varies at every stroke; but experiments have shown that it is essential for the saw to be lifted off the work at the end of the cutting stroke and put down again accurately at the end of the return stroke. If this is not done the output will either be seriously interfered with or the blade will be injured.

Fig. 8 shows the device by which the release of the saw is obtained. It will be seen that an eccentric set in time with the crank-pin on the crankshaft works a plunger in connection with the dash-pot. This plunger comes down and closes the port *A* at exactly the end of the stroke, thus gently lifting the frame sufficiently off the work during the return stroke and letting it down again as soon as the working stroke begins. There are no complications and no wear in this device, as both pistons are simply made a good fit and worked in oil. A foot-valve is provided to let the oil in when the frame is lifted by hand.

Later modifications of this device have been made to make it useful for other purposes. The port is made small enough to convert the larger cylinder into a dash-pot, thus making it impossible for the frame to fall, as it can only be lowered as fast as the oil is pressed through the small port *A*. This port is about 1/32 inch in diameter in the case of the small machines.

The stroke of the author's machine is from 5 to 8 inches. The longer stroke adopted in the larger machines was not found necessary to get rid of the swarth, but simply because it was found advisable to reduce the strokes as the length of the frames was increased. The question of the relative length of the blade to the stroke and the diameter of the bar is interesting. A long stroke should be avoided, as it entails a correspondingly long blade as well as a more cumbersome machine. If there is no lift on the return stroke, the stroke must be made as long as the section being cut, to get rid of the swarth.

Fig. 9 shows a 12-inch section being cut with a machine operating on a 6-inch stroke. In this diagram the middle part of the blade is shown black. This section has no opportunity of getting rid of its swarth, and will therefore, if not lifted, take the greatest part of it backward and forward. With sufficient lift on the return stroke, however, the swarth is dropped and raked 6 inches forward on the cutting stroke. Consequently it is only necessary to make the teeth deep and large enough to hold the swarth gathered during two strokes.

The lubricant used for saw blades is soap-suds, and great attention has been paid to the pump and tank used for lubricating purposes. The fact that the swarth made by the saws is exceedingly fine, and that it is much more difficult to operate a pump properly with suds than with oil, necessitated a careful provision to keep the swarth away from the pump. Fig. 10 shows the arrangement of the tank and connection, where it will be seen that the suds are first collected by a recess in the bed and then drained at the front end, which is farthest away from the point where the swarth is dropped. The suds then run through a trough to a tank at the back end of the machine. This tank is divided by two weirs, the lubricant going under the first weir and over the second. In this way any light swarth floating on the surface of the fluid is stopped.

Type of Pump Used

Wing pumps were decided upon as most satisfactory for this service, but the best type available was of such construction that it would not wear well. The simple type of pump shown in Fig. 11 was finally adopted. In this type a by-pass is provided, not with a separate valve, but simply by making the wings of the pump taper against the pressure, so that when a full discharge is not required the increased pressure of the suds presses the wings inward. The cover is fastened by screws instead of being secured by a thread in the end of the cylinder, this design making it easy to rebore when necessary. The wings are provided with two small slots of such a length that one spring put in the middle will press up the wings on each side. This is an improvement over the old method where the wings met in the middle, thus leaving very little bearing surface. The gradual wearing of this bearing caused friction which led to the destruction of the pump.

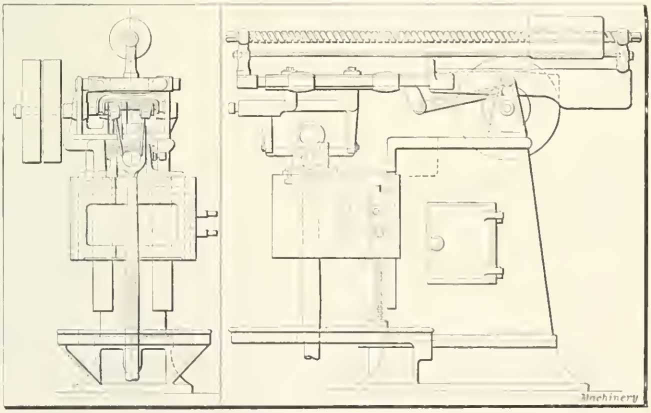


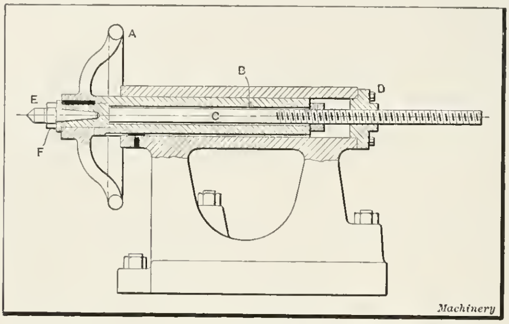
Fig. 13. The Shaping Machine Saw

The result of these improvements is that sawing can be done practically true, say to 0.010 inch in cutting a 6-inch bar, and mild steel can be cut at a speed of approximately 1 to 2 inches per minute. The breakage of the blades is also rare. In conclusion, the author states that his purpose in presenting this review is merely to trace the development of a most useful tool, so far as it has gone. He is of the opinion that nothing like perfection has yet been approached, and believes that in rapidity of work, endurance of blades, and in the size of machines, the reciprocating straight-blade sawing machine has many advantages sufficient to warrant making its improvement a matter of careful study.

IMPROVED LARGE LATHE TAILSTOCK

A new form of tailstock for large lathes designed to facilitate adjustment when centering heavy and awkward parts, was recently illustrated in the *Practical Engineer*. The common position of the handwheel on the outer end of the tail spindle is so far from the center point on large lathes that the machinist can reach it with difficulty when watching the center enter the work. On very large forge lathes the adjusting handwheel is sometimes placed on the side of the tailstock, near the inner end of the spindle and is connected to the screw by a shaft and bevel and spur gears to overcome the difficulty. This construction is objectionable, of course, for medium size lathes on the score of cost.

In the new design the handwheel *A* is placed on the inner end of the tailstock where it is mounted on the screw *C*. The center *E* is set in the end of the screw, the screw being made with an enlarged end for the socket. The screw is supported by the quill *B* and is threaded in the nut *D*. A nut *F* is provided on the center for ejecting it as the construction does not permit the self-discharging principle of the common form of tailstock to be used.



Tailstock for Heavy Lathes having Handwheel on Inner End

The contributor of the design points out that it is not well adapted to small lathes because of the interference of the handwheel with the compound rest. By giving the handwheel considerable dish, however, and overhanging the nose of the tailstock this defect might be overcome. The projection of the screw is another objectionable feature which might be avoided by slightly changing the design so that the parts would telescope, the nut being made in the form of a tube with the thread at the end. This construction would necessarily make the quill somewhat larger relatively than shown in the illustration, but would materially reduce the overall length and improve the appearance.

An objection to the design not mentioned by the contributor, of little importance, perhaps on heavy lathes, but of some weight in the design of small lathes, and especially toolroom lathes, is that the tail center is mounted in a revolving part and cannot, therefore, be considered a dead center. Eccentricity of the center point would cause trouble by throwing the centers out of line.

* * *

FATIGUE STRESSES IN MACHINE STEEL

In a paper on "Endurance Tests of Machine Steel," presented before the International Association for Testing Materials, New York, September, 1912, Mr. J. O. Roos of Hjelmsäter calls attention to the so-called "fatigue ruptures" which occur in parts which are subjected to continually repeated shocks or stresses of small magnitude. Machine parts which are subjected to continual stresses in varying directions, or to repeated shocks even though of comparatively small magnitude, can hardly be satisfactorily designed (nor can the material be chosen) from a mere knowledge of the behavior of the material under a steady stress, such as imposed upon it by ordinary tensile stress testing machines. From the numerous cases of machine parts broken under actual working conditions, and which Mr. Roos had had occasion to examine in the course of his work, the most tangible and positive result obtained was that at least 80 per cent of these ruptures had been caused by fatigue stresses, the surface of the fracture showing the characteristic crack for this kind of a break. Among the pieces of this kind examined were railway car axles, parts of steam engines, and parts from motor cars and trucks. Most fatigue ruptures in practice are caused by bending stresses, and very frequently by a revolving bending stress. Hence, to test materials for this class of stress, the tests should be made to stress the material in a manner similar to that in which it will be stressed while under actual working conditions. This can be accomplished by subjecting a projecting test piece held at one end to a load at the other end, and revolving the test piece while subjected to the load. A machine for carrying out tests of this kind has been developed in the United States by Mr. Henry Souther of Hartford, Conn.

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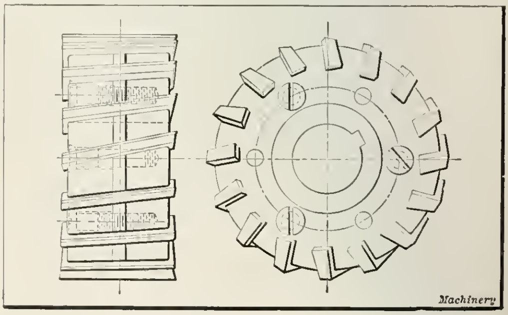
THE NITROGEN INDUSTRY IN NORWAY

One of the interesting features of the eighth international congress of applied chemistry, held in New York during the early part of September, was a lecture delivered by Dr. Samuel Eyde of Christiania, Norway, in which he described the development of the nitrogen plants that have recently been built in Norway, and in the development of which he has played a leading part. Lantern slides were shown of four great nitrogen plants under Dr. Eyde's control, having a total capacity of 200,000 horsepower and producing yearly 80,000 tons of nitrate of lime for fertilizing purposes, 10,000 tons of nitrate of ammonia for use in explosives, and 10,000 tons of nitrate of soda for use in coloring industries. It is very interesting to note how a country so poor in regard to natural resources as is Norway, except for the enormous power represented by the water falls, has in this way been able to develop an industry requiring practically no other raw materials than air and water. It has been predicted that chemical industries in which electricity plays an important part will, in the future, be largely concentrated in the Scandinavian countries because of their available water power, and hence their cheap supply of electric energy. As Norway, especially, is a country which is not suited for agriculture, the development of these industries is a highly important factor in its prosperity.

* * *

NEW TYPE OF INSERTED-BLADE MILLING CUTTER

The accompanying illustration shows a new development in inserted-blade milling cutters, patented by the Sächsischen Maschinenfabrik in Chemnitz, Germany. The body of this inserted-blade cutter consists of two disk-shaped parts, held together by screws and dowel pins, as indicated in the accompanying illustration. The slots are milled in the two parts at the same time, the disks being held a suitable distance apart. The blades are then inserted and the two parts clamped together by the screws shown. This clamping, of course, binds or wedges the blades firmly in place, as the two disks are brought up against each other. The dowel pins prevent the body parts from rotating with relation to each other.



New Type of Inserted-blade Milling Cutter, of German Design

SCIENTIFICALLY MANAGED PRESS WORK

WORCESTER PRESSED STEEL CO.'S METHOD OF ROUTING MULTIPLE-OPERATION JOBS

BY CHESTER L. LUCAS

To start sheets of heavy steel at a blanking and drawing press at one end of a row of presses and keep the semi-completed shells moving down the entire line of drawing presses, passing the work from operator to operator, until it emerges after the thirteenth operation a completed steel bowl, is a feat of modern press work of which the Worcester Pressed Steel Co., Worcester, Mass., may well be proud. Fig. 1 shows the line of presses used on this work, and Fig. 2 represents a section of the connected presses, showing how the work is passed from press to press.

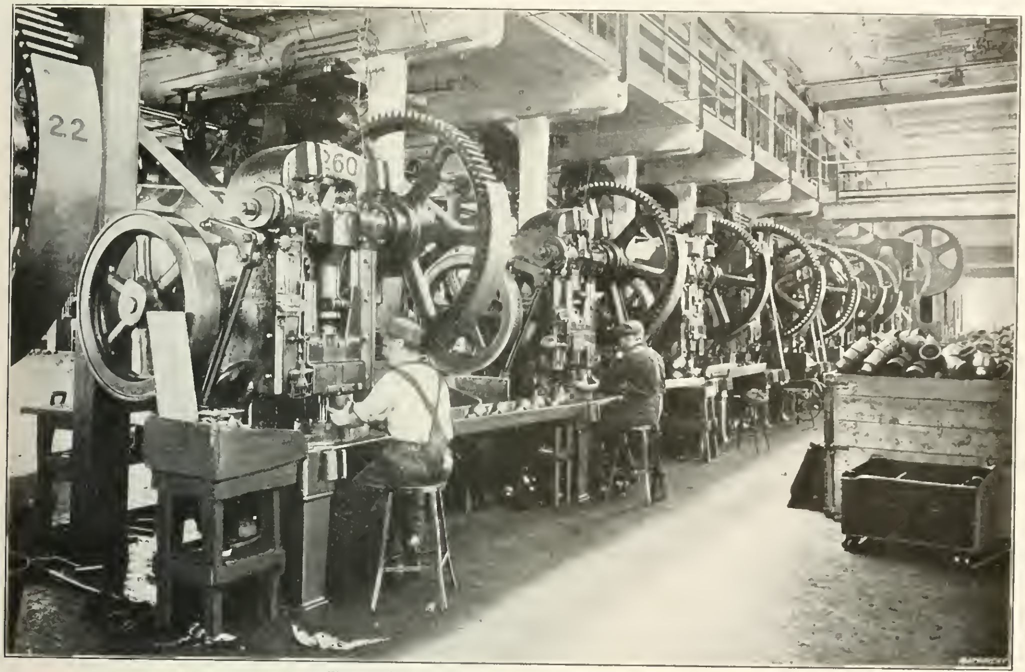


Fig. 1. The Presses used in Producing the Steel Bowls

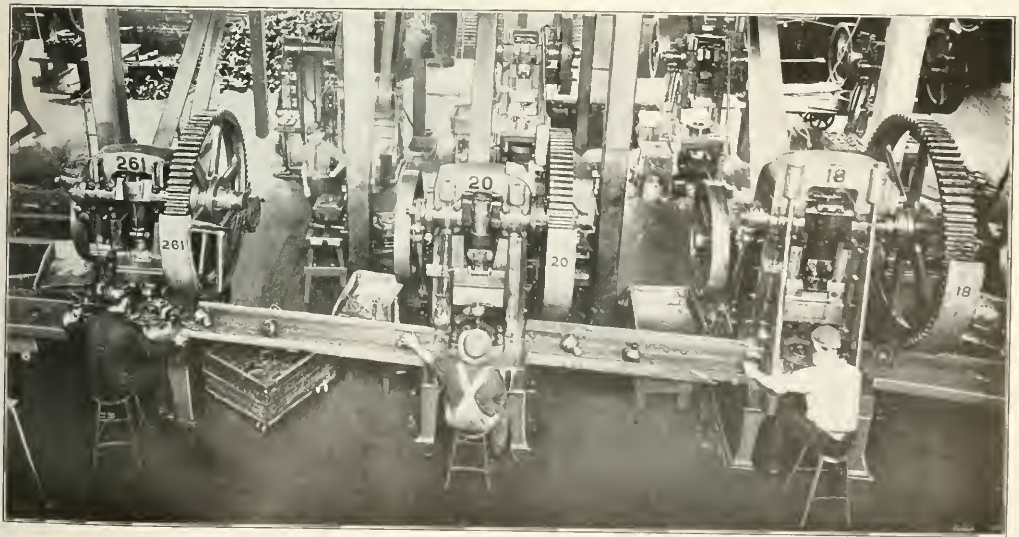


Fig. 2. A Section of the Row, showing Method of Handling the Work

The pressed steel bowl referred to is one which is used in large quantities on a special class of machinery. The completed bowl is approximately as shown in the line engraving, Fig. 3, being five inches in diameter. The fact that the stamping is made from heavy sheet steel, 0.150 inch thick, is the point which makes the production of this piece the more remarkable. The successive steps in drawing the shell

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* Associate Editor of MACHINERY.

are clearly indicated in the group illustration, Fig. 4, which shows the results of the work performed in each of the thirteen operations. By comparing the work with the two-foot rule shown in the foreground, a good idea of the dimensions of the pieces can be obtained.

The first operation, namely, that of cutting and drawing the blank, is performed on a large double-action power press, and after leaving this press the shells go to a large single-action press. Another reduction follows which leaves the blank deeper, but smaller in diameter. After this stage the shells are annealed and taken to the first press in the foreground of the illustration Fig. 1. From this point the shells continue down the line of presses, being passed from operator to operator by means of chutes along which the work is thrown. The method of routing the work is more clearly illustrated in Fig. 2. Before the shells are completed another annealing operation becomes necessary, because the final operations, which are for the purpose of setting the metal at the tip end of the shell, require that the stock be as soft as possible. Owing to their location it was impossible to clearly show two of the presses used for final punching and setting operations, but Figs. 1 and 2 adequately illustrate the principle of handling this job.

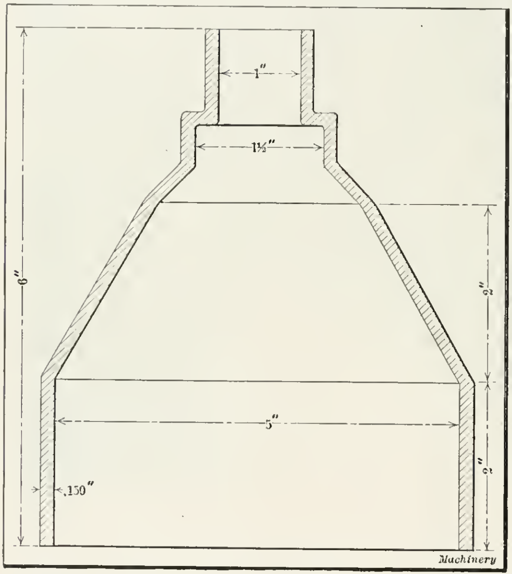

Fig. 3. Details of Steel Bowl

These shells are made in lots of from 5000 to 10,000, and after the presses are set up and the blanks started, the completed shells are turned out at the rate of 400 per hour. It is obvious that this method of handling press-work pushes the work off the floor and out of the way quickly. Piles of half completed work do not accumulate, and once started, there is a steady stream of completed shells traveling to the shipping room until the last shell has gone "down the line."

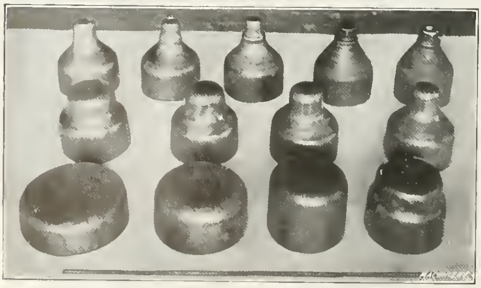

Fig. 4. Successive Steps in the Press-work

In Fig. 5 may be seen a large Toledo double-action drawing press, a machine which handles drawing and forming operations on large work like brake drums, axle housings, cases, shells, etc. This press is one of the largest of its type ever built in this country and has a capacity for exerting a 1000-ton pressure. The area of the bed is 60 inches square; the stroke of the plunger is 26 inches; stroke of the blank-holder is 18 inches. The crankshaft of this press is 12 inches in diameter, and the construction of the toggle mechanism is such that a long dwell under heavy pressure is given to the blank-holder. The advantage of this feature is that it provides means for drawing sheet metals with a minimum of trouble from wrinkling. The press frame is of the built-up type, rigidly bound together with forged steel tie-rods 6-inch diameter which have been shrunk into place. The power for operating is furnished by a 75-horsepower motor.

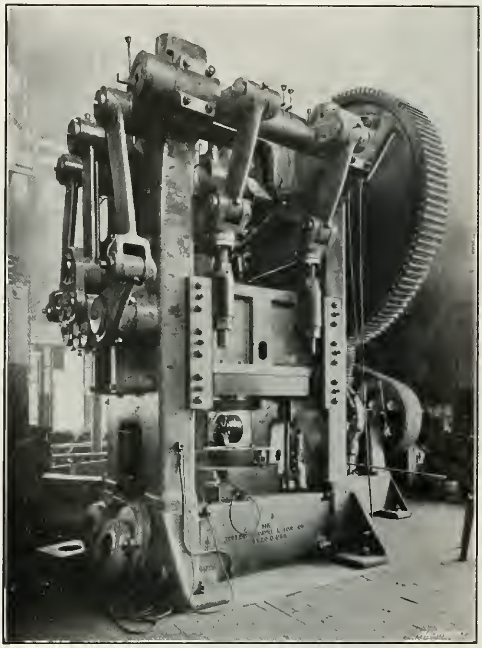

Fig. 5. The Large Toggle Drawing Press

The premium system of piece work is employed on all operations in the factory, and it works out with great success. One of the chief reasons for its success, and one which other factories will do well to note is manifested in the presence of large signs on the bulletin-boards, a facsimile of which is shown in Fig. 6, which assures the men that piecework prices once established will not be reduced for at least a year's time.

NO PIECE WORK RATE WILL BE CUT
AFTER ONCE ESTABLISHED FOR A CERTAIN
PIECE, PRESS AND CONDITION
FOR ONE YEAR
EARN ALL YOU POSSIBLY CAN
YOU WILL BE SHOWN HOW AND HELPED TO
DOUBLE YOUR WAGES.

Fig. 6. A Factor in the Success of the Premium System

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INDEX TO MACHINERY

The eighteenth volume of MACHINERY was completed with the August number, and the general index covering the engineering, shop and railway editions is ready for distribution. Copies will be sent to any address on request.

PREVENTION OF ELECTRICAL ACCIDENTS IN MACHINE SHOPS

In an article in the *Engineering Magazine*, Mr. Emmett Campbell Hall deals with the question of electrical accidents and mentions some of the precautions that ought to be taken in order to avoid them.

Considering the extensive use made of electricity both for lighting and power in almost all modern industrial establishments, the general lack of knowledge concerning its dangers, and the not infrequent helplessness and panic which is manifested when someone receives an accidental shock, is somewhat surprising. Most electrical accidents are due to ignorance or carelessness, and not infrequently an ill-advised attempt at rescue results in a second accident. Scarcely less important than a knowledge of how to avoid a shock, is information as to what should be done if such accidents do occur, as they sometimes will through unavoidable causes, even when the greatest care is exercised.

The human body is an electric conductor, although not so good a one as a wire or a metal rail, and current will flow through the body when it is made part of a circuit. The amount of current which will flow through the body depends upon the voltage or pressure of the current, and upon the completeness of the contact between the body and the circuit. A single-cell battery, giving one to two volts, can cause a current to flow through the body, but the current is too small to be felt. A shock, though not a violent one, will be received from a 110-volt circuit; currents of greater strength must be carefully guarded against.

If a perfect insulator could be found, a man might stand upon it and place his hand upon a trolley wire through which a 500-volt current was passing, and receive no shock, because the circuit through the body would not be complete, and no current could flow. If a man should stand on damp earth and handle a charged wire with gloves slightly damp from sweat, he would probably receive a severe shock; if he wore no gloves, the shock would knock him down, and possibly kill him. There is no such thing as a perfect insulator, though for practical purposes a number of things may be so considered. The most that can be done is to insulate the body to such a degree that the current which passes through it will be so small that no shock will be felt. In other words, a small percentage of the total force of the current is almost sure to pass through the body, no matter what form of body insulation is used. It is therefore obvious that the amount of current which will get through the insulation increases as the voltage that is handled increases. It is not difficult to guard against shock from a 110-volt current, comparatively little insulation being effective. It is much more difficult to protect the body from 250 volts, and circuits of 500 volts or more should be carefully approached, no matter what form of insulation is used.

Next to contact with live wires, the most likely cause of shock is contact with parts of machines or equipment that are not supposed or intended to carry current, but which are accidentally charged with electricity. This charging is caused by the failure of insulation, or by a live wire coming in contact with the equipment. The frame of a motor or cutting machine, or the iron casing of an enclosed switch, may become alive and will be as dangerous as a trolley wire.

The frame of an electric locomotive is usually so completely in contact with the track rail that a man cannot get a shock even by standing on the rail and touching the locomotive; but this, under one peculiar condition, may not be true. If the rails have been heavily sanded, the locomotive may be almost completely insulated from them, and in that case a shock may be received from the locomotive frame or from the draw-bars of the cars coupled to the locomotive.

It is impossible to tell whether conditions are safe unless the man concerned has made them so himself—no one can tell by looking at a motor, for instance, whether or not the parts that carry current have come in contact with the frame of the machine. Whenever possible, common sense should dictate that the current be cut off before anything is touched that *might possibly* be charged. If it is impossible to cut off the current, or if repairs must be made to live apparatus, the only way to be safe is to provide something suitable to stand on while doing the work. *Dryness* is the most desirable quality in such an article. Perfectly dry boards, free from nails, are good.

Rubber gloves, or leather gloves in good condition and without metallic fastenings, will protect the body from shock. If the rubber covering of gloves is worn thin, the gloves give almost no protection, and the same is true of leather gloves which from any cause are damp. Rubber boots without nails in the soles or heels are good protection when new, but if the soles are worn or cracked their value is doubtful. Rubber tape on the handles of pliers and other tools cannot be depended on unless the tape has been freshly and carefully applied. If a man has to make some adjustment, he should use but one hand, if possible, and he should also try to place his body in such an attitude that the involuntary recoil from a possible shock will remove his hands from the apparatus instead of causing him to grasp it.

When a man has received a shock which renders him senseless, two things should be done as soon as possible; remove the victim from contact with the electric wire, and revive him by getting him to breathe. Great care should be exercised by the rescuer not to get a shock himself. If a switch is at hand, the current should, of course, be cut off, but if there will be any delay in cutting off the current, remove the body from the circuit by means of a piece of dry wood, using it to push the body aside or to lift from the body whatever is carrying current to it. Tools with *dry* wooden handles, such as picks or shovels, may be used for this purpose. The body can be safely grasped with the hands, if the hands are protected with several thicknesses of *dry* cloth, or if the rescuer stands upon a piece of *dry* wood. Take hold by the victim's clothing only, if practicable, not of the body where bare. If nothing else can be done, it may be possible to short-circuit the current, and thus blow the circuit breakers or fuses. A short circuit may be made by placing a piece of pipe or other metal article so that it will connect the two sides of the circuit. For instance, if the victim is in contact with a trolley wire, the wire, chain, or what not, should be thrown across the trolley wire and the track rail, so as to be in contact with both. In doing this, one must, of course, be sure that the pipe or chain leaves his own hand before it touches the current-carrying part of the circuit.

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WAGES IN VARIOUS COUNTRIES

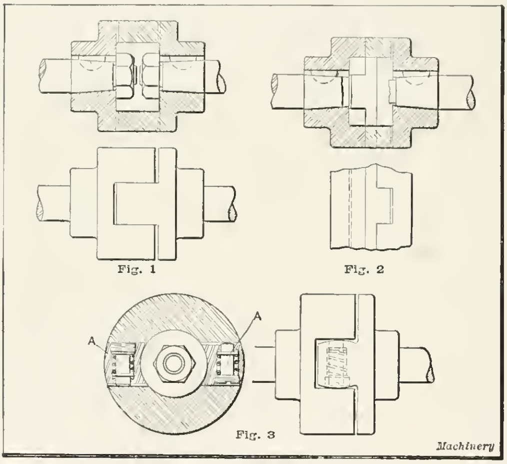
From the results of thorough investigations undertaken by the Board of Trade, England, relating to the wages paid to workmen in England, Germany, France, Belgium and the United States, some interesting data on the comparative wages in these countries may be obtained. These data present a fair average, as not less than ninety-four industrial centers in Great Britain, thirty-three in Germany, thirty in France, fifteen in Belgium and twenty-eight in the United States furnish the basis for the comparison. As a general average it may be stated that the wages of American workmen are 50 per cent higher than those of English workmen. In the European countries wages are highest in England and lowest in Belgium. English workmen are, in general, paid 25 per cent more than German workmen, and 36 per cent more than workmen in France. Relating to wages in the metal industries, the following figures will be of interest: Lathe hands are paid in London $9.50 per week of fifty-four hours; in Berlin, from $9.10 to $9.45 per week of from fifty-seven to sixty hours; in Sheffield, $9.25; in Düsseldorf, from $8.00 to $8.75; and in Antwerp, $5.85, for sixty hours a week. Of European countries England shows not only the highest wages paid but also the shortest working hours. Belgium with the lowest wages has also the longest working hours. The investigation also covers the cost of living in the different countries. Thus, for example, rents for similar accommodations are nearly twice as high in England as in Belgium, and about twice as high in the United States as in England. The average prices of food products as compared with the English prices are 17 per cent higher in Germany; 18 per cent higher in France; 1 per cent lower in Belgium; and 28 per cent higher in the United States.

AUTOMOBILE MAGNETO COUPLINGS

BY GEORGE E. POPE*

Recently a magneto coupling was to be designed which was to combine simplicity with full freedom of universal-joint action. Several designs were tried, the results obtained being recorded in the following.

The first coupling designed was made as shown in Fig. 1, with the exception that the tongue was made about 0.010 inch smaller than the slot. This design, of course, had a universal-joint action, but the noise was very objectionable. This noise was partly due to the great difference in power transmitted while the armature of the magneto traveled by a gap as compared with that transmitted when it passed a pole. The objectionable noise was eliminated by making the tongue a sliding fit in the groove, as shown in Fig. 1, but this construction necessitated an accurate alignment of the magneto shaft with the driving shaft, and defeated the object of a universal-joint action. Another design, as shown in Fig. 2, was then tried. This is simply an adaptation of what is commonly known as "Oldham's" coupling. This worked very satisfactorily and the only objection was that there was considerable milling work to be done on the intermediate piece.



Figs. 1 to 3. Different Types of Couplings Designed

The next step in the development was to make the tongue of the coupling shown in Fig. 1 with rounded sides, as indicated in Fig. 3. This arrangement gave a satisfactory universal-joint action, especially when the tongue was made 0.010 inch smaller than the groove and the spring pins *A* were added to keep the driving surfaces in contact. In this coupling, however, it is necessary that the tongues be milled properly; and the first operation in doing this work consists of merely milling a slot through the end as if the grooved part of the coupling was about to be made. The permissible maximum width of this groove or slot is readily determined, as indicated in Fig. 5. This slot serves a double purpose; *i. e.*, it relieves the form cutter of most of the work, and it provides a means for preventing the work from turning when milling the upper side of the rounded portion of the tongue, as shown in Fig. 6, where the cylindrical piece *B* enters into the groove milled while one side of the tongue is formed.

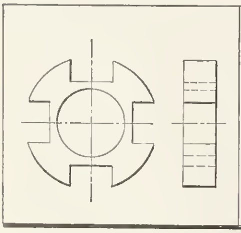


Fig. 4 Alternative Design of Connecting Part in Fig. 2

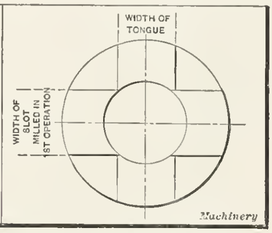


Fig. 5. Illustration of Method of finding Width of Tongue in Fig. 3

The fixture shown in Fig. 6 is, perhaps, of special interest, on account of its quick action in bringing the set-screws *C* into position. The piece carrying the set-screws is a section of cold-rolled steel placed between the uprights *A*, which take the backward thrust of the screws. These pieces are hinged freely at both ends on pins, the ends of which are milled off, as shown. These ends are in contact with flat springs which hold the parts *D* in an upright position with the screws vertical while the work (of which there can be six or ten pieces in the same fixture) is being removed or inserted.

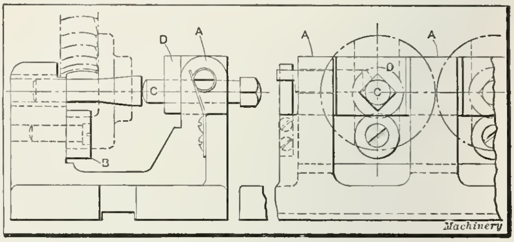


Fig. 6. Milling Fixture used for Milling Tongue in Coupling in Fig. 3

A slightly different design for a coupling of the type shown in Fig. 2 is to have the intermediate piece contain the slots, instead of the tongues. The intermediate piece will then look as indicated in Fig. 4. These pieces can then be milled in gangs on an arbor, but the other parts of the coupling become more difficult to mill, as both of them now have tongues, and it is doubtful if anything is saved by this design.

It may be remarked that although these different designs of couplings were made primarily for automobile magnetos, they probably can be applied to other kinds of work where it is inadvisable or impracticable to accurately align the connecting shafts.

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* Address: 586 Warren St., Bridgeport, Conn.

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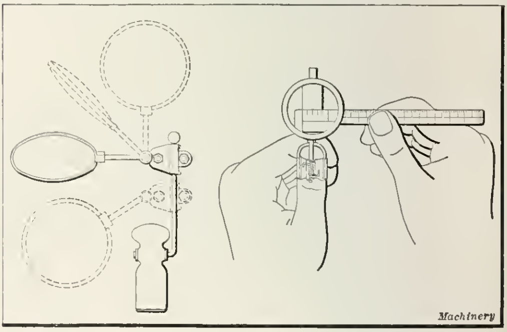
HANDY MAGNIFYING GLASS FOR SHOP USE

The accompanying illustration shows a useful device recently placed on the market by Messrs. Pfeil & Co., Clerkenwell, London, E. C. This device, as illustrated in the *Mechanical World*, consists of a magnifying glass mounted on a special clip which can be clasped onto the left-hand thumb, and is known as the "third hand." The object of the device is to enable an article to be held, examined and turned under the lens, and yet leave the other hand free for holding the measuring instrument. The clip can be clasped on any finger so that small articles can be examined on the palm of one hand and moved and turned around by the other. The illustration to the right suggests one of the uses of the device. As shown by the dotted lines in the illustration to the left, the magnifying glass is universally jointed to the holder so that it can be set in almost any position.



Handy Magnifying Glass that can be attached to the Thumb, leaving Both Hands Free to handle Work and Measuring Instrument

COMMERCIAL GRINDING*

A FEW PRACTICAL EXAMPLES FROM ACTUAL WORK

BY F. B. JACOBS†

Where is the machinist of twenty or more years' experience who cannot recall the time when small and medium-sized shafts, spindles, etc., were always carefully turned from Bessemer steel and finished by filing? In those days, the few grinding machines that existed were generally of the universal type, and were confined to the tool-room, being used only on work that had to be corrected after hardening. While it can not be denied that the shop practice of the "good old days" resulted in excellent mechanics, it is also quite evident that the concern that still employs the old methods finds itself seriously handicapped in meeting prices set by modern practice. In the finishing of accurate machine parts, the grinding machine has replaced the lathe, and the grinding wheel has taken the place of father's file.

The present-day grinding machine owes the greater part of its success to the modern grinding wheel; for no matter how carefully the machine is designed and constructed, its output is always seriously handicapped if wheels of the wrong materials, grits, grades and bonds are used. The following illustrations and descriptions are not intended to show what could be done under ideal conditions; on the other hand they are taken from actual work as the writer found it in various shops under everyday working conditions.

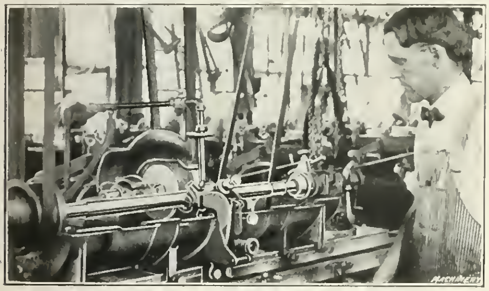


Fig. 1. Finishing Steel Shafts in a Brown & Sharpe Universal Grinder

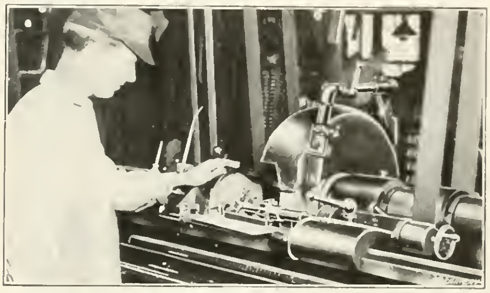


Fig. 2. Grinding Bevel Gear Hub with a Wide-faced Wheel

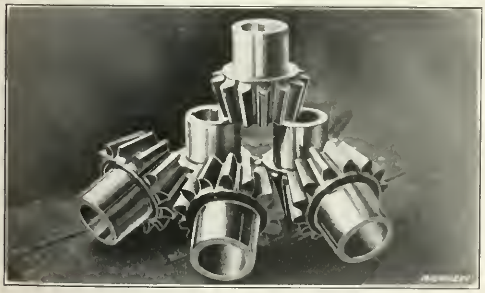


Fig. 3. Group of Bevel Gears being ground in Fig. 2

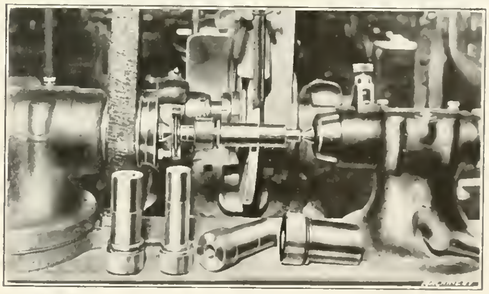


Fig. 4. Grinding Jig Bushings

In Fig. 1 is shown the operation of finishing a 40-point carbon steel shaft in a Brown & Sharpe No. 3 universal grinder, equipped with a carborundum wheel 365 grit, L grade, B3 plus bond. This piece is 2 feet 10½ inches long, and 1⅝ inch in diameter. It is first rough-turned, leaving 0.015 inch for grinding. As the illustration shows, the work is supported by a compound back-rest, this being necessary to overcome chattering under heavy cuts. While removing the greater amount of the stock the back-rest jaws are used "solid," bearing in a groove ground for this purpose. While taking the last few cuts the jaws are held against the work by the springs with which the rest is provided, care being taken to see that the jaws do not bear hard enough on the piece to throw it out of alignment. The time consumed in grinding this piece is twenty minutes, and the finish left is excellent.

The grinding operation shown in Fig. 2 is a radical departure from ordinary grinding practice, as the traverse feed is discarded except as a means of locating the work in its relative position with the wheel. The work consists of grinding bevel gear pinions used in the differential gear of automobiles, several of which are shown in Fig. 3. These are made of machine steel, pack-hardened. The surface to be ground is 1 7/16 inch long, and 1¾ inch in diameter. The grinding is done on a Norton plain grinder, equipped with an "Aloxite" wheel, made specially for this class of grinding. This wheel is 18 inches in diameter, 2-inch face, 5-inch hole, 246 grit, N grade, D-497 bond, and is run at a speed of 1400 R. P. M. Experience has shown that a saving of as high as fifty per cent of the grinding time is possible in grinding hardened steel pieces of comparatively short lengths by the method described.

As shown in Fig. 2, the work is held between the centers of the grinding machine on an ordinary mandrel or arbor, and is "dogged" in the regular way. The work speed is 140 R. P. M., and for removing 0.020 inch, the grinding time is 1¾ minute per piece. After locating the work between the centers, the operator brings the shoulder of the pinion to bear slightly on the wheel, and then, by means of the cross-feed screw, the wheel is fed directly to the work until the proper diameter is reached. This is shown by the graduations on the cross-feed. Before grinding, the wheel is carefully trued, and owing to its rapid cutting and accurate sizing qualities, many dozen pieces can be accurately finished without altering the adjustment of the cross-feed stop or re-truing the wheel. It may be added that grinding under these conditions is only in its infancy, and it can be safely stated that before many years have passed it will be common practice to use wheels as wide as six or eight inches for finishing work by the method described.

The grinding of jig bushings is an operation that calls for extreme care, otherwise the value of accurate spacing of the holes in the jig is lost. It is not intended, however, to convey the idea that the tool-maker should consume unnecessary time by carefully feeling his way along, because the tool grinding department can be made as efficient as any other, by the use of the proper wheels and methods. The bushings shown in Fig. 4 average one inch in diameter and are two inches long. They are made of tool steel, hardened, and drawn very slightly. The grinding is done on a Brown & Sharpe No. 2 universal grinder equipped with an "Aloxite" wheel 12 inches in diameter, ½-inch face, 5-inch hole, 405 grit, N grade, D-497 bond. This wheel is run at a speed of 1800 R. P. M. The bushings are held on special arbors as illustrated in Fig. 5. These arbors are straight and a wringing fit in the bushing for the greater part of their length. A slight taper at the end serves to hold the bushing from turning. The illustration shows this taper somewhat exaggerated, to illustrate the principle.

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*See also "Efficiency in Cylindrical Grinding," MACHINERY, March, 1912, and the articles there referred to.

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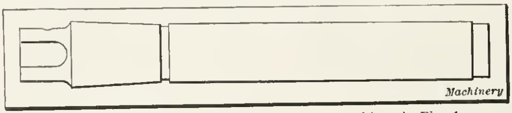

Fig. 5. Arbor used when Grinding the Jig Bushings in Fig. 4

In grinding these bushings, a work speed of seventy-five feet per minute was used, while the traverse feed was the fastest that this machine was capable of giving in connection with this work speed, or one-quarter of the width of the wheel for each revolution of the work. Under these conditions the bushings were ground in five minutes each, which is very rapid when it is considered that the limit of accuracy is approximately 0.0003 inch. The bushings were afterwards finished by lapping to fit the lining bushings.

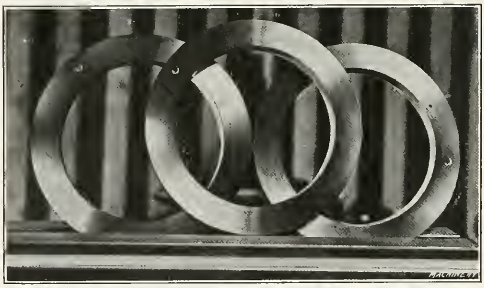

Fig. 6. Thrust Bearing Rings, 8 inches in Diameter, shown being ground in Fig. 7

The process of face grinding, or the finishing of the sides of pieces by holding them in a chuck on the universal grinding machine, and feeding them past the periphery of the grinding wheel, is by no means of recent origin, this method having been employed for many years in finishing tool work, such as the sides of milling cutters and other tools of like nature. In the last few years, however, owing to the rapid cutting qualities of the modern grinding wheel, face grinding has become a regular commercial process. In Fig. 6 are shown several thrust bearing rings, eight inches in diameter, with a six-inch hole. These rings are made of machine steel, and, after being pack-hardened, are rapidly and economically ground on a No. 2 Bath universal grinder as shown in Fig. 7. The grinding wheel used is "Aloxite," 8 inches in diameter, ¾-inch face, 1¾-inch hole, 365 grit, O grade, D-496 bond, and is run at a speed of 2300 R. P. M.

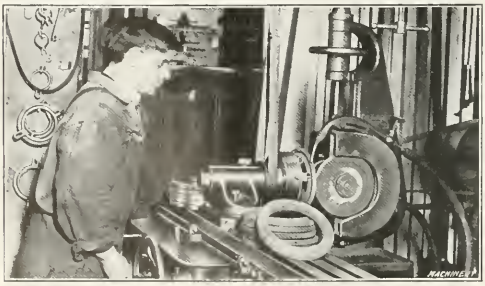

Fig. 7. Grinding Thrust Bearing Rings on a Bath Grinder

The work is held in a three-jaw chuck which is screwed firmly to the headstock spindle and set at an angle of 90 degrees with the wheel spindle. In locating the work in the chuck, the operator exercises care so as not to clamp the jaws too tightly; otherwise the pieces will spring out of shape. The work speed is 140 R. P. M. for both the roughing and finishing operations. In roughing, the operator feeds the wheel directly into the work until the sparks show heavy; then, by means of the traverse feed, the work is automatically carried back and forth past the wheel, the operator feeding the wheel into the work about 0.001 inch at each reversal of the platen. When the piece has been ground nearly to thickness the cross-feed is thrown out, the work still feeding past the wheel. This process, generally called "grinding out," gives an excellent finish even when a comparatively coarse wheel is used. Owing to the rapid cutting qualities of the modern grinding wheel, this is accomplished in five or six strokes. The grinding time for these pieces, including chucking, when removing approximately 0.010 inch, is five minutes, and the finish left is excellent.

* * *

STRENGTH TESTING OF STEELS

In a paper on "Research of the Hardness of Steel," read by Capt. C. Grard before the congress of the International Association for Testing Materials held in New York City, September, 1912, an investigation into the accuracy possible with the Brinell hardness testing method was recorded. From this investigation it appears that when commercial apparatus, as ordinarily used for making the Brinell test, is employed, and the test is carried out with ordinary care and precaution, it is reliable within an error of five Brinell units above or below the actual hardness. In other words, if the hardness of two pieces of metal is tested, and the difference on the Brinell scale is more than ten hardness units, it is certain that there is an absolute difference in the hardness of the pieces tested. With regard to the conditions under which the tests should be made, it may be stated that the pressure should be gradually applied during a time of two minutes or more, and the pressure should be kept on the test piece for a period of at least five minutes.

As has already been pointed out by Mr. Brinell himself, and as mentioned in an article on "The Brinell Method of Testing the Hardness of Metals," published in MACHINERY, engineering edition, September, 1908, this method of testing the hardness of metals offers a convenient means of ascertaining, within close limits, the ultimate strength of iron and steel. This, in fact, is one of the most interesting and important results of this method of measuring hardness. In order to determine the ultimate strength of iron and steel, it is only necessary to establish by experiments a constant coefficient which serves as a factor by which the hardness numerals are multiplied, the product being the ultimate strength. The coefficients, as usually stated, give, when multiplied by the hardness numerals, the ultimate tensile strength of the material in kilograms per square millimeter. Of course, coefficients can easily be worked out by means of which the hardness numerals can be multiplied so that the strength can be obtained in pounds per square inch.

In Capt. Grard's paper, this relation between hardness and tensile strength was exhaustively dealt with, and the following coefficients are given for different grades of steel:

Steels, extra soft	$K = 0.360$
Steels, soft and semi-hard	$K = 0.355$
Steels, semi-hard	$K = 0.353$
Steels, hard	$K = 0.349$

It will be seen that these coefficients differ by but a slight amount and it was suggested by another member of the congress of testing materials that a uniform constant be adopted by the International Association for Testing Materials, which would be used for calculating the tensile strength directly from the results of the hardness tests. (A complete treatise on the Brinell hardness testing system was published in the September, 1908, number of MACHINERY, engineering edition. This article is reprinted in MACHINERY'S Reference Book No. 62, "Testing the Hardness and Durability of Metals").

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The oily superintendent is a slick proposition.

STANDARDIZATION OF AUTOMOBILE DRAWINGS*†

SIZE OF SHEETS, PROJECTIONS, LETTERING, ABBREVIATIONS, CROSS-SECTIONING, ALTERATIONS, DIMENSIONS, ETC.

The following items should be considered in connection with the standardization of automobile drawings:

1. Size of sheets. 2. Arrangement of views on the drawing and method of projection. 3. Character and weight of the lines on a drawing. 4. Style of lettering and numerals, and the size of same. 5. Abbreviations for names of materials. 6. Cross-sectioning. 7. Method of making records of alterations. 8. Placing of finish marks on drawings. 9. Methods of dimensioning. 10. Methods of noting working limits or tolerance. 11. Location of general notes on the sheet. 12. Length of undercut. 13. Checking instructions. 14. Notation for tap and die sizes. 15. Nomenclature of parts.

At the Chalmers Motor Co., Detroit, Mich., an effort has been made to develop a logical system of making drawings along the lines outlined. There is a need for general standardization of automobile drawings. This industry is no longer a matter of a few scattered factories—there are hundreds of plants concerned with the making of drawings for identical parts; yet there are probably not five men in the Society of Automobile Engineers who use the same system for making drawings. Nevertheless, there is a constant changing about among the draftsmen and members of the society. They go from one factory to another, and every time a change is made it is necessary for these men to become familiar with an entirely new system of drawings. This increases the chances for error and causes a loss of time. It forces a man to fill his mind with detail matters about drawings when, as a matter of fact, he ought to be concerned with matters of design only.

In addition, almost every company in the country has some parts made outside of its own factory. This is particularly true of forgings, brass castings and pressed steel parts. There are some manufacturers of these parts who handle the work for as many as fifteen automobile factories. Here is a chance for error on account of each factory sending a drawing of a different size, made to a different scale, with notes and instructions made out in a different manner, on different parts of the sheet. It is hardly fair to blame the workman for failing to read correctly one of these drawings, if it is different, as it often is, in every respect, from other drawings which he has been handling previously. No matter, however, who is at fault, the error is there, and it may impede production for a considerable length of time. Hence, there is little use to argue further as to the need of standardization of automobile drawings; it remains merely to discuss the methods now in use and to determine which methods ought to be adopted by all. The following is a record of the practice of the Chalmers factory, as already mentioned.

Size of Sheets

First, in the matter of the size of the sheets, five sizes are used. The first is the standard letter size, 8½ by 11 inches. All other sizes are developed from the first size; that is, all are multiples of 8½ by 11 inches, or of one of those dimensions. No. 1 sheet is always made with a wide blank margin at the left, on the short dimension and a narrower uniform blank margin on the other three sides. The drawing or sketch is placed on the paper to read lengthwise of the sheet. Sheet No. 2 is 11 by 17 inches, with a wide blank margin at the left, on the short dimension, and a narrower blank margin on the other three sides. The drawing is made to read lengthwise of the sheet. Sheet No. 3 is 17 by 22 inches, sheet No. 4, 22 by 34 inches, and sheet No. 5, 34 by 44 inches, with the same arrangement of margins.

These are the sheets which have been used up to this time. However, a change has been considered as follows: To use only sheet No. 2, which is 11 by 17 inches, drawing large objects to a reduced scale on this size sheet, with a statement of the scale used on the sheet margin, so that the drawing will be readily understood. The new method would do away with the necessity of having different sized sheets, and all of the books for shop use would be made up with one size of sheet. In making drawings of such parts as crank-cases, cylinders, etc., they would be drawn to a reduced scale with the machinery dimensions only placed on the sheet. Pattern drawings would, of course, be made full-size, and would be kept in the drafting-room for factory reference. One or two large drawings might also be placed in the tool-room or at some other convenient point, for reference after a job is started. All of the drawings in regular use, however, would be 11 by 17 inches.

In connection with the arrangement of the sheets, a standard stamp should be adopted. A stamp 9½ inches long by 2 inches wide, with space for name, notes, material specifications, heat-treatment, material, by whom drawn, traced, checked, and approved, standard parts, date, and the symbol number, should be used. This stamp is always placed in the lower right-hand corner and along the margin of the sheet. The upper right-hand corner has a space 2⅝ inches wide and as long as necessary, running down the right-hand margin of the sheet, and divided into three portions. This is the revision table; in this space all notations of corrections, the date of correction, by whom made, and the dimension or part corrected are recorded. This table has all of the changes made on any particular drawing, so that it can be referred to at any time; no matter how unimportant the correction, it is always recorded here.

Method of Projection

The second item is the arrangement of the views on the drawing and the method of projection. For simple drawings, three views are about all that are necessary, with perhaps the addition of the necessary sections. No matter how simple the piece, three views should always be shown. The third angle projection is used; this is the best, because it gives the person handling the drawing a clear understanding of the front, top and side elevations.

Character and Weight of Lines

The third point is the character and weight of lines on a drawing. All full lines should be at least 0.030 inch heavy. All dotted lines should be 0.020 inch, with a mean length of dot of 3/16 inch and a spacing not in excess of 1/16 inch. All of the borders should be 0.060 inch heavy. It is, of course, understood that plenty of ink should always be used.

Style and Sizes of Letters

Fourth, the style of letters and numerals and their sizes should be considered. The best practice is to have all letters or notations on drawings made in upper case type, vertical form, and of about 0.020 inch uniform weight of line. For letters, too, plenty of ink should always be used. All notes and instructions on the drawings should be underlined with practically the same weight of line. This not only makes the notes more emphatic, but also has a tendency to keep all of the lettering uniform. Every word should be started with a capital letter approximately 1/8 inch high, the balance of the word being written with smaller sized capital letters, approximately 3/32 inch high.

Abbreviations

No abbreviation should be made so short as to be confusing. When necessary, the word should be written out in full. Mistakes as to materials are about the most serious that can occur; here one cannot be too careful to obviate the chance of error. The following abbreviations are used:

For iron casting—"I. Cast."
For malleable casting—"Mal. Cast."
For steel casting—"St. Cast."
For brass casting—"Brs. Cast."
For bronze casting—"Brz. Cast."
For aluminum casting—"Alum. Cast."

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* Abstract of paper by George W. Dunham to be presented before the Society of Automobile Engineers at its Winter meeting in New York, January, 1913.

† The following articles on drafting-room practice and kindred subjects have previously been published in MACHINERY: "The Printing Press in the Drafting-room," January, 1912; "The Drafting-room System of the American Locomotive Co.," June, 1911, and the articles there referred to. See also MACHINERY'S Reference Books No. 2, "Drafting-room Practice"; No. 8, "Working Drawings and Drafting-room Kinks"; and No. 33, "Systems and Practice of the Drafting Room."

The abbreviation for forgings is "Forg."; for steel stampings, "St. Stamp."; for pressed steel, "Press. St." In describing sheet metals always begin with the word "Sheet." This is no abbreviation at all, but it is best to use the full word, since it precludes all possibility of error.

Cross-sectioning

For all detail drawings, a cross-sectioning is used as if the material were cast iron, with lines 0.015 inch heavy, spaced 1/16 or 0.025 inch apart. On assemblies, however, the standard cross-section of various materials should be used. The different characters of sectioning are confined to assembly drawings.

Recording Alterations

The method of making records of alterations should be standardized, because workmen shift about a great deal, and all alterations should be uniform. When several different systems of noting alterations are used, it is impossible for a man to understand all of them without considerable explanation, and, of course, no man likes to confess ignorance of a drawing if he is used to working with drawings. When a figure is changed, a lower case letter should be located alongside the figure changed. This letter should be surrounded by a circle on the tracing; then the same letter should occur again in the upper right-hand corner where notation of alterations is made. Here the letter should be followed with the figure as it originally read, followed by the date and initials of the man who made the correction. In this manner all changes can be so recorded as to enable one to find the dimension as it was prior to the change, and also to discover when and who made the change. If this system were uniform for all automobile drawings, there would never be any confusion in regard to alterations.

Finish Marks

Next we come to the matter of placing finish marks on drawings and to the right lettering to be used. The Chalmers Motor Co. uses the capital "F" with the foot of the letter resting on the line indicated as finished. However, a very good practice in use in other shops, is the placing of a lower case "f" with the cross bar on the intersection of the body of the letter and the line to be finished. Of course care should be taken to see that the letter is always placed at right angles to the line, otherwise the intersection will be less noticeable, and the letter may be overlooked. The method of showing the amount of finish on the drawing is followed by some, but this is inadvisable, as the amount of finish is dependent on the methods used in the shop and changes as the routing system may be altered from time to time.

Methods of Dimensioning

All dimension lines should be 0.015 inch heavy, and should be placed outside of the views, as far as possible. Elevations and end views of an object to be dimensioned should be tied together with projection lines of the same weight as the dimension lines, with the dimensions placed between. All diameters of holes occurring in the body of the drawing should be carried out for dimensioning with full projection lines. Never place the diameter of a hole inside the hole itself, except when the hole is very large. Numerous diameters should never be marked transversely across the face, with the dimension lines intersecting a common center.

All dimensions should read from the bottom and right-hand side, as far as possible. It is not necessary in motor car work to add the customary inch marks to the figures. Section through threads should be shown with two parallel lines approximately the depth of the thread. The customary method of showing threads by inclined lines should be avoided. This has a tendency to blur a drawing badly.

Tolerances

There should be an understood allowable variation or tolerance in rough forgings and castings where a dimension is shown in a common fraction; on finished work where a common fraction is given; and on finished work where a decimal is given. Very close limits or tolerances should be shown by writing the maximum and minimum dimensions allowable, in decimals. These decimals should be written in full, and not with plus or minus marks as is often done. They should be uniformly written, one above the dimension line and the other underneath. For example, for a piece of one and one-half inch diameter, with a minus variation of 0.003 inch, 1.500 should be written above the dimension line and 1.497 underneath.

Notes

Notes should be grouped in one part of the sheet, either in the left- or the right-hand lower corner, as may be thought best. If this manner of making notes is followed generally, workmen will become accustomed to look for notes in a certain part of the drawings. This will eliminate the chance of overlooking important notations, often with embarrassing results.

Length of Undercut

The twelfth item is the diameter and length of undercut at the end of a threaded part or ground shoulder. In most work the undercut is just sufficient to permit the grinding wheel or thread tool to clear itself, and in the case of a ground dimension it is generally necessary to allow at least ⅛ inch in length—sometimes more, if conditions will permit. For threading operations it is well to allow 1/8 inch, although 3/32 inch has been used very successfully.

Checking Instructions—Tap and Die Sizes—Nomenclature

Thirteenth comes the matter of checking instructions. These should be carefully outlined and rigidly followed.

The checker should be instructed to check for general appearance of the drawing. If this is done, the condition of the work turned out of the drafting-room will be kept up to the highest standard. Undoubtedly the quality of the drawings has a very decided effect on the quality of the work in the factory.

All drawings should be checked very carefully for design. If there is any question in a checker's mind as to the design, he should call the matter to the attention of the chief draftsman at once.

All drawings should, of course, be checked for accuracy, and for working limits.

Particular care should be taken that all figures necessary to make the piece are on the drawing.

The finish marks should be carefully checked.

All drawings should be checked for threading and grinding reliefs.

Instructions for hardening, tempering, annealing, plating and polishing should be checked with the utmost care.

Material specifications and treatment require most careful checking.

The general notes should be gone over.

There should be a check on standard parts going with any particular part.

The name and, finally, the number should be checked.

The fourteenth point concerns tap and die sizes. Tap and die sizes should be given together with the pitch diameter and tolerance, wherever possible.

The nomenclature of parts is now under discussion in the nomenclature division of the standards committee of the Society of Automobile Engineers, and this is a matter to which reference can be made first when this committee has completed its work.

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PROPOSED BUREAU OF FARM POWER

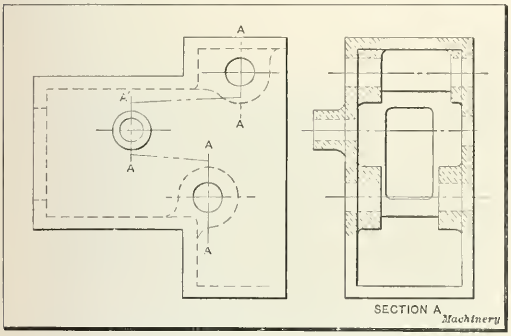
A bill has been brought into the House of Representatives (No. 25,782) by Mr. Henry T. Rainey, with the object of establishing a Bureau of Farm Power in the Department of Agriculture. It is the purpose of the bill to create a bureau which will investigate and report to the Department of Agriculture upon all matters pertaining to the methods of furnishing power on farms, and on all labor-saving machinery adapted for use on farms. This bureau would investigate such subjects, for example, as the use of electricity, gasoline, and steam in propelling farm vehicles, in operating plows, reapers, mowing machines, thrashing machines, and other farm machinery. In general, the bureau should make reports upon all such devices which would tend to lessen the amount of labor necessary in agricultural pursuits, and the expense of producing and marketing farm products.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DENOTING SECTIONS ON DRAWINGS

In denoting the points at which sections are made it is customary to place different letters at each point and refer to these letters in the title of the view showing the particular section, thus: section at *AB;* section on *ABC;* section through *ABCD*. The method employed by the writer is to use one letter only for any particular section. Every break and the ends of a section are denoted by the same letter, as shown in the accompanying engraving. The section is then referred to simply as section *A*, section *B*, etc.



Method of Denoting Sections on Drawings

J. COULSON

[The illustration shows a feature of drafting practice not used by draftsmen as much as it could be advantageously, that is, showing the cross-sections of a piece with dotted lines instead of full lines. This use of dotted cross-sections enables the object to be drawn in full lines as though not sectioned, and thus to show in the same view sections on any parallel plane without interfering with the remainder of the drawing. The dotted sectioning is shown in the cross-section at the right in the above illustration.—EDITOR.]

BURNISHING THREADING DIES

In the July number of MACHINERY a contributor recommends the passing of a master threaded plug through dies as a means of smoothing the threads of the dies. This operation is to be performed both after cutting the thread, while the die is still in its soft state, and after hardening. Lard oil is used as a lubricant, but no mention is made of an abrasive.

If one might judge from the effect of running a hardened spindle in an ordinary journal under dry conditions, the effect of the treatment outlined, on the threads of the die, might be thought to be similarly disastrous; because before the plug could act as a burnisher the oil would necessarily have to be squeezed from between the thread surfaces. In the opinion of the writer the removal of 0.001 to 0.0015 inch would tend to tear the thread. If the material is not removed, but simply compressed, the stresses set up in this way would certainly increase the tendency to distort in hardening.

It is also said that another advantage is gained in that the lead of the threads, distorted in the hardening process, is corrected. Now, as the die has been gashed or fluted at the time of the second burnishing operation there would be a tendency for the die to cut the master plug. At any rate, its influence on the master plug would, perhaps, be greater than the influence of the master plug upon the die thread; thus the pitch of the plug would be altered, it seems, at the same time that a correction, or rather a partial correction, of the lead of the die thread was made. Hence this advantage seems of doubtful value, and would almost require the making of a new plug for each die made, which would scarcely pay.

It would seem that the burnishing should rather be left to be done by the work to be cut by the die itself; or, let the die be used at first on a piece of soft material, such as cast iron. It is well known that cast iron has a burnishing effect. In lapping, for instance, a cast-iron plate merely kept wet with benzine is not only a burnisher, but a comparatively fast abrasive. The writer has before him at the moment of writing several dies in which the threads are quite smooth and bright. The only burnishing process to which they have been subjected is use.

Manchester, England. FRANCIS W. SHAW

THE DROP WORM-BOX

An article in the May number of MACHINERY prompts the writer to record some troubles experienced by him in connection with the drop worm-box form of trip motion. The accompanying engraving Fig. 1 shows the most common form, provided with a slight improvement. As pointed out in the previous article, the worm-box often fails to release when the feed shaft runs in the direction denoted by arrow *A*, the tendency being for the worm to cling to the worm-gear.

As a means of obviating this difficulty, the former contributor suggests placing the reversing motion in the worm-box, arranging it in such a way that the feed shaft always would turn in the direction of arrow *B*. This arrangement, however, is not always possible, since the reversing mechanism may have other duties to perform, as in the case of a turret lathe having a turret and a cross sliding saddle, both of which need to be reversed at times. Hence, some means of overcoming the difficulty other than by placing the reverse in the worm-box is necessary.

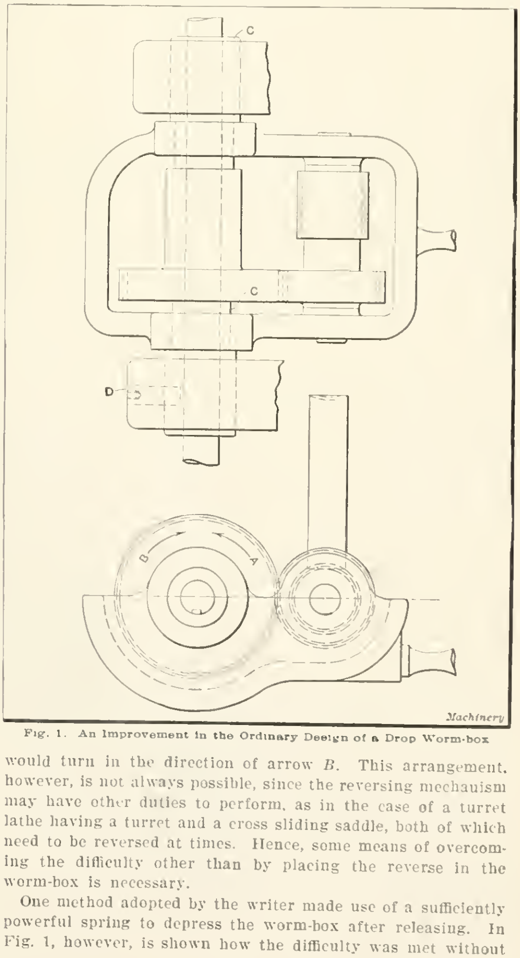


Fig. 1. An Improvement in the Ordinary Design of a Drop Worm-box

One method adopted by the writer made use of a sufficiently powerful spring to depress the worm-box after releasing. In Fig. 1, however, is shown how the difficulty was met without using the spring. Usually the worm-box is mounted directly on the feed shaft, in which case the reaction of the pressure increases the friction on the feed shaft to a sufficient extent to squeeze out the oil film, thus increasing the coefficient of friction. The shaft itself then tends to pull the worm-box upwards, in addition to the direction of pressure at the teeth of the gear. By pivoting the worm-box on bushings at *C*, the friction between the shaft and worm-box is entirely eliminated. In the case in question the trouble entirely ceased with this construction, and springs were not needed.

An additional advantage of this method of pivoting is that the endwise adjustment for allowing the parts of the trip motion to be placed as required is provided. The method of holding bushing *C* is by means of pins *D* having small tapped holes in order to make possible their withdrawal.

Another case in which trouble was met with is shown in Fig. 2. In this case the worm-box contained a two-speed arrangement as shown. The sliding gears were moved by the shipper and rod shown by the dotted lines at the bottom. As the apron in which the worm-box was fitted was sliding along the bed, the endwise friction gradually tended to force the gears to disengage. The sliding gears were simply mounted directly on the feed shaft at that time. By imposing bushing *B*, which fits endwise between the bosses inside of the worm-box, this difficulty was overcome. Key *A* engages with a groove in the feed shaft and in the sliding gears, and fits in bushing *B* in a slot cut clear through it. Previous to applying the bushing *B* the shipper which slides the gears was locked by friction. The faces of the shipper which make contact with the large gear, however, were badly cut up.

J. COULSON

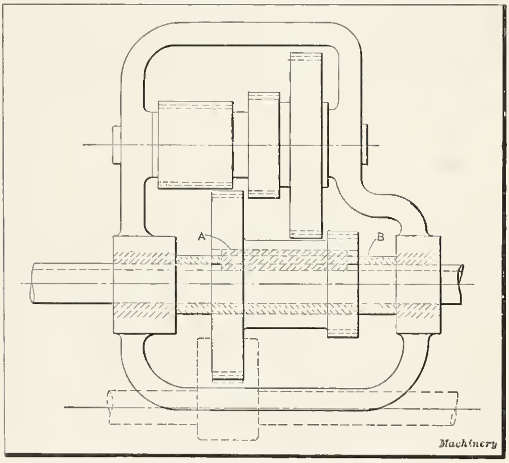


Fig. 2. Method of Overcoming the Tendency of the Gears in the Gear-box to disengage

TO ANNEAL AND HARDEN HIGH-SPEED STEELS

Place the piece to be annealed in an iron pot or pipe, pack steel chips around it, ramming them tight, and lute the cover well with fire clay, heat to a lemon yellow and hold the heat six to eight hours. Place the box in charcoal ashes and leave until cold.

Tool bits and small tools made of "Cyclone" special high-speed steel can be hardened successfully by heating to a yellow white heat and quenching in a good size piece of beef suet; plunge the piece into the suet and leave until cold; it will be found hard and tough.

To anneal "Blue Chip," "Novo" and "Rex" high-speed steels, pack the piece in an iron box or pipe with slacked lime rammed tightly around it and lute the box with fire clay. Heat to a yellow and hold the temperature one hour, and then bury the box in charcoal ashes until cold; or, if a blacksmith's forge is used with charcoal for fuel, leave it to cool down with the fire.

Another method is to pack the piece to be annealed in an iron pot or pipe with cast-iron chips and charcoal dust, or burnt molding sand, half-and-half. Ram the mixture well around the article, taking care that there is at least an inch of packing material around each piece. Lute the cover with fire clay and heat very slowly to an orange color. Hold the heat fifteen minutes and bury the box in slacked lime or charcoal ashes until cold. These formulas have all been tried and have given excellent results.

W. C. BETZ

New Britain, Conn.

PRACTICAL METHOD OF MANUFACTURING DOUBLE-ANGLE END-MILLS

A great deal of trouble is often experienced when manufacturing small double-angle end-mills by ordinary methods. It is difficult to align the teeth properly, because of the necessity of resetting the machine when milling the second angle. The grinding of these end-mills is just as difficult, because of the necessity of raising or lowering the emery wheel to obtain the proper clearance for each angle. In the following is described a method of manufacturing double-angle end-mills without the use of special machinery, so that both angles may be milled at one setting with the same milling cutter without readjustment. This, of course, insures the proper alignment of the teeth. The grinding operation of both angles is performed in the same way.

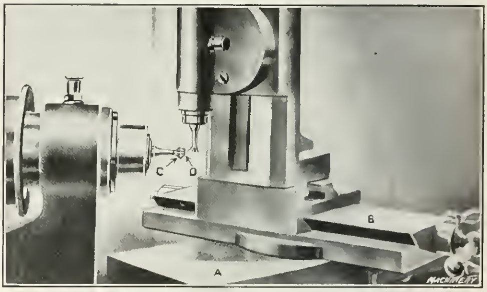


Fig. 1. Milling the Teeth in Double-angle End-mills

In Fig. 1 is shown a No. 4 Elgin bench lathe with milling attachment, as manufactured by the Elgin Tool Works, Elgin, Ill., set up for performing the milling operation. The spindle of the milling attachment is set in a vertical direction and the milling cutter is set central with the work. The lower slide *A* is set at the right angle to mill the cutting surface of the teeth at *C*, while the top slide *B* is set for milling the teeth at *D*. Both cuts are taken on the rear side of the work.

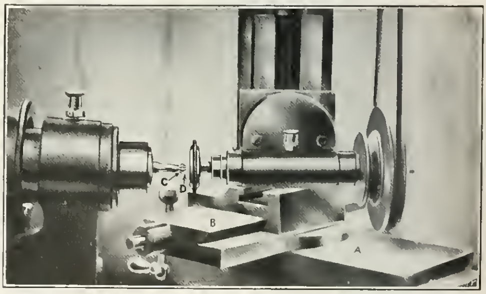


Fig. 2. Grinding the Teeth in Small Double-angle End-mills

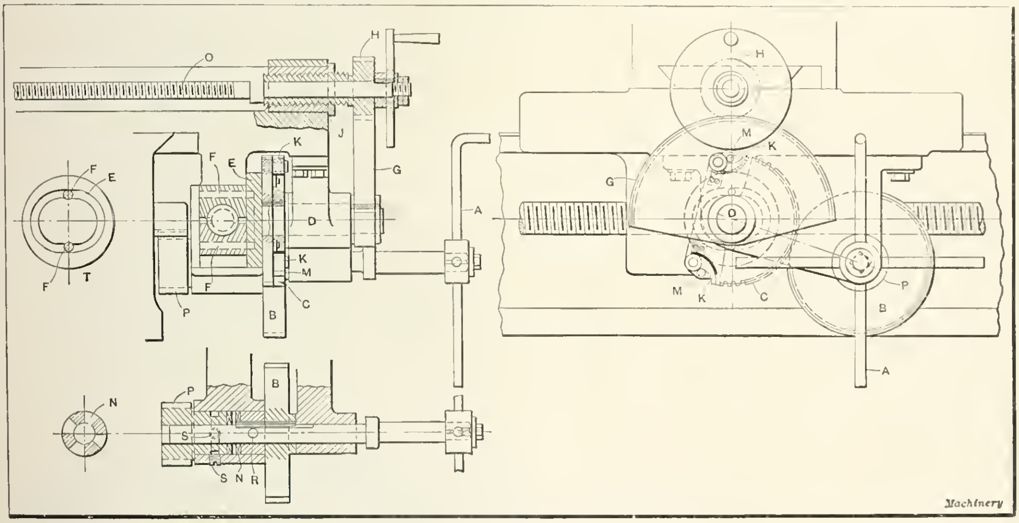
In Fig. 2 is shown the grinding operation, which is done in much the same way, except that slide *A* is used for grinding the teeth at *D*, and slide *B* for grinding the teeth at *C*. The spindle of the milling attachment in this case is set in a horizontal direction, with its center line below that of the cutter, so as to provide proper clearance for the teeth. The emery wheel is dressed flat on the top with a short angular surface on each corner. These surfaces correspond to the angular surfaces on the cutter, thus making it possible to grind both angles at the same setting of the wheel. As the spindle of the attachment is parallel with the axis of the lathe spindle, the extreme sharp point of the cutters can also be blunted by the wheel without resetting by setting the pulley of the grinding attachment over and turning the attachment into a traverse spindle grinder.

Left-hand cutters may be made by this method as well as right-hand. The illustrations show the making of a double 45-degree angle end-mill. Regular angular cutters may be made in the same way by substituting an arbor chuck for the taper chuck being used. The lathe-head index plate is used for the indexing, and as the slide-rest is graduated, it is a simple matter to duplicate the work at any time.

Chicago, Ill. MILTON C. TAYLOR

NOVEL CONSTRUCTION OF APRON MECHANISM FOR SCREW-CUTTING LATHE

The accompanying illustration shows an arrangement used in the apron of a screw-cutting lathe, by means of which only one handle *A* is needed to manipulate the carriage when cutting threads. When one cut is finished it is only necessary to turn handle *A* about one-quarter of a revolution, and the tool is withdrawn from the work. The half-nuts are also unclasped from the lead-screw at the same time, and by pushing handle *A* inwards, the rack-pinion is brought into mesh with the rack so that the carriage can be moved back and another cut begun. To bring the tool back into position, simply pull out the handle and turn it back about one-quarter of a revolution. This both clasps the half-nuts on the lead-screw and brings the tool back to the work.



A Novel Design of Mechanism for Screw-cutting Lathe

When handle *A* is turned, gear *B* turns sector *C*, which is keyed to shaft *D*, on the end of which is cam *E*. The two pins *F* passing through the half-nuts fit in a slot cut in cam *E* and open the nuts. The sector *G* is also turned; this meshes with gear *H*, which is threaded into bushing *J*, fastened to the carriage. Hence, screw *O* is withdrawn and the tool-slide with it. When the half-nuts are opened, sector *C* is in such a position that spring catch *K* only is in engagement with gear *B*. Hence, if this gear is turned further, the catch simply slips so that the handle can be turned around and the carriage brought back with the rack-pinion in engagement with the rack without moving the half-nuts or withdrawing the tool any further. The spring catch *K* fits against pin *M*, so that when gear *B* is turned back it pushes against the catch and brings the sector into mesh with gear *B*, thus closing the half-nuts and bringing the tool in to the work. There are two of these spring catches, one at each end of the sector, so that the carriage can be moved either way, according to whether a right- or left-hand thread is being cut.

In the illustration, the sector is shown in the position it occupies when the nut is closed and the tool is in engagement with the work. In the lower left-hand view is shown a section through the rack-pinion shaft. When the handle *A* is first turned the teeth of clutch *N* are out of engagement with the clutch teeth in the rack-pinion, so that *B* is turned without turning this pinion. When handle *A* is pushed in, however, the shaft and clutch *N* are moved along until the teeth of the clutch engage with the clutch teeth in the rack-pinion. Clutch *N* is fastened to the shaft by pin *R*, and screws *S* hold pinion *P* in position, allowing it simply to revolve on its shaft. When the saddle is moving along when cutting the threads, clutch *N* is out of engagement with the rack pinion, and pinion *P* only revolves. At *T* is shown the slot in the cam for the pins in the half-nuts.

Manchester, England. W. R. OAKES

SYSTEM FOR ALTERING DRAWINGS

In the course of his work in the drawing-room the writer has often had occasion to change large portions of assembly drawings or complicated details. This requires a great deal of time and energy. Below is described a system which has been used to great advantage in cases of this kind.

Suppose that the design of a machine has been changed, which will require the erasing of some details and the drawing of new ones in their places, or making an entirely new drawing, which may not be convenient at the time. First of all make a good Vandyke negative from the tracing; then using a black crayon, mark out every line that is not required in the new drawing, taking care to mark out the lines on both sides of the negative, as otherwise they are likely to show up later. Then make a good black-line print from the Vandyke, using a paper with a smooth surface; this print will now show blank places where the lines were marked out with crayon. Now draw the new parts in ink just the same as if the tracing were altered, and make a blueprint from this black-line print. This will be as good as one made from a tracing. The write print is now filed with the tracings as an original drawing.

One of the chief advantages of this system is that the original tracing is kept intact, and in case it has to be referred to in the future, one does not have to depend on finding an original record-print, but can refer directly to the tracing. From personal experience the writer has found this system to save at least half the time required to change a tracing, and, whereas a tracing can seldom be changed more than once, under this system as many changes as required may be made.

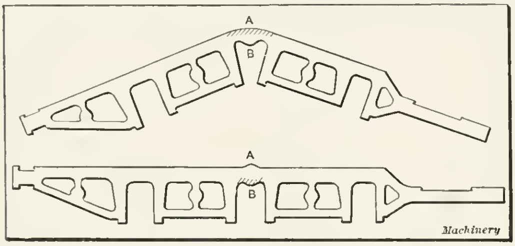
This system is also useful in connection with drawings that are changed continually according to specifications. In this case, make the tracing complete in every respect, including dimension lines, but no dimensions. Then make from this a black-line print and fill in on the latter all the dimensions and notes necessary for the shop. Make a blueprint from this print and file the black-line print as a tracing. This does away with the possibility of losing the record-print when marking up blueprints, as is often the case.

Philadelphia, Pa. Edward Robins Glenn

[See also an article entitled "Changing Drawings Quickly," published in Machinery, October, 1907.—Editor].

SHORTENING A CAST-STEEL LOCOMOTIVE FRAME

Locomotive frames are usually made of steel castings and weigh from two to four tons each. They are from 25 to 30 feet long, and the top rail has a rectangular section of from 5 by 7 to 6 by 9 inches before finishing. Sometimes, owing to variations in the methods of casting, or improper shrinkage allowance in the pattern, these castings are either too long or too short to true up when machining. It is simple enough to lengthen a frame under a steam hammer, but it is not possible to shorten it by this means. The usual method for shortening a frame is to heat it between two of the pedestal legs, as at *A* and *B* in the illustration; then, by cooling the edge *A* and bending the frame across the anvil, the metal will upset at *B*. The frame is then heated again and cooled at *B*, after which it is straightened. The metal will be upset at *A*, thus shortening the frame. In the two heats a reduction of from ½ to ¾ inch may easily be obtained. It is evident that if the bending were done in the opposite direction, relative to the parts being cooled while bending, the frame would be lengthened instead of shortened.



Method for shortening a Cast-steel Locomotive Frame

Rochelle, Ill. J. H. Maysilles

AN EXAMPLE OF POOR DESIGN

The designer is often blamed for poor designs when he has done his very best to compromise between the conflicting practical requirements, and between conflicting orders issued to him. In some cases, however, we find objectionable designs due to either lack of judgment or an effort to unduly reduce the first cost.

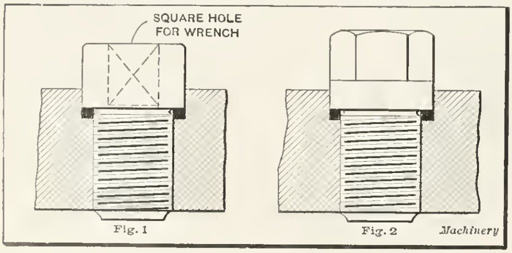


Fig. 1 Fig. 2

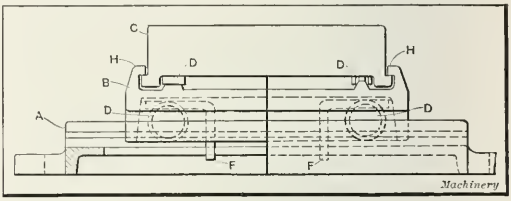
Figs. 1 and 2. An Example of a Poorly Designed Screw for Hydraulic High-pressure Work, and the Design used to replace it

An intensifying hydraulic pump failed to reach the desired pressure on account of leakage. The leak was through the stop-screw on the delivery valve on the high-pressure side. With the idea of a quick repair, the screws on the suction side and the high-pressure side were changed. In tightening the leaking screw on the suction side, however, it broke off. The screw was designed as shown in Fig. 1, and the cause of the defect is easily seen. The section of metal at the bottom of the head is very thin and the leakage took place in this square hole in the head of the screw. The screw was replaced with the type shown in Fig. 2, which was made from a solid bar. The screw shown in Fig. 1 was of cast brass, which is objectionable for hydraulic high-pressure work because it is liable to be of a porous texture.

London, England A. L. Haas

A TAPPING FIXTURE

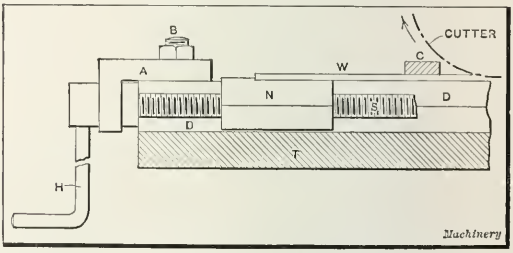
The accompanying illustration shows a tapping fixture which is easily operated and which can be used for a wide range of work. It consists of a baseplate *A*, bolted to the table of a drill press with a tapping attachment, and a center plate *B* and top plate *C*, which are each provided with two plain and two grooved rollers *D*, rolling in tracks at right angles to each other. In this way it is possible to move a piece of work clamped to the upper plate to any position, without having to shift it on the table itself. Stops *F* are provided to prevent the plates from over-running. The overlapping projections *H* are provided so that the plates cannot separate when subjected to pressure. M. W. W.



A Convenient Tapping Fixture

MILLING FIXTURE FOR THIN STOCK

About one hundred feet of rectangular-section steel rods was required for a set of models, the section of the steel being 0.088 by ⅞ inch. As this section was not available as a standard size, and as it was impossible to get so small a quantity rolled, it was decided to mill down ⅛ by ⅞-inch drawn steel, which was on hand, to the required size. This was done in a milling machine with the aid of the simple fixture shown in the accompanying engraving. In this illustration, *T* is a section of the milling machine table, through one of the T-slots *D*. The screw *S*, a standard stock part in the shop where this work was done, was provided with a handle *H* and a bearing *A*, which was also a stock part. This bearing was bolted to one of the other slots. The screw when so arranged operated a cast-iron nut *N* the entire length of the T-slot. Nut *N* was provided with a lip or shoulder rising 1/16 inch above the table for the purpose of driving the strip to be milled under the cutter. The lengths in which the flat steel rods were required were slightly less than the travel of the nut, which made this arrangement possible. Two clamps *C*, one of which is not shown, were placed at the front of, and behind, the cutter, and fastened so that the pieces to be milled would just slide under them as the work was being milled. By beveling the entering end of the strip to be



A Simple Method of Milling Flat Stock

milled on top and feeding the piece lightly until it had reached under the second clamp, which held down the work on the side already milled, no trouble was experienced from the lifting up of the work. Had this occurred it would have been necessary to feed with the cutter. A spiral cutter with nicked teeth was used. Of course, the width of the slot in the milling machine table was less than the width of the strip. In this case the slot was 9/16 inch wide.

Middletown, N. Y. Donald A. Hampson

A FIXTURE FOR SQUARE GRINDING

In the manufacture of high-grade automobiles, the square shaft is replacing the old-style feather key to a very considerable extent, especially in the transmission and heavy driving parts. There are also some parts of the motor in which the square hole and shaft has an advantage; one piece in particular is the valve push-rod, perhaps better known as the valve tappet, shown in Fig. 1. This push-rod is made from machine steel, carbonized and hardened so that it is necessary to grind all of the working parts. The square part is 0.748 inch across the flats and has an allowable variation of only 0.0005 inch; this requirement, of course, necessitated the making of a very accurate fixture.

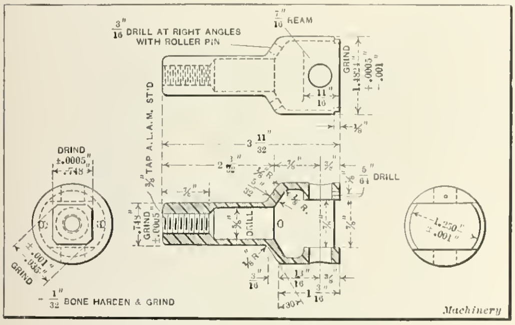


Fig. 1. The Valve Push-rod to be ground

The first operation is that of grinding the large diameter, and rough grinding the corners of the square. This is accomplished in the usual manner, that is, by using a long center to enter the bottom of the hole of the large end and an ordinary center in the square end. The next operation is the grinding of the square body which must be perfectly concentric and parallel with the large diameter. The fixture for accomplishing this operation is shown in Fig. 2. It worked successfully, and was quickly and easily operated.

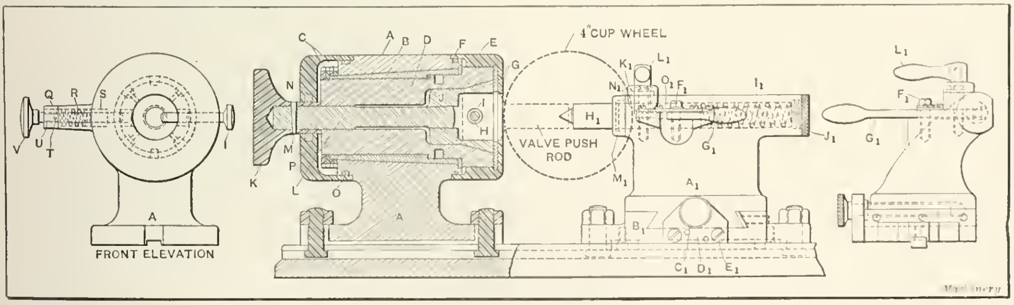


Fig. 2. Fixture used in Grinding the Square Body of the Valve Push-rod shown in Fig. 1

One of the greatest difficulties encountered in grinding fixtures, is that of preventing emery dust from collecting on the working parts, and considerable care was taken to design and make this fixture as nearly dust-proof as possible, regardless of the extra first cost. Another difficulty to overcome was the distance the tailstock was required to travel to allow the push-rod to be removed from the chuck. The size of the square also necessitated the making of a special tailstock, which will be described later. In designing this fixture, the question of future use, as well as that of accuracy and production, was considered. It frequently happens in the manufacture of automobiles that slight changes in the parts necessitate a complete new fixture unless some provision has previously been made. By making new collets, this fixture may be used for many purposes. The entire fixture was made as small and compact as possible. It has been the writer's experience that a neatly designed and well made fixture receives much better care in the hands of the ordinary workman than one that is poorly designed, unhandy and roughly made; and it is upon the care such tools receive that their continued accuracy and usefulness depends.

Referring to Fig. 2, the casting *A* is bored taper to receive the bronze bushing *B*, slotted through on one side to allow for adjustment, which is accomplished by lock-nuts *C* drawing the bushing *B* into the tapered hole in the casting. Spindle *D* has a very important function to fill—that of indexing—and is made from hardened and ground tool steel. To insure the greatest degree of accuracy, the indexing holes in the spindle must be protected from emery dust; consequently, they are placed under cover as much as possible, and are also protected by dust cap *E*, which is made from machine steel and fitted closely on the threaded portion of the spindle *D*. This cap is also closely fitted to the end of casting *A*, the latter having a groove cut in it to receive the felt washer *F*. In the forward end of cap *E* is another felt washer *G*, which in connection with the washer *F* makes it almost impossible for any dust to get into the bearing or indexing holes.

To retain the correct relation of the roller pin hole in the push-rod, Fig. 1, to the square body, the locating plug *H* is fitted into the bushing *I*, which is pressed firmly into the spindle *D* and passes through one side of cap *E* and chuck *J*. As this plug *H* is made to fit closely in the roller pin hole, Fig. 1, it is evident that the hole will be held in the correct relation to the square body.

The chuck *J* is of the ordinary spring collet type, keyed to the spindle *D*, and is operated by the handwheel *K* and draw-in bolt *L* which are held together by tapered pin *M*. Handwheel *K* is also used for indexing the spindle. The front end of the handwheel bears against spindle *D* so that when it is turned in the proper direction, it draws the chuck back into the spindle, thus closing it on the work. Felt washers *N* and *O* are inserted in the dust cap *P*, forming a perfect protection for the working parts in this end of the fixture. The indexing device is of the ordinary spring plunger type and is held in the boss *Q* on the casting. The indexing device consists of a spring *R*, bushing *S*, stop-pin *T*, plunger *U* and knob *V* for operating.

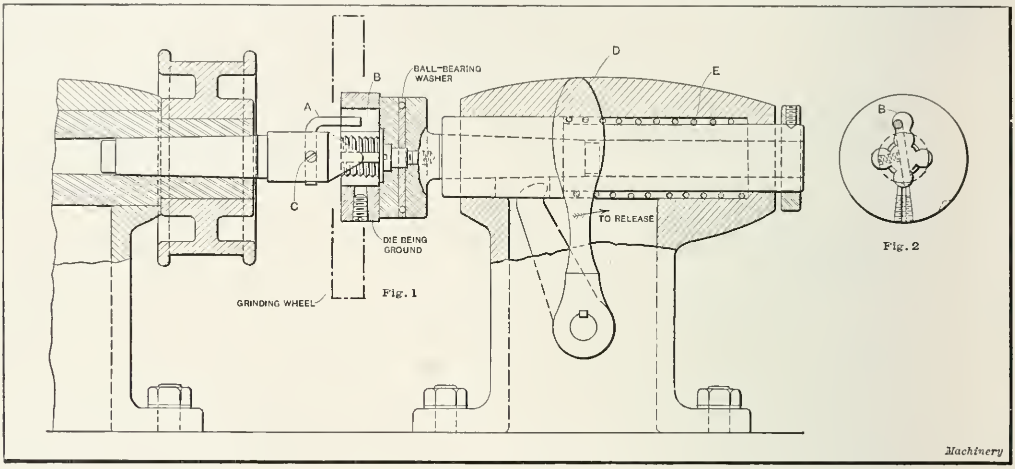
Some difficulty was experienced in obtaining parallel sides on the square body, as the work was performed with a cup grinding wheel on a plain grinding machine (an old style Landis grinder) having no table adjustment. The dovetailed base of the tailstock A_1, shown to the right in Fig. 2, overcame this difficulty and gave good results. The upper part of the tailstock fits in a dovetailed groove in the base B_1 and is adjusted to the desired position by the screw C_1 held in the block D_1, the latter being fastened to the base by screws E_1. The fulcrum pin F_1 is placed in the lever G_1 in such a position that an angular movement of the lever of about 52 degrees gives a 1½-inch lateral travel of center H_1.

The tension spring I_1 is sufficiently strong to keep the proper pressure on the valve push-rod, and it is retained in the spindle by a cap-nut J_1. The center H_1 can be locked in any position by clamp-block K_1 and handle L_1. The dust-caps M_1 and N_1 and plate O_1 protect the working parts of the tailstock spindle from dust. As the square body of the valve push-rod to be ground is ¾ inch, it necessitated the flattening of one side of the center bearing in the casting, and also the off-setting of the center point on the movable center H_1. This fixture has been in use for two seasons, grinding about 50,000 push-rods with good results, and is still in good condition.

Lansing, Mich. E. H. Pratt

METHOD OF GRINDING THREADING DIES

The accompanying engraving shows a method which has been successfully used for grinding the outside of threading dies after hardening. Fig. 1 shows the arrangement with the die in position in the machine, while Fig. 2 shows an end view of the die, indicating how it is driven. The steel wire *A*, which is about 5/32 inch in diameter and bent so as to enter the hole *B* in the die, acts as a driving dog. It is held by set-screw *C* in the center.



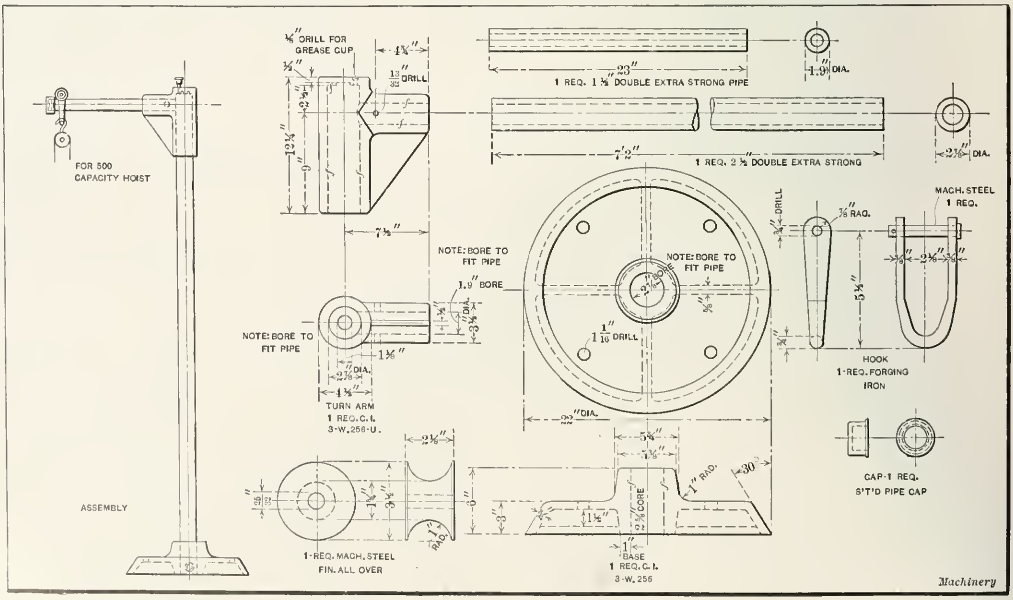
Figs. 1 and 2. Method of Grinding Threading Dies on the Outside after Hardening

When placing a die in the machine, the operator pulls the tailstock center by means of lever *D*, thus compressing the spring *E*. With his left hand he then places the die against the driving center and immediately releases lever *D*, allowing the tailstock pad or center to bear against the die by the action of the spring. The tailstock pad is provided with a ball-bearing washer to eliminate friction. The die is now held in position for grinding.

Server

HOIST FOR LATHE CHUCKS, FACEPLATES AND HEAVY WORK

The accompanying illustration shows assembled and detail views of a handy and substantial hoist of cheap construction, which has been found convenient for handling heavy work, large chucks, faceplates, etc., on the lathe. It is bolted to the floor, back of a large lathe, or whatever machine it is used in connection with. It is especially valuable where it is impossible to use a portable or jib crane, and being of cheap but substantial construction, it can be used for a large range of work.



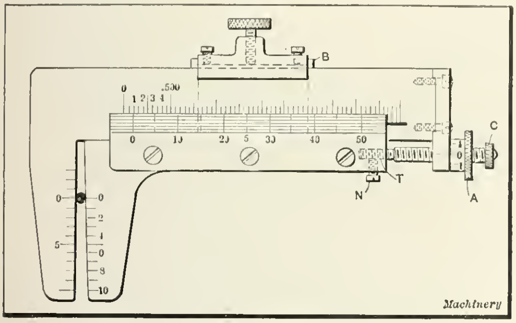
A Handy Hoist for Lifting Lathe Chucks, Faceplates, etc.

The hoist consists mainly of two castings, the base and the

bearing for the revolving arm. The upright and arm are of extra strong pipe, and the forged yoke with the steel roller completes the device.
M. W. W.

VALUE OF A DECIMAL WIRE GAGE

The use of numbers in wire gage measurements may originally have been considered a convenience, but when another "number" gage differing from the original in the sizes designated by the numbers was added, the system became complicated. The basis of these different number gages is that each succeeding number designates a dimension differing by some fractional part of an inch from the preceding one, but each originator of a gage made the difference from each succeeding number different from the others, so that if we now compare the sizes and numbers of the different wire gages we find that no two are alike. There might, in former years, have appeared to be a reason for these different wire gages, with the numbered plates having slots corresponding to a letter or number designating the size of the wire, but since the micrometer and vernier scales have come into more common use, wire manufacturers generally prefer, when an order is given, to have the order specify the diameter of the wire in thousandths of an inch. Then why not discontinue the old gage numbers entirely?



A Convenient Decimal Wire Gage

In a catalogue before the writer, the standard wire gage of a large wire company gives No. 1 as 0.2830 inch; the same company's steel music wire gage No. 1 is 0.0156 inch. The B. & S. jewelers' wire gage No. 1 is 0.001 inch. Why should there be this difference in the designation of the sizes of wire? Whether the wire be brass wire, or music wire, or jewelers' wire, why should not the diameter corresponding to the given number be the same?

Now, why could not a new system be adopted in which, for example, No. 50 would mean 0.050 inch in diameter, and No. 200 would mean 0.200 inch in diameter? The B. & S. jewelers' wire gage is based on this system, and is the only practical system of wire gages in use. Many years ago, the writer made and sold a decimal wire gage to a number of manufacturing concerns based on this system of decimal identification number. This gage, as shown in the accompanying illustration, was adapted for measuring wire from the very smallest size up to 0.500 inch and was especially useful for inspecting wire in the stock-room. It was more easily used on wire than the ordinary micrometer and could be read to 0.00025 inch with accuracy.

This measuring instrument, as shown, has hardened taper jaws, the taper being such that the distance across at graduation 10 is 0.010 inch larger than that at 0; the gage bar is graduated as indicated, each graduation being 0.050 inch. A vernier scale is provided so that measurements as close as 0.010 inch can be read directly on this, and finally the graduations on the taper jaws give the dimensions in 0.001 inch; hence, it is possible to use this gage as graduated to measure wire of any size from 0 to 0.500 inch in diameter. The nut and screw at the right end of the gage are for the purpose of quickly and definitely locating the vernier at the reading required. The screw upon which the locating nut revolves has 20 threads per inch; thus one revolution of the nut agrees with one graduation on the bar.

Assume that it is required to set the gage to read ⅛ or 0.125 inch. First move the sliding jaw so that its zero line is opposite the second line from 0 on the bar, and from that reading continue to move the sliding jaw until 20 on the vernier scale coincides with the nearest line on the gage bar. The reading of the vernier, then, is the 0.120 inch. Now if we insert a piece of ⅛-inch wire between the taper of the measuring jaws we find that it will enter between the jaws until the graduation marked 5 is reached, the desired dimension being $0.120 + 0.005 = 0.125$ inch. Now if the piece inserted should only enter halfway between the 5 and 6 graduations on the jaws, it would be one-half of a thousandth inch too large. If it should enter as far as between the graduations 5 and 4, it would be one-half of a thousandth inch too small.

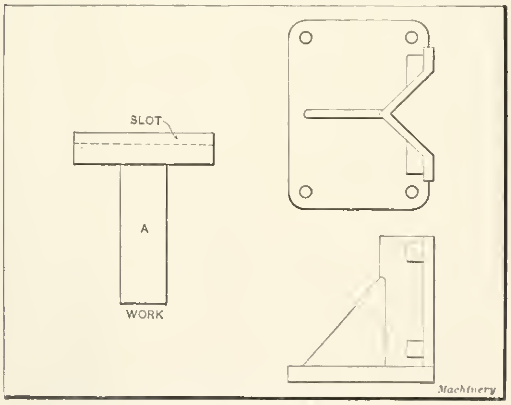
As another example, assume that we first set the zero of the sliding jaw opposite the three-tenths graduation on the bar, then move the vernier scale until line 15 coincides with the nearest graduation on the bar, and insert a wire that would enter between the jaws to the graduation corresponding to 7; the dimension of this wire would then be $0.300 + 0.015 + 0.007 = 0.322$ inch.

The adjusting nut *A* at the right end of the gage is graduated with five graduations. This makes it possible to set the vernier rapidly and accurately, as each graduation is equivalent to a 0.010-inch movement of the sliding jaw. The screw *C* on which the nut revolves is stationary and as there is a thread of different pitch at the end *T* of this screw, an accurate setting for the correct reading of the nut can be obtained. A set-screw *N* with a brass shoe at its end is employed to bind the adjusting screw in place. The gib *B* and gib screws on the top of the bar are to hold the sliding jaw tightly, so that it will move without lost motion. The set-screw on the top fastens the slide in the desired position.

Springfield, Mass. FRANCIS W. CLOUGH

MODIFIED FORM OF MILLING FIXTURE

The accompanying illustration shows a knee or angle plate which differs from the average type. Instead of having two flat faces as usual, this angle plate has one flat face, while the other is provided with a V-groove; wings are formed at the edges of the V, and these are planed off so that the knee can be placed with the V-side as a base, whenever flat work is to be clamped to the plain flat face. Lugs are cast upon these wings which are drilled for bolts for clamping purposes. An example of the work for which the fixture is adapted is shown at *A* in the illustration. Any part having a cylindrical stem and a slot, groove, or keyway cut across the end can be securely held in this plate while milling. Unless the work has a very long stem it can be done better and quicker by using this device than by gripping it in a vise and feeding in a vertical direction.



Modified Form of Angle Plate and Type of Work for which it is adapted

Middletown, N. Y. DONALD A. HAMPSON

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

HIGH-PRESSURE HYDRAULIC JOINTS

When oil is the fluid conveyed in a high-pressure hydraulic pipe line, glue makes an excellent material for applying to the threaded pipe connections, caps, etc. It will set and become hard very quickly. It is necessary to have the parts clean before the glue is applied.

Toronto, Canada. J. Cranford Smith

HARDENING SOLUTION FOR NOVO STEEL

The following receipt for hardening "Novo" and "Novo Superior" steel will be found useful: To one quart of kerosene oil add one pound of table salt, thus making a saturated solution. Heat the steel to a bright cherry red, rub cyanide of potassium on the parts to be hardened and heat again to a bright cherry red. Then dip the steel into the solution until cold.

Bristol, Conn. Irving E. Schubert

ENAMEL FOR INSULATED WIRE

The following is a satisfactory solution for coating wire with an enamel insulation. It consists of seven parts by weight of tri-acetyl-cellulose $[C_6H_7(C_2H_3O)_3O_5]$; ninety parts chloroform ($CHCl_3$); and three parts phenol (C_6H_5OH); thyme (a compact under shrub); and castor oil, added as a softener. This solution can be saponified, though not very easily, by a solution of potash. It can be more readily saponified, however, by the use of alcoholic potash. This enameling solution is much less inflammable than celluloid. It is colorless, but can be rendered visible by adding an aniline dye.

Pittsburg, Pa. H. M. Nichols

CEMENT FOR FILLING HOLES IN CAST IRON

The following is a good mixture for a cement for filling holes in cast iron, and may be well known to many: powdered cast iron, 40 parts; powdered sal-ammoniac, 1 part; powdered sulphur, ½ part. These ingredients are thoroughly mixed together and placed in an air-tight receptacle in a perfectly dry condition until wanted. When a hole in a casting is to be filled, take what appears to be the required quantity of the mixed powder, moisten it with water to the consistency of paste or putty, and fill the hole or depression, smoothing it up and allowing it to set.

When very deep depressions are to be filled, add to the above mixture an equal weight of fresh "vulcanite" Portland cement before dampening. After the water has been added, so that the mixture has the desired consistency, add non-volatile oil to the extent of 8 per cent by weight of the dry mixture used, and work the mass until the oil is fully emulsified; then apply the paste, finishing with a facing of the original mixture containing no Portland cement. This will produce a filler which will not shrink in setting.

St. Louis, Mo. C. H. Casebolt

OILS AND FATS AS HARDENING MEDIUMS FOR STEEL

Oils and fats produce, as a rule, less hardness in steel than does water. The hardness which they produce is usually accompanied by toughness. Thus such tools as are liable to crack in hardening, and where the greatest possible hardness is not required, are usually hardened in oil or fat. According to the *Metallarbeiter*, petroleum hardens more sharply than any other oil; then follows glycerine, which is too little known in this connection; then the lighter mineral oils; and at the foot of the list come the vegetable oils, as, for example, linseed oil. Among the fats, melted tallow and whale oil are the most used, the former giving a greater degree of hardness than the oils.

No matter what substance is used, however, one must not lose sight of the fact that there must be sufficient of it to permit the article being hardened to be moved quickly to and fro in the hardening medium, just as when water is used, so that the bath will not get hot. In most cases there is usually too little oil employed; the lack of success is then attributed to the use of the oil or fat, instead of to the fact that too little of it was used. R. G.

PRODUCING A BLUE COLOR ON NICKELED STEEL

By the use of the well-known bath of hyposulphite of soda and acetate of lead it is possible, by simply dipping, to produce a blue color on various metals. This is used for the purpose of producing an imitation steel finish on different metals. As is well known, the action is very satisfactory, and the articles thus treated look exactly as though they were made of steel that had been blued by annealing. Although this color can be produced on all metals, it is best brought out on nickel and nickel-plated articles. The brilliant white color of the nickel constitutes a good background for the thin blue coating; and for this reason the color is especially lively.

If this blue color is to be produced on unpolished nickel, it is recommended to color directly after plating, in order to prevent the surface getting spotted. With polished nickel, great care must be taken in cleaning. For this reason it is desirable to rub the nickel with rouge (crocus powder), as this can be readily removed from the metal and contains less mineral oil than "Vienna chalk."

For those who do not know the dip process thoroughly, it might be stated that the liquid for producing the blue color consists of 226 grams (8 ounces) each of sodium hyposulphite and lead acetate, and nine liters (8 quarts) of water. The solution is used boiling hot. The color is first yellow, then purple, and at last blue. When the right color is obtained, the articles are rinsed and dried, and then lacquered—otherwise the color will fade.

Dresden Germany. Robert Grimshaw

THE CHEAP BLACKENING OF BRASS

The following solution for blackening brass is nothing new; in fact, it has been known for a long time. Owing to its cheapness, ease in working and adaptability for many purposes, it has been deemed advisable to bring it again to notice, Many platers, of course, will recognize it as an old solution known to the plating industry for many years, but they may not have realized its advantages for some classes of work. The solution is made as follows:

Water	1 gallon
Sugar of lead	8 ounces
Hyposulphite of soda	8 ounces

The solution is used as hot as possible and the brass work, is simply dipped in it and allowed to remain until black. This takes about a minute or less. The articles are then rinsed in cold water, then in hot water and dried. If scratch-brushed dry, the black deposit will have a high luster.

When dipped into the solution, the surface of the brass article becomes yellow, then blue and finally black. The article should not be taken out until all the surface has become blackened. The deposit on it is sulphide of lead. The articles should always be lacquered as the black deposit is likely to oxidize and fade if not; but if coated with lacquer, it seems to be quite permanent.

For a cheap class of goods that require a black finish, this solution can frequently be used to a good advantage. It requires no electric current, being used as a dip. The color, to be sure, is not coal black, but resembles a graphite black more than anything else and has a slight gray shade. It is sufficiently black, however, to answer many purposes and it is so easily applied that it can be used on cheap goods with only a slight increase in cost.—*Brass World.*

* * *

Always provide some means for holding bolts from turning while the nuts are being screwed on, if a wrench cannot be used on the head of a bolt.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

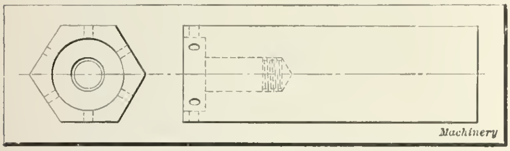
MARKING ON BLUEPRINTS

The most simple and at the same time probably the most effective method of marking on blueprints is to use a common soap-stone pencil, similar to those used in machine shops and tool-rooms. The end of the pencil should be ground to a sharp point on an emery wheel. Lines and letters made in this manner cannot be distinguished, when first made, from those originally on the blueprint, and will stand an almost indefinite amount of wear before becoming obliterated.

Indianapolis, Ind. F. B. Hays

A SIMPLE DRILL JIG

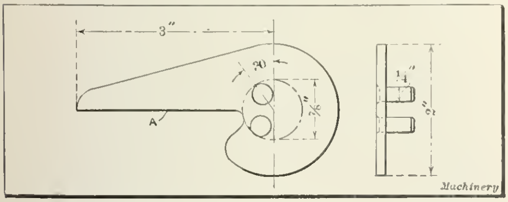
On a number of special capstan-head screws, six holes were to be drilled, as indicated by the illustration, which shows the jig used for the drilling operation. This jig was made from a piece of hexagon steel rod. Instead of tapping out the full length of the hole for the screw, only a few threads were cut at the bottom, which saved time in handling the product to be drilled. In this instance the heads of the screws extended far enough out of the jig so that they could be turned by hand. This jig was casehardened and has proved itself good for long service. Jigs of this type are quickly made, and the cost is so small that even for experimental work it often pays to make such a jig.



Middletown, N. Y. Donald A. Hampson

MILLING CUTTER TOOTH TESTING GAGE

The gage shown in the accompanying illustration is intended for testing the radial direction of the faces of formed milling cutters, especially gear tooth cutters. The two pins shown bear on the inner side of the hole in the cutter, and thus the line *A* will be a true radial line, the elongation of which passes through the cutter center. Gear cutters should be tested, from time to time, with this gage to make sure that the faces of the teeth are in a radial direction, as, otherwise, the shape of the gear tooth being cut will not be an exact duplicate of the original gear cutter form.



J. S. B.

REPAIRING LATHE CHUCK SCREWS

The square heads of chuck-jaw screws sometimes become so badly worn that their keys will no longer fit them, and it becomes difficult to use the chuck. To order a new screw sometimes means quite a delay. The writer has used the following method successfully: Remove the jaw, take out the screw and heat it to a cherry red; then, with a few sharp blows, upset the square end of the screw until it is large enough to file to its original size; take care not to injure the threads of the screw during this operation. Then file the head of the screw to fit the chuck key. After hardening, the screw is as good as new.

W. H. Addis

Lafayette, Ind.

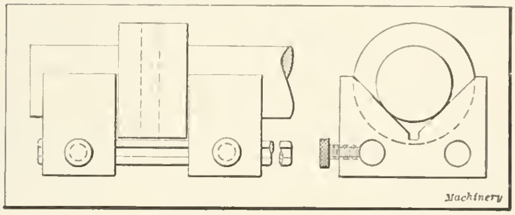
LATHE FILE HANDLES

The writer generally saves all ends cut off from new belts and cuts them up into pieces, about 1¼ inch square, into which he drills a hole, about No. 40, ⅝ inch deep. These pieces are used by the tool- and die-makers when they want a handle for a small file. Usually they drive a piece of leather onto the file tang and then shape it to suit their requirements. The toolmakers prefer these to wooden handles.

St. Louis, Mo. James S. Glew

CONNECTED V-BLOCKS

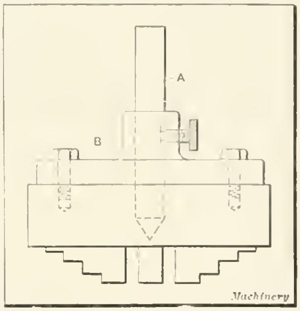
The accompanying illustration shows two uniform V-blocks which are connected so as to be used as one unit. Blocks so connected are handy for work of the kind shown in the illustration; in fact, they form a very effective jig, or rather jig replacer.



Manchester, England Francis W. Shaw

AN ACCURATE CENTER PUNCH

The writer had a number of different sizes of rods to center, and to do this work quickly, a center punch was made from a three-jaw universal chuck, as shown in the illustration. A face-plate *B* was made and bolted to the back of the chuck, for carrying the punch *A*. In one side of the center punch a flat was milled for the end of a screw which prevented the punch from dropping out. The chuck was set over the end of the shaft, and the jaws were tightened with a chuck wrench, and then the punch struck with a hammer. This method of centering was very quick and accurate.



Superior, Neb. J. N. Bagley

CUTTING COARSE INTERNAL THREADS IN THE LATHE

In cutting coarse internal threads with a cutter held in a bar which is clamped rigidly in a fixture fastened in the T-slot of the compound rest, it is impossible to have the cutter cut one side of the thread at a time. To accomplish this result, engage the split nut on the lead-screw to the full capacity of its engagement for a few cuts; then engage the nut a little less than full, holding it there by the hand so that the carriage will lag a little behind the previous cut. Continue doing this for a few cuts, and then engage the split nut to its full capacity, and so on. Lead-screws which are provided with an Acme thread allow the accomplishment of this "trick" without any trouble.

It might be considered bad practice to only partially engage the split nut, because of the uneven wear on the nut and screw, but this does not seem objectionable to me, as the engagement is so nearly full that the consequent wear is very slight. In the general run of shop work, nuts having a coarse thread to be cut are the exception rather than the rule, so that this kink would not be frequently employed.

Los Angeles, Cal. John A. Wood

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

CAVEATS NOT GRANTED BY PATENT OFFICE

F. A. G.—Are caveats no longer granted by the United States Patent Office?

A.—Section 4902 R. S., authorizing the filing of caveats for inventions was repealed by act of Congress June 25, 1910, the new law taking effect July 1, 1910. Since this date there has been no provision of law for the filing of a caveat in the United States Patent Office, and it is no longer permissible for an applicant to file a caveat for the purpose of obtaining further time in which to mature his invention.

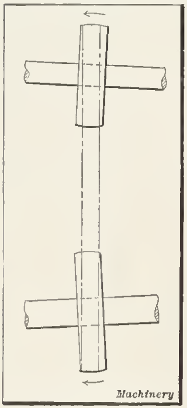
ALLOWABLE SHAFT DEFLECTION FOR GEARING

D. E. W. Co.—In calculating the size of shafts carrying gears how much should be allowed as the maximum permissible deflection? We are unable to find anything printed on this subject that is at all satisfactory and we are therefore appealing to you. Any information that you can give us on this subject will be very much appreciated.

A.—None of the available authorities specifies the allowable shaft deflections for gearing. The general rule is to mount all gears close to the bearings so as to minimize the bending moment, and most designers apparently proceed on the assumption that the deflections are negligible when the shafts are sufficiently strong to stand the torsional stresses and the gears are mounted close to the bearings. Data from practice followed when gears are not set closely to the bearings is requested.

WHY BELTS RUN TO THE HIGH SIDE OF PULLEYS

T. J. C.—It is common experience noted by all mechanics that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, runs to the "high side." Why is this so?



Illustrating the Tendency of Belts to run to the High Side of Pulleys

A.—A belt runs to the high side of the pulleys because of the direction of motion of the parts of the belt between them. As the free part of the belt winds onto the leading side it tends to follow the same line of motion around the pulley face, and if the shafts are out of parallel the belt path becomes at first a helix which if continued would run off the pulley on the high side. The illustration of an exaggerated case shows the belt leading to the left or high side of the pulleys, the edges of the belt being projected in a straight line to emphasize the drift to the side. When the pulleys are crowned, the crowning counteracts the tendency of the belt to run off unless the shafts are badly out. The crown of the pulleys, by the way, acts in the same manner on both sides of the belt when the shafts are parallel. Both sides of the belt crowd toward the center which is the highest part of the pulleys, and it is thus that crowning prevents belts running off the pulleys.

SOLUTION OF A TRIANGLE

F. B.—In the triangle shown in the accompanying illustration, angle A and side b are known. It is also known that the length of side a is to the length of side c, as 10 is to 8. What is a simple method for solving this problem? I have looked for a solution in various textbooks in vain.

A.—The sides of a triangle are to each other as the sines of the angles opposite the respective sides. Hence, in the triangle shown,

$$\frac{\sin A}{\sin C} = \frac{a}{c}$$

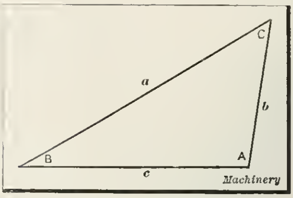
From this we get

$$\sin C = \frac{c \sin A}{a}$$

but, as

$\frac{a}{c} = \frac{10}{8}$, we have $\frac{c}{a} = 0.8$

and, therefore, $0.8 \times \sin A = \sin C$. The angle A being known, angle C is thus determined, and the triangle is solved in the same manner as any triangle in which one side and the angles are known. (See MACHINERY's Reference Book No. 54, "The Solution of Triangles," page 49.)



Solution of a Triangle

* * *

METALS USED FOR STEAM TURBINE BLADES

In an article in *La Technique moderne*, M. P. Breuil deals with the metals used in the construction of steam turbine blades, the data given referring to continental European practice. In the Zoelly turbine, blades made from 5 per cent nickel steel are used, while Harlé & Cie. prefer steel with 32 per cent nickel. The advantage of this steel, however, might be considered doubtful, as Rateau has found steel with 25 per cent nickel unsuitable for turbine blades. The opinions of French manufacturers of special steels differ widely as to the contents of nickel. It does not seem as if the influence that nickel has on metal used for turbine blades has been fully investigated, and there is considerable uncertainty as to the behavior of the metal in a turbine blade. The bronzes, as well as the monel metal, which are used for turbine blades by some of the manufacturers, soften considerably at temperatures above 570 degrees F., and have a relatively low elastic limit, but they have the advantage of being but little affected by corrosion.

Attention is further called to the fact that on the side of the admission of steam the first blades work in high temperatures, with dry steam at great velocity; the blades further back are subject to lower temperatures and lower velocities of steam, but the steam is wet, and there is, besides, the friction of metal particles carried away by the steam. The guide blades are stationary, and are not subject to the action of centrifugal forces like the rotor blades. It appears, therefore, that different metals ought to be used for each of these three classes of blades, but in all cases the metal used must possess great resistance to chemical and mechanical corrosion, and be easily machined by ordinary shop processes.

As to the chemical corrosion of metals by hot steam there are practically no reliable data. From investigations of the action of salt water on metals it would appear that aluminum and manganese bronzes and monel metal would give good results, but it is quite possible that chemical corrosion is altogether very slight as compared with physical, and the material used ought to be chosen on the basis of resistance to the latter, with respect to which nickel steel appears to have very high qualities, with its breaking strength of 80,000 pounds per square inch, elastic limit of 57,000 pounds per square inch, hardness (Brinell) of 180, and elongation of 20 to 22 per cent. It is, moreover, naturally hard, not brittle, and comparatively cheap. There are no data as to its probable behavior at high temperatures, but having a low percentage of nickel it would probably behave like other steel, and would reach the minimum of its elastic limit and elongation at about 570 degrees F., without, however, becoming brittle. The firm of Wickers Maxim makes turbine blades of laminated bars with a steel core and nickel surface, the nickel layer being extremely thin.

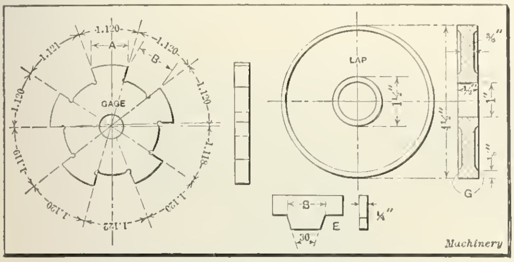
* * *

As an example of the importance of having the walls of shops and factories painted in light colors in order to increase the light in the workroom, it may be of interest to note that in one case where the intensity of the illumination in a saw-tooth roof building was 9.7 foot-candles in the center of the building, it was 13.5 foot-candles at a distance of three feet from the whitewashed walls, showing an increase of nearly 50 per cent due to reflected light from the walls.

MAKING A HUB CLUTCH GAGE

BY J. M. HENRY

In the following article is described a successful method for making a hub clutch gage of the type illustrated in the accompanying engraving. The first difficulty met with is that of distortion in hardening, which, however, may be overcome by using "Ketos" or "Paragon" oil-hardening steels, in which case it is possible to machine the gage to within 0.002 inch of the finish size, and finish it by lapping. For the lapping, a disk lap is used, and the operation is performed in a milling machine. The disk lap is turned as shown in the engraving, and placed on an arbor in the milling machine. It is trued up on the sides *G* to insure its running parallel with the ways so as to be completely in contact with the work. The gage is then mounted on the index centers and one side of the lap is set central with it. The blank is indexed around until it just touches the lap, a sounder being used to determine when this takes place. The lap is now charged with emery and oil, the machine is started, and the gage rapidly passed by the lap a number of times. After having lapped the first surface, the gage is indexed around to the next lug and the operation repeated, thus continuing around the gage until having lapped one side of the lugs. The opposite side of the lap disk is then set central with the gage, and the gage indexed around the opposite way until the other side of one of the lugs touches the lap, after which the lapping is continued until the dimension *A* is correct on all the lugs. A templet *E* is used, from time to time, to test the accuracy of the spacing.



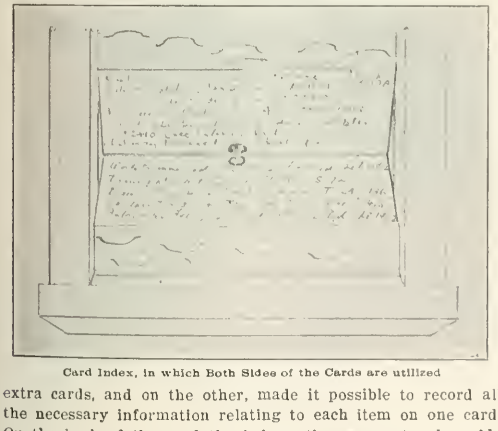
The Gage to be lapped, the Disk Lap, and the Templet

* * *

UTILIZING BOTH SIDES OF INDEX CARDS

BY CARD INDEX

The accompanying illustration shows how both sides of the cards used in a card index were utilized in the tool-designing department of a large firm. This method on one hand, saved extra cards, and on the other, made it possible to record all the necessary information relating to each item on one card. On the back of the card the information was entered upside down so that when the cards were pressed towards the front of the drawer, the information entered could be easily read. In the engraving two separate cards are shown for convenience, but it is understood, of course, that all the information pertaining to one subject is entered on the two sides of the same card.

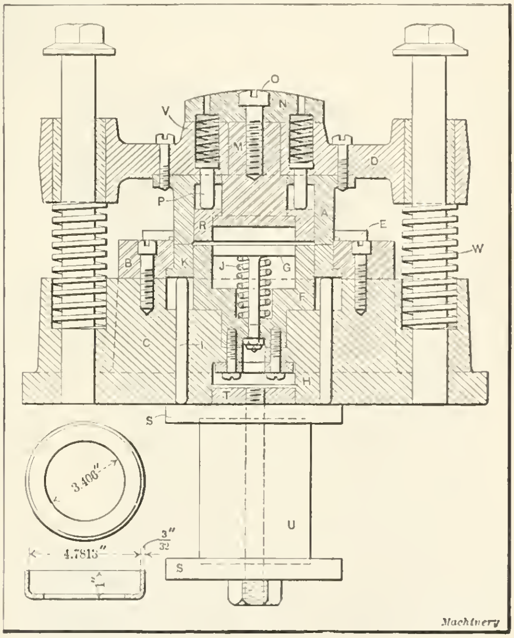

Card Index, in which Both Sides of the Cards are utilized

A COMBINATION DIE

BY A. J. DUDLEY

The shell shown in the lower left-hand corner of the accompanying engraving is a retainer for the ball races of an automobile clutch. This retainer is a sheet-metal stamping made in a powerful trimming press having a 5-inch stroke. The style of die used is a combination die which produces the shell complete in one operation within the limits of tolerance required—0.001 inch for all dimensions except for the height of the shell. The blank for the shell is approximately 6⅜ inches in diameter. The material is hot-rolled steel, 3/32 inch gage, fed into the die in the form of a strip.

In the illustration, *A* is the blanking punch and drawing die, made of tool steel, hardened and ground; *B* is the blanking die which is secured to a cast-iron die-block *C*. A stripper *E* is secured to die *B* by screws (not shown). The drawing punch, and die for the center hole in the shell, is shown at *F*, and the retaining plate for this punch at *H*. Punch *F* is also made of tool steel, hardened and ground. A knockout *G*, operated by a helical spring *J*, ejects the waste center blank. Some difficulties were first experienced with this knockout owing to the sticking of the blank, but this was overcome by placing a small knob in the center of the knockout (and a corresponding recess in the face of punch *M*) which deflected the blank enough to prevent it from sticking. Punch *M* does not operate until nearly at the end of the stroke. At *K* is shown the shell stripper which also acts as the spring pressure pad during the drawing operation. This is supported by four pins *I* resting upon the flange *S*. A powerful rubber spring *U* effects the stripping of the finished shell from punch *F*.



A Combination Blanking and Drawing Die and Work for which it is used

Another pressure pad and stripper is provided at *R*. It is supported by pins *P* and helical springs *V* and bottoms on the inside flanges of punch *A*. The buffer plate *N* acts as a retainer for punch *M* and is provided with vent holes to release the air pressure produced by pins *P* and pad *R*. Heavy square helical springs *W* open the die after each stroke, the rubber spring *U* assisting in this operation during part of the stroke.

Owing to the limited height available between the bolster plates of the press, it was impossible to use an adapter—hence, the necessity for spring operation. The die has worked successfully for several months, but it has been found necessary to lubricate it copiously when in operation.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

COCHRANE-BLY UNIVERSAL SHAPER

Diemakers and toolmakers are often obliged to use a number of machines for making a die or jig, especially if the shape is at all complicated or irregular. This means that the work must be reset in each machine, which not only requires extra time but often makes it difficult to secure accuracy between the different surfaces, thereby increasing, in many instances, the amount of hand work necessary for fitting and finishing. The Cochrane-Bly Co., of Rochester, N. Y., is now manufacturing a universal machine that has been designed to perform quite a variety of operations at one setting of the work; therefore it is especially adapted to the making of dies, jigs or to general tool-room work. This machine is known as a universal shaper, but, in reality, it is a shaper, slotter, milling and drilling machine combined.

Fig. 1 shows a view of the right-hand side and Fig. 2 the left-hand side with the circular table in position. This machine consists principally of a column supporting the knee and table, a shaper ram, a milling and drilling spindle, and suitable speed- and feed-changing mechanisms. The milling spindle and shaper ram have universal adjustments so that tools can be presented to the work at any desired angle. Fig. 4 shows the heads in a vertical position drilling a die, and Fig. 3 shows the shaper ram set in a horizontal position.

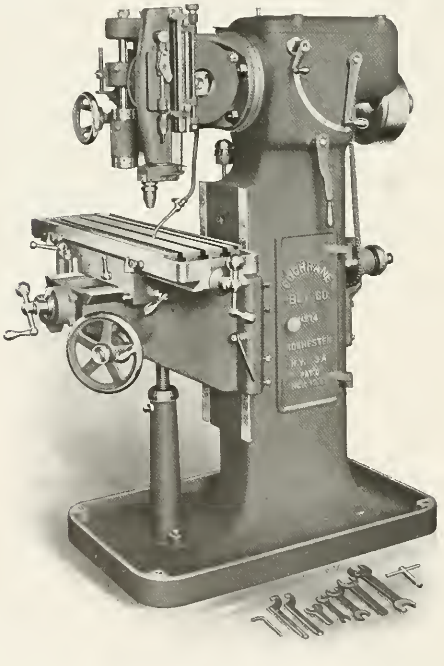


Fig. 1. Combined Universal Shaper and Milling Machine for Die, Jig and General Tool Work

The drive is from a constant-speed clutch pulley at the rear; this transmits the power through a double cone of spur gears to the main head, which carries bevel gears for driving both the shaper ram and milling spindles. The cones of spur gears provide means for varying the speeds, and their arrangement is shown by the sectional view, Fig. 5. The speed changes are effected by means of a driving key *A* which is shifted into engagement with any one of the five upper gears, thus giving five speed changes for the shaper ram and milling spindle. The position of this key is controlled by the large lever seen in Fig. 1 near the top of the column. The end of this lever swings around a graduated quadrant which shows the number of ram strokes per minute for any one of the five positions. The key in the gear cone, as well as the gears and shafts, is hardened, and all bearings are provided with bushings. The clutch pulley, when idle, runs on roller bearings, and the clutch is engaged or disengaged by the vertical lever seen at the side of the column in Fig. 1.

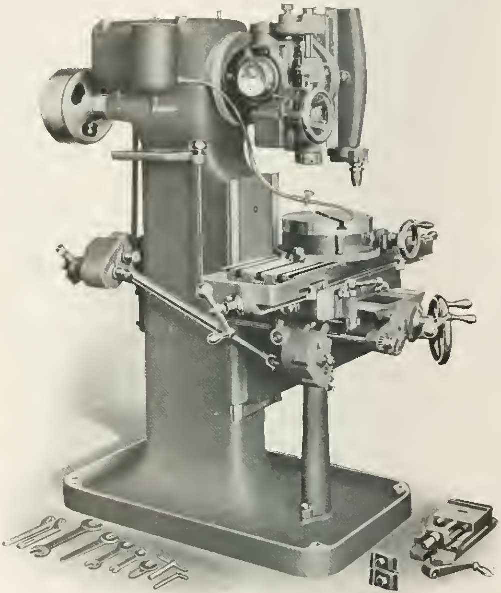


Fig. 2. Universal Shaper equipped with Circular Table Attachment

The main head has a bearing in the column and is locked in position by three bolts which engage a circular T-slot. The entire head, including the shaper ram and milling spindle, can be revolved about a horizontal axis (after loosening the clamping bolts) by turning a small crank which is located at the upper end of the graduated quadrant previously referred to (Fig. 1). This crank operates the worm *B*, Fig. 5, which,

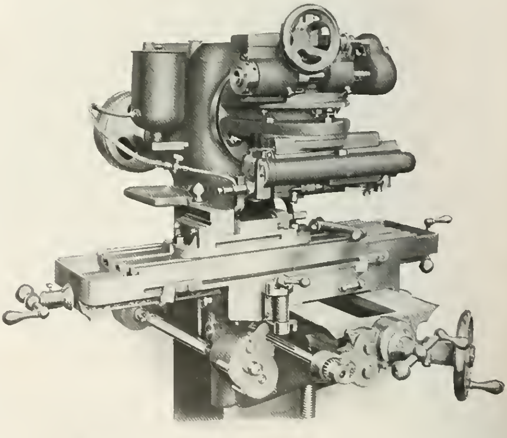


Fig. 3. Shaper Ram set in a Horizontal Position

in turn, engages a worm-wheel attached to the inner end of the main head. The shaper and milling heads each have an independent adjustment about an axis at right angles to the main head, which makes it possible to locate them at any angle. All three heads have large circular bases which are graduated to degrees.

The milling spindle is driven by bevel and spur gears from the main head and runs either right or left. It has a slide movement of 3½ inches for drilling and boring, which is controlled by a handwheel operating through worm-gearing. A micrometer screw-stop, reading to thousandths of an inch, is provided to facilitate accurate adjustments. The spindle is fitted with taper bronze bushings and adjusting collars to take up wear.

The shaper ram is driven through bevel gears and a crank-and-link mechanism. It has a quick return and the stroke can be adjusted from zero to six inches. The tool-head of the ram swivels and can be set to work at any angle. The ram is equipped with a mechanism (illustrated in Fig. 6) which provides a positive relief for the tool on the upward or return stroke. The clapper is held firmly against the tool-head during the cutting stroke by means of a knuckle-joint mechanism, and it is released at the end of the stroke by a relief dog, which strikes the lower roll or tappet shown in the illustration. The clapper remains in the released position on the return stroke and it is thrown into the working position again when the dog engages the upper roll. These rolls are adjusted for any length of stroke by means of a right- and left-hand screw which is turned by a knurled knob at the top.

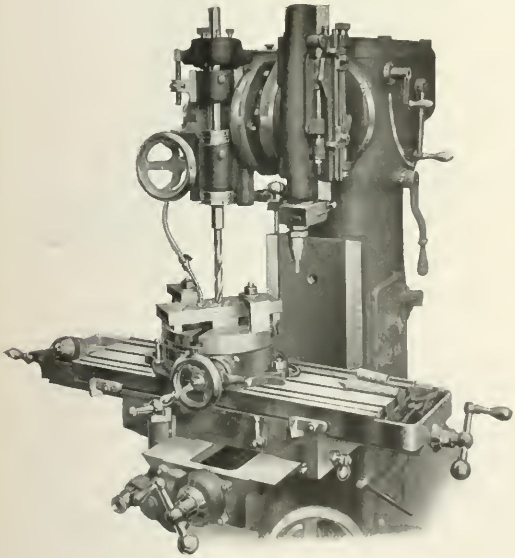


Fig. 4. Drilling a Die with Milling Spindle

Power feed is provided for the longitudinal and transverse movements of the table and also for the circular table, if desired. The feeding motion is derived from a sprocket *C*, Fig. 5, which is connected by a silent chain with the feed-box, seen at the rear in Fig. 2. From this point the motion is transmitted to the front of the machine by a universally jointed, telescoping shaft in the usual manner. When the milling spindle is being used, the feed is continuous, whereas an intermittent feed, which takes place on the return stroke, is required for the shaper ram. Either a continuous or intermittent feed is obtained from the rear feed-box, which is shown in detail in Fig. 7. For a continuous feed, the drive is through spur gears, and for an intermittent feed, a crank-and-ratchet mechanism is brought into action, provision being made for disengaging either the gear or crank mechanisms.

Tool-holders for various styles of shaping tools are interchangeable in the tool-head. Three forms of tool-holders are illustrated in Fig. 8, which also shows a set of standard slotting tools such as are carried in stock by this company. The slotter tool-holder *A* takes all shapes of slotting tools having 3/8-inch square or 7/16-inch round shanks, and it is used when shaping out small dies, for broaching and for cutting internal keyways, etc. The shaper toolpost *B* holds lathe or shaper tools of ½-inch or ¾-inch size, and is used when the machine is working either as a horizontal shaper (as shown in Fig. 3) or as a vertical shaper. The extension holder *C* takes ⅜-inch square bits and can be used for inside or outside shaping operations.

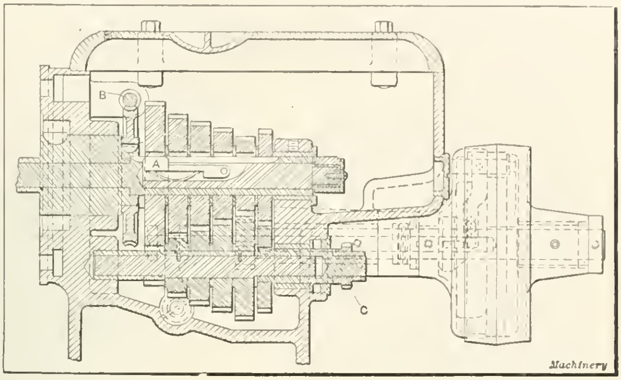


Fig. 5. The Constant-speed Clutch Pulley and Speed-changing Mechanism

The table of this machine has a working surface of 28 by 9 inches and there are three ⅝-inch T-slots for clamps. The feed-screws are accurately cut and are provided with ball thrust bearings. There are also compensating nuts for taking up wear and large graduated dials reading to thousandths of an inch. The saddle has a bearing on the knee 12 inches wide, and provides a way 18¼ inches long for the table. Both of these slides are fitted with taper gibs. The saddle carries the feed mechanism and the feed-control handle is mounted at the front. The knee has a bearing 10 inches wide and 13½ inches long on the column, and is fitted with an adjustable gib and locking screws. The thrust on the elevating screw is taken by a ball bearing. The circular table is 12 inches in diameter and is furnished with or without power feed. It is graduated in degrees and is revolved by a handwheel, the dial of which reads to five minutes. Provision is made for disengaging the worm-gear, when it is desirable to revolve the table quickly by hand. The column is cast in one piece and has sufficient metal to absorb all vibration. The head of the column containing the driving and speed-changing gears, forms an oil-tight box so that these gears run in a bath of oil.

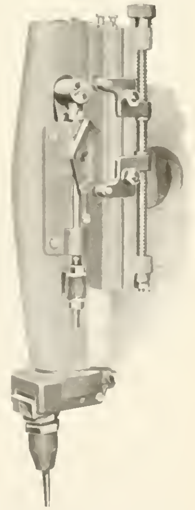


Fig. 6. Detail View of Shaper Ram showing Relief Mechanism

The machine has been designed throughout to provide convenient operation, all control levers being within reach of the operator from the front of the machine. The durability of the construction has also received careful consideration, the spindles, shafts and driving gears being hardened and all bearings bushed. While this machine was designed to be accurate and sensitive on fine work, the driving mechanism is sufficiently powerful to permit taking heavy cuts for removing stock rapidly.

Some of the principal dimensions of this machine are as follows: Longitudinal travel of the table, 22 inches; transverse movement, 10 inches; vertical adjustment, 18 inches; angular adjustment of the main head, 360 degrees; maximum stroke of shaper ram, 6 inches; maximum distance from end of ram to table, 15 inches; number of speeds, five; number of strokes per minute, from 25 to 150; angular adjustment, 30 degrees each way from the center; maximum distance from end of milling spindle to table, 16 inches; maximum distance from center of spindle to face of column, 13½ inches; number of taper, No. 9 B. & S.; size of hole through spindle, 17/32 inch; angular adjustment, 45 degrees each way from the center; number of speed changes, five; variation, from 55 to 330 revolutions per minute; micrometer stop adjustment, 3½ inches. The shaper ram has an intermittent feed varying from 0.002 to 0.032 inch per stroke, and the milling spindle has six feed changes varying from 0.004 to 0.048 inch per revolution. The net weight of the machine is 2000 pounds; the height over all, 65 inches.

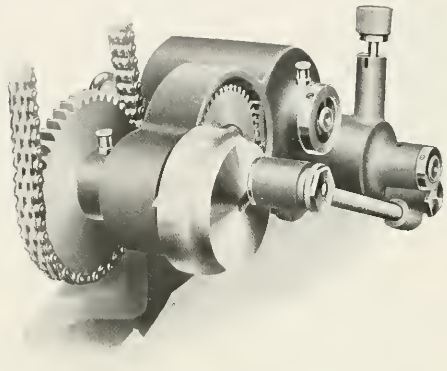


Fig. 7. Mechanism for Obtaining Continuous Feed for Milling and Intermittent Feed for Slotting

The equipment includes an oil tank and hose; shaper, slotter and extension tool-holders; a spud-bar for the milling spindle; a set of slotter tools; wrenches, etc. The following extra equipment can also be furnished, if desired: A circular table with or without power feed; a milling machine vise; draw-rods for the milling spindle; spring collet with bushing and nut; drill chuck; expanding milling arbors; milling machine center; center for circular table; sleeves for the spindle, and a self-contained motor drive.

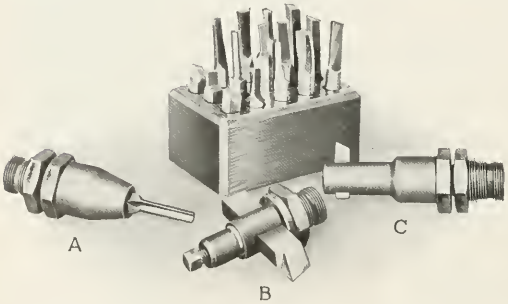


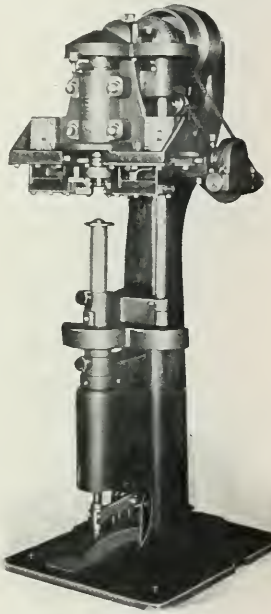
Fig. 8. Set of Slotting Tools and Different Tool-holders

The full universal features of this machine, in conjunction with the various tools which can be used, make it possible to machine a large variety of such work as blanking and forging dies; punches; forming tools, such as are used in turret lathes, automatic machines, etc.; jigs, especially when shaping, milling and boring operations are required; and similar classes of work. While the machine was designed more particularly for the tool-room, the universal features make it possible to handle with the regular equipment and standard tools, a large variety of work which ordinarily would require several machines of different types and also special tools and fixtures.

NEW SQUARE CAN DOUBLE SEAMER

A new automatic double seamer has recently been designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is adapted for square, oval and oblong work and will seam cans ranging from ¾ inch to 5½ inches in height. The rate of production depends somewhat on the size of the can, and the expertness of the operator, and varies from 12,000 to 20,000 ends in ten hours.

The machine is driven by an automatic friction clutch encased in the two-step driving cone. A hand brake arranged on the end of the driving shaft, automatically engages and releases after the work is done and insures stopping the spindle in exactly the same position after every cycle. By referring to the accompanying illustration, it will be noted that the lower spindle drive is positive, the lower spindle starting and stopping in unison with the upper spindle. This insures a perfectly straight body after double seaming.



Bliss Automatic Double Seamer

All movements are automatic so that the operator has nothing to do but place the can on the chuck and depress the treadle. This causes the lower spindle to rise and engages the clutch, thus starting the driving shaft which is connected to the chuck spindle by bevel gears, and bringing the double seaming rolls into action. The can is automatically revolved the required number of times, and the double seamer rolls, after going through their motions, are automatically retired, the clutch is automatically disengaged, the chuck is stopped, the lower plate is dropped and the can released. The weight of the machine is 1100 pounds.

STANDARD MACHINERY CO.'S PRESSES

The press shown in the accompanying views represents a new line that has just been brought out by the Standard Machinery Co., 7 Beverly St., Providence, R. I. The particular machine illustrated has a net weight of 13,500 pounds. It is heavily back-geared with cut steel gearing, and is equipped with this company's instantaneous roller friction-clutch. This clutch allows the machine to run continuously or to be automatically stopped after each revolution either by hand or foot. The clutch grips the instant the treadle or handle is depressed, instead of allowing the flywheel to turn from one-half to a full revolution before coming into engagement. After engagement, there is less than 1/32 inch travel on the periphery of the balance wheel. Another noteworthy feature of the clutch is that it enables the press to be stopped at more than one point in a revolution. Most of the clutches applied to these presses are made to stop on the up stroke and down stroke, which adapts the machines for heavy forming, embossing or similar operations in connection with which it is essential to have the dies dwell after striking.

This machine is extra heavy and rigid in design. It is fitted with stay-rods and is of the open-side and open-back type. The construction of the upper and lower connections as well as the adjusting and clamping device is worthy of note. The lower connection consists of a forged steel ball fitted into a hemispherical center in the ram. On the upper part of this ball there is a bronze retainer which is also hemispherical on the lower part. The upper part of the lower connection is threaded and fits into the upper connection. The clamping is effected by the four screws shown in the upper connection. This connection is split through the center and each of the screws passes through to the opposite side. Around each screw there is a bronze bushing. These bushings and the holes in the upper connections are threaded, and in order to clamp the upper connection to the lower, after the ram is adjusted to the proper height, the screws are tightened and the bronze bushings, which are fitted to the threads of the lower connection, are forced against the shank of the lower connection. This gives a positive grip which will not slip. The bronze bushings around the clamping screws prevent the lower connection from being marred or bruised. The upper connection is bronze-bushed around the wrist-pin and the latter is five inches in diameter.

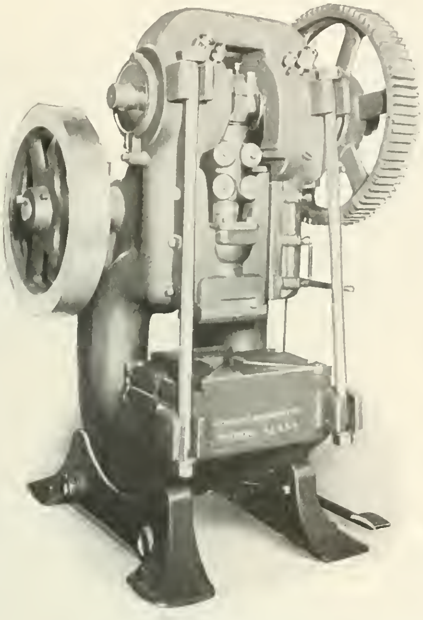


Fig. 1. Heavy Back-geared Press built by Standard Machinery Co

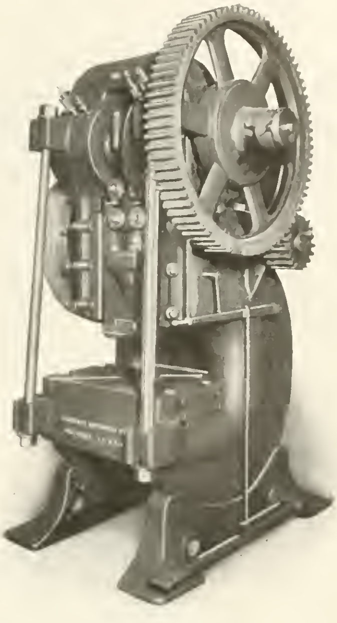
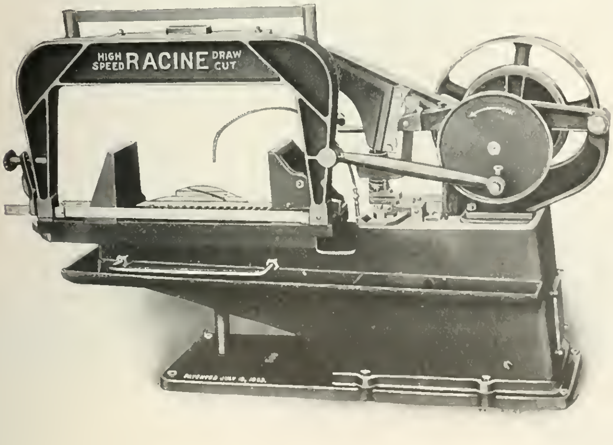


Fig. 2. Another View of Standard Press

The boxes of the main bearings can be adjusted for wear and the press is arranged, on the left side of the crankshaft, to permit the attachment of a roll or dial feed. The bolster plate is fitted with T-slots so that die-holders and dies of various sizes can be attached. The hole in the bed is generally made to specifications. The boxes for the back-gear shaft are bronze lined and have large oil grooves. The pinion is of cut steel and the driving or clutch gear is made of special "gun iron." The machines are equipped with a tight-and-loose pulley drive in addition to the balance wheel, when so specified. The main frame is liberally proportioned to endure all kinds of shocks incident to cutting and embossing operations. This particular line of presses is not only made single back-geared but double back-geared and either plain or motor driven.

The weight of the press is 13,500 pounds and the weight of the flywheel, 900 pounds. The gear ratio is 1 to 4½. The stroke of the press is 3 inches; diameter of the crankpin, 5 inches; adjustment of the slide, 6½ inches; distance from the slide to the bolster plate, with the stroke down and adjustment up, 7 inches; distance between the uprights, 16 inches; width of bed from front to back, 18 inches; width from right to left, 30½ inches; and the overall height, 8 feet 6 inches.



Racine Twelve-inch Metal-cutting Machine

RACINE METAL-CUTTING MACHINE

The Racine Tool & Machine Co., Racine Junction, Wis., has brought out a new 12-inch metal cutting machine. This machine, which is illustrated herewith, is intended for machine shops, steel warehouses, structural steel works, etc., and is designed to do rapid and accurate work. It will cut 6-inch round machinery steel in 20 minutes and 12-inch I-beams in 10 minutes. The capacity is given as 0 to 12 inches, although the machine can be furnished to take stock measuring 12 to 15 inches. The blades used can vary in length from 17 to 24 inches.

The blade is lifted clear of the work on the return stroke by means of an automatic device. This prevents the blade from dragging on the non-cutting stroke, thereby greatly increasing the life of the blade and the output of the machine. There is a quick-acting vise which swivels to an angle of 45 degrees and can be adjusted so that the entire length of the blade can be used. With a 24-inch blade, stock measuring 11 to 12 inches can be cut at an angle of 45 degrees. The blade holders are made from a 1- by ¾-inch flat bar fitted into a milled slot which holds the blade secure with the work. There is also a blade tightener which enables the operator to vary the tension without using a wrench. A cutting compound is supplied to the blade by a geared, circulating pump. The saw frame automatically holds itself at any height, which is very convenient when placing stock in the machine. When the machine is cutting to its full capacity, only about ¾ horsepower is required for driving.

CINCINNATI FRICTION-DRIVEN SWIVEL-HEAD LATHE

The latest development of the Cincinnati Precision Lathe Co., Fosdick Bldg., Cincinnati, Ohio, is a bench lathe equipped with a swivel-head which can be located at any angle with relation to the ways of the bed. This machine, a general view of which is shown in Fig. 1, has a friction drive similar to the one employed on this company's precision bench lathe which was illustrated in the department of New Machinery and Tools for May, 1912. The swivel-head has angular graduations on the base for setting it in any required position, and it is securely held by an eccentric bolt at the left end and a hardened bolt at the front or right end. The position of the head is accurately maintained by a hardened and ground circular ring inserted in the upper base and fitting closely in a circular slot in a plate that is bolted to the lathe bed. This swivel-head, in conjunction with a combination external and internal toolpost grinder and a double swivel slide-rest, makes the machine a universal precision grinder and lathe.

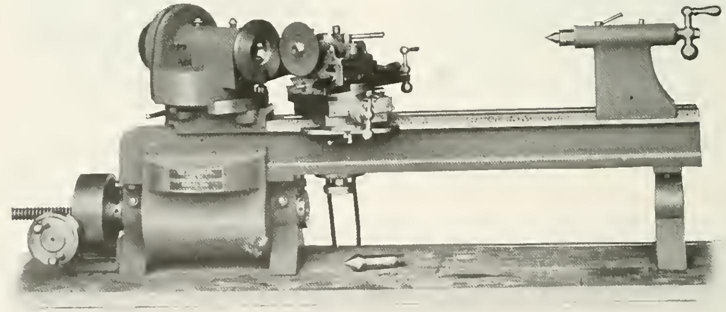


Fig. 1. Swivel-head Lathe arranged for Face Grinding

Fig. 1 shows the position of the headstock and slide-rest for face grinding. The head is set at an angle of 30 degrees, and each swivel rest is also set to the 30-degree position, thus giving a total angle of 90 degrees. Fig. 2 shows the machine arranged for angular grinding, the operation in this case being that of truing the lathe center. Fig. 3 is a rear view of a lathe equipped with a standard head and serves to show the clutch lever (which is also applied to the swivel-head type) for controlling the starting and stopping of the spindle. The friction driving wheel (which is also clearly shown in this view) is first located on the horizontal driven disk for the required speed, as shown by a speed indicator on the outer edge of the hand adjusting wheel. The main spindle can then be engaged instantly for operating at this speed, by a downward pressure on the clutch lever previously referred to, whereas an upward movement of this lever disengages the spindle. The application of this device makes a countershaft unnecessary for operating the lathe. For the operation of a grinder, a combination countershaft for the lathe and grinder is employed.

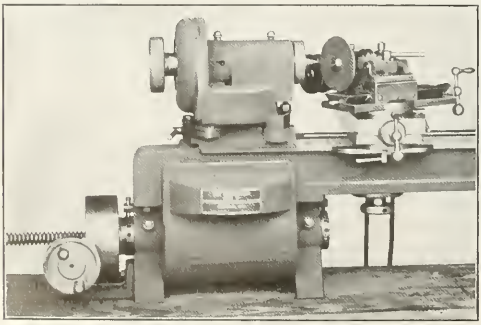


Fig. 2. Angular Grinding on Swivel-head Lathe

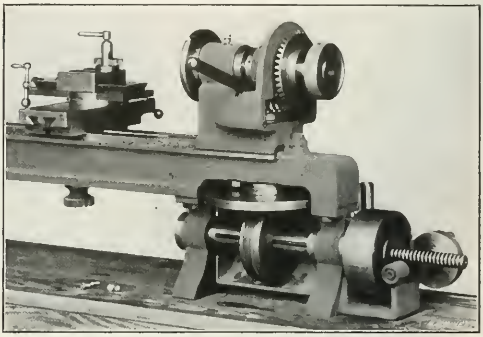


Fig. 3. Rear View of Lathe having Standard Head

The construction of the spindle control clutch is shown by the sectional view, Fig. 4. There is a hardened taper member *A* which, when raised by lever *B*, forces four hardened pins outward against a split ring *C*, thus bringing the latter into engagement with the miter gear *D*. As soon as this engagement takes place, all the working parts of the clutch are revolved with the gear and vertical driving spindle in the center. This engagement is effected with a very slight pressure on the hand lever and the weight of the lever is balanced by a small spring as shown, which causes the inner or forked end to "float" in the circular lifting slot, thus eliminating friction and wear.

The split ring *C* is slightly under size in its released position so that there is no friction at this point when the clutch is disengaged. The entire clutch mechanism is constantly lubricated and the application of the clutch is uniform and powerful. Moreover, the gear is engaged in such a way that its alignment is retained. The clutch handle is located conveniently for the left hand of the operator, so that the ma-

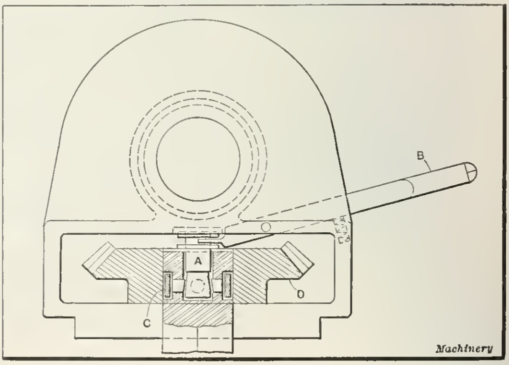


Fig. 4. Clutch for Starting and Stopping Lathe Spindle

chine can be stopped and started easily and quickly. Provision has also been made for starting and stopping, independently of the driving belt, by placing the friction driving disk into a slight depression in the center of the horizontal driven disk. When the driving disk is in this position, the entire machine is stationary, excepting the driving friction shaft which, in this case, acts as a self-contained countershaft.

This friction drive eliminates a cone pulley and permits spindle bearings that are practically continuous. The direction of rotation is easily reversed, and wear between the friction members is taken up by means of eccentric bushings which enable the driving shaft to be raised or lowered parallel with the face of the driven disk. The location of the belt pulley makes it possible to apply power from beneath the bench, as well as from the side or overhead. The grinder can also be driven from beneath the bench, if desired. This lathe has a swing of 8 inches; a 32-inch bed; and a maximum distance of 15 inches between the centers. With the constant-speed driving pulley revolving at 1000 revolutions per minute, speeds ranging from 850 to 2500 revolutions per minute are available.

AJAX RECLAIMING ROLLS

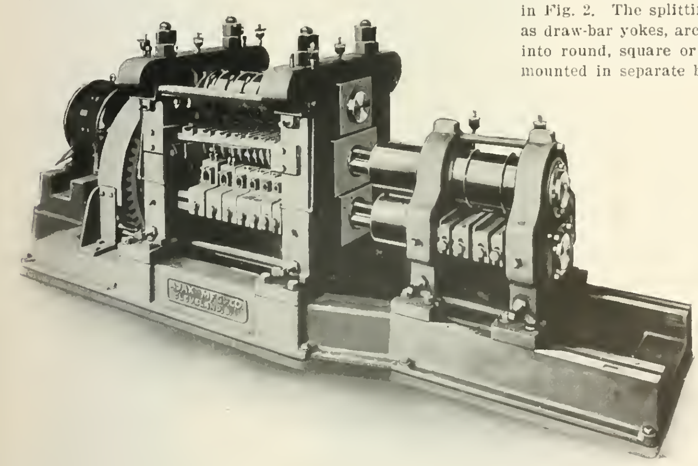


Fig. 1. Ajax Reclaiming Rolls for Re-rolling Round, Square or Flat Bars from Scrap Iron or Steel

The reclaiming rolls illustrated in Fig. 1 were designed for re-rolling scrap iron and steel, in order to reclaim the large amount of material which is thrown on the scrap pile and sold at scrap prices. The waste represented by the scrap heap is a very important item on railroads, but by means of these rolls, all discarded parts, such as truss rods, arch bars, draw-bars, center pins, etc., can be reclaimed by heating and re-rolling them into round or flat stock from which bolts, car fittings or similar parts can be made. These reclaiming rolls are built by the Ajax Mfg. Co., Cleveland, Ohio.

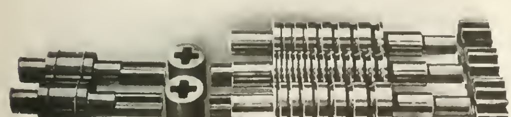


Fig. 2. The Three Reducing Rolls and the Splitting Rolls for Splitting Flat Stock Longitudinally preparatory to Re-rolling

The machine shown in Fig. 1 is a "three-roll-high" type and is provided with an auxiliary or secondary set of rolls for splitting flat stock longitudinally preparatory to re-rolling it in the main reducing rolls. The scrap bars are ordinarily cut into lengths varying from two to five feet. The length depends upon the section, and is decreased as the size of the bar increases. These bars are heated in suitable furnaces and are then started through the rolls. The first pass reduces the bar to an elliptical shape and it is then rolled round on the return pass. This process is repeated until the stock is reduced to the required size.

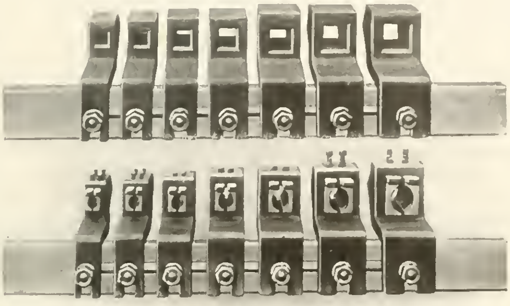


Fig. 3. The "In-and-Out" Guides for Round Stock

The rolls used in this machine are turned from forged steel of special analysis and are mounted in phosphor-bronze bushed bearings. A set of three main reducing rolls for rounds, and a pair of splitting rolls with the crab connection, are shown in Fig. 2. The splitting rolls shear lengthwise such flat stock as draw-bar yokes, arch bars, etc., and thus facilitate re-rolling into round, square or flat stock. These two sets of rolls are mounted in separate housings, as shown in Fig. 1. The yoke over each of the main housings insures ample strength and rigidity. The smaller housings are seated on T-slot ways so that the splitting rolls can easily be removed. The baseplate of the machine is cast in one piece. Two sets of main reducing rolls are furnished, one being for rounds and one for squares or flats, as may be specified. The solid bearings of the main rolls can be adjusted vertically by means of double wedges. The main housings have bronze adjusting pieces which are located against the sides of the bearings and provide lateral adjustment for the main rolls. These bronze pieces are slightly tapered and adjustment is effected by shifting them in or out.

The main reducing rolls are 12 inches in diameter and 40 inches long between the housings and are grooved to reduce 2-inch rounds from 1¾ inch down to ½ inch, inclusive. The range of the main rolls for producing flats depends upon the nature of the scrap, although an idea of the capacity can be obtained from the foregoing figures. A steel channel or trough should be provided back of the machine for receiving the bars when they finally leave the rolls. Against the side of this channel the bars are straightened and allowed to cool.

The machine is equipped with suitable "in-and-out" guides for either round or flat stock. Fig. 3 illustrates sets of in-and-out guides for round stock. The first pass is through an "in" guide (see upper view) between the upper and middle roll, and the bar, rolled to an elliptical shape, comes out through an "out" guide. The bar is then returned through an "in" guide (see lower view) between the bottom and middle roll and comes out round. This process is repeated until the stock is reduced to size. The main rolls have a peripheral speed of approximately 300 feet per minute.

Ample heating capacity should be provided for heating the scrap stock, and two furnaces are recommended, one being a heating chamber for bars up to four feet long and the other for bars up to eight feet long. These furnaces should be placed in front of the rolls and at right angles. The production of these rolls varies according to the nature and size of the scrap bars and the size to which the bars are re-rolled. The heating furnace equipment also affects the production so that it is difficult to give an accurate estimate. The average production, however, ranges from six to eight tons in ten hours, and the fuel cost averages about $6.00. The operating crew consists of from four to five men, including a roller and assistant roller, a heater, a helper and a man to carry the re-rolled bars to the cooling and straightening tables. The power required to operate the rolls, when driving by belt from a lineshaft, will range from 20 to 40 horsepower, whereas if a direct-connected motor drive is employed a 50-horsepower motor is recommended.

BEAUDRY POWER HAMMER

Beaudry & Co., Inc., 141 Milk St., Boston, Mass., have brought out a new design of power hammer. This new hammer is applicable to general forging work and it is especially adapted for plating and drawing steel, or for use in the manufacture of cutlery, edge tools, files, agricultural implements, spindle and general toolmaking or any forging operations requiring an extremely quick blow. The hammer can be operated at a high rate of speed and is designed for continuous service.

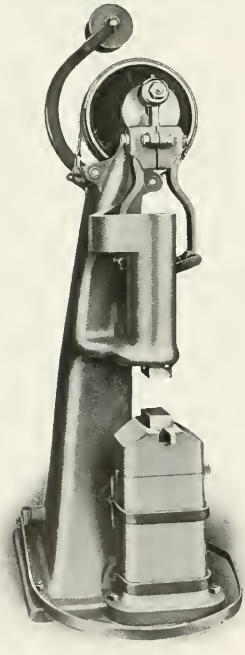


Fig. 1. Beaudry "Peerless" Power Hammer

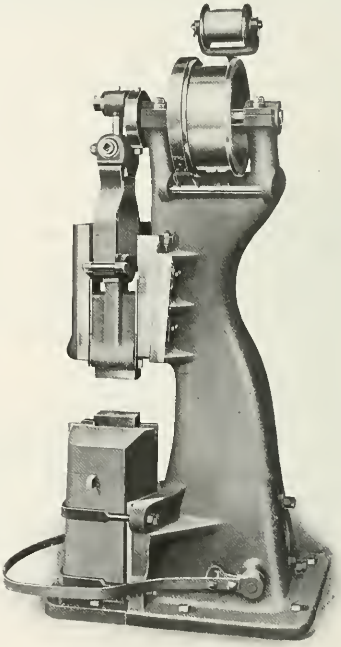


Fig. 2. Side View of Beaudry Hammer

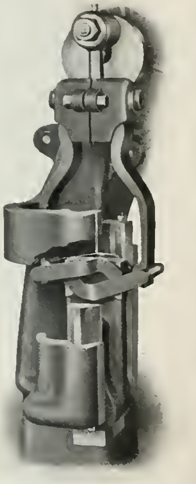


Fig. 3. Sectional View of Hammer

Front and side views of this hammer are shown in Figs. 1 and 2. The ram is connected by means of spring arms and two long steel links which are arranged to occupy a minimum space and, at the same time, give a maximum freedom and lift of the ram, as well as an elastic and cushioned but powerful blow. The tension on the spring arms and links is maintained and adjusted by means of tension nuts in a spring box. These working parts are clearly shown in the sectional view, Fig. 3.

The hammer is started, stopped and regulated by a foot-treadle extending around the base. By varying the pressure on this treadle, any desired speed or force of blow is instantly obtained. The idler pulley for the driving belt, and the brake band, are reversible so that the hammer can be run in either direction. The anvil is a separate casting and a wood filler is inserted between it and the frame to eliminate vibration. The anvil is secured to the frame by strap bolts and, as shown in Fig. 1, it is offset so as to clear the main frame casting, thus allowing long bars to be held on the dies in any position. The anvil has an independent and adjustable shoe die.

The frame is cast in one piece, is very rigid and occupies little floor space. The ram is of steel and is carefully fitted into heavy V-shaped guides. It is adjustable on the connecting-rod for varying the height above the dies and is at all times almost entirely contained within the guides, thereby insuring accurate alignment of the dies and a true, square blow. The ram guides are cast solid with the frame and to one of them is fitted an adjustable, composition, taper gib for taking up wear. The steel crankshaft is of large diameter, has long bearings and runs in babbitted bushings chambered for oil. The crankpin is adjustable for varying the length of the stroke.

The steel connecting-rod operates on a hard, bronze sleeve and is connected with the spring box. The latter is also of steel and into it are fitted the two spring arms to which the links are hooked. These spring arms are held in place by tension nuts, which, as previously mentioned, serve to maintain and vary the tension on the arms. The spring arms are forged from Swedish steel and are carefully tempered. The links are steel castings.

The brake (which is clearly shown in Fig. 2) will hold the hammer in any position. The treadle working in conjunction with the belt-tightening pulley and band brake, serves to instantly stop or start the hammer. The belt pulley is large and has a wide face, thus giving the driving belt ample contact area. This new hammer is made in seven different sizes. The ram of the smallest size weighs 25 pounds, and the largest size, 200 pounds; whereas the approximate weights of the smallest and largest hammers are 1200 and 4409 pounds, respectively.

WAHLSTROM AUTOMATIC DRILL CHUCK

Where a drilling job requires the use of a number of different sized drills, a lot of time is lost in changing from one size to another. The Wahlstrom automatic drill chuck, made by the Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., and illustrated in Figs. 1 and 2, has been designed to avoid this waste of time. Reference to Fig. 2 will show that this chuck consists of a body *D* surrounded by a shell *E*. This shell is knurled on the outside and when it is desired to change drills, it is merely necessary to grasp the shell and hold it against the drive of the drill press. This opens the jaws so that one drill can be removed and another inserted in its place. When the change has been made, the shell is released and the new drill is in position ready for use.

The drill is secured in the chuck by means of three rockers *A* which are pivoted in jaws *B;* the latter are carried in the body of the chuck. When the shell is held back in order to open the chuck, it is twisted against the tension of spring *F*, a suitable stop being provided between the body of the chuck and the shell in order to stop the chuck when it has been opened to its maximum capacity. When a drill is inserted and the shell released, the tension of the spring *F* twists the shell around in relation to the chuck body. In so doing, the jaws *B* are forced in toward a common center through their bearing on three eccentric surfaces on the inner side of the shell. This brings the rockers *A* against the shank of the drill and holds it in position ready for use. When the drill is fed up to the work, the rockers *A* swing on their pivots and the eccentric faces of these rockers are forced in against the shank, the gripping being in direct proportion to the force which is required to drive the drill.

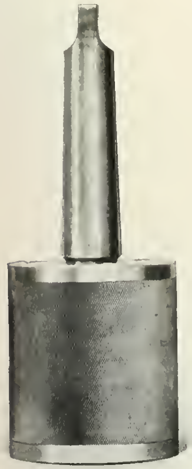


Fig. 1. The Wahlstrom Automatic Drill Chuck

In the design of any drill chuck acting upon this principle, it is necessary that the eccentricity shall be very small in order to secure the required grip. This has been the reason for the limited range of previous types of chucks which have been designed along these lines. In the present case, the provision of the jaw extensions *C* have made it possible to greatly increase the capacity. Reference to the two end views shown in Fig. 2 will make it clear that when the jaws are reduced for the smaller sizes of drills, the jaw extensions *C* are located between the jaws and the eccentric surfaces of the shell. This is the case until the jaws have been opened to about one-half of their capacity. In this position the jaw extensions come up against the shoulders in the shell as shown, and the jaws then come into direct contact with the eccentric surfaces of the shell. They are in this position until the chuck has been opened to its full capacity.

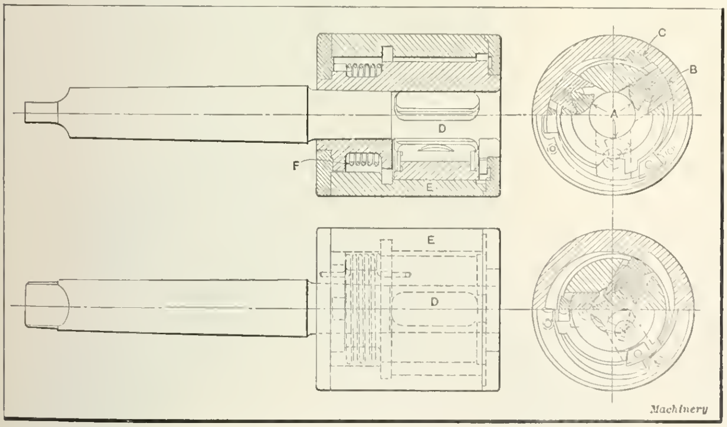


Fig. 2. Cross-sectional View showing Arrangement of Gripping Mechanism

This chuck is suitable for all kinds of drilling, reaming, tapping and counterboring operations where straight shank tools are used. In the case of tapping, it is necessary to grind three flat surfaces on the shank of the tap to provide the necessary drive for backing out the tool. The range of the chuck shown in the illustrations is from a ¾ inch drill down to a No. 33 drill. The chuck will also be placed upon the market in a larger and smaller size. It is constructed entirely of high carbon tool steel with the exception of the jaws *B* and rockers *C;* these are made of high-speed steel. The ¾ inch chuck is commonly made with a No. 3 Morse taper shank, but any other taper can be furnished.

THE WAHLSTROM OIL CUP

Difficulty is sometimes experienced with small oil cups from two causes: first, the cups are difficult to install in cramped positions; and second, the covers in use render it difficult to fill the cups without spilling considerable oil.

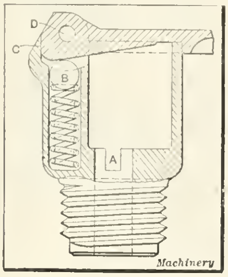


Fig. 1. Cross-sectional View of the Oil Cup

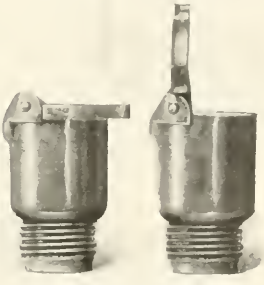


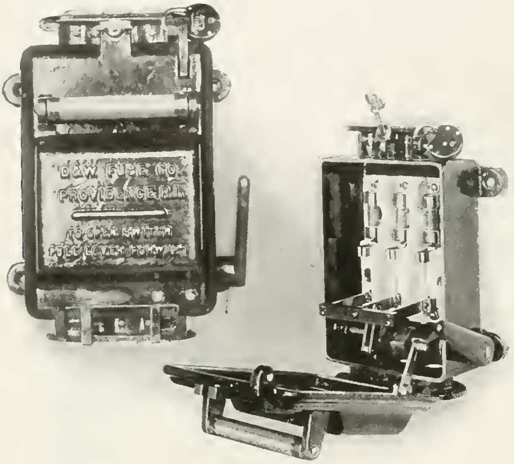
Fig. 2. Oil Cup with Cover Closed and Open

The Wahlstrom Tool Co., 346 Carroll St., Brooklyn, N. Y., has recently placed a cup upon the market designed to eliminate these difficulties. Instead of applying a hexagon at the base, which requires the use of a wrench to screw the cup into place, the Wahlstrom oil cup has been provided with a slot *A* as shown in Fig. 1. This makes it possible to use an ordinary screw-driver when installing the cup. This is generally a more convenient method and it has a further advantage of not marring the outside of the cup. The type of cover used is pivoted at *D*. This enables the cover to be lifted as shown in Fig. 2, thus providing plenty of room for adding fresh oil or for the admission of a screw-driver when installing. The provision of this pivoted cover also makes it easy to use a wire to clean out the oil channels, should they become clogged.

Reference to Fig. 1 will show that there is a spring and ball *B* located in a hole at the left-hand side of the cup. This spring serves the double purpose of holding the cover down when the cup is supposed to be shut, and also of holding it up when the cover is lifted to add fresh oil. In the latter position, the ball *B* is in contact with the surface *C*. The use of this spring does away with the necessity of holding the cover up with one hand while oiling. Where cups are located in close places, this cover design is particularly useful in that it allows the spout of the oil can to be used to lift it. The cup is also made practically dust-proof by the liberally proportioned flange on the cover, which comes down over the top of the cup as shown in the cross-sectional view. These cups are made in seven regular commercial sizes with diameters ranging from ¼ inch to ½ inch.

COMBINED SWITCH AND FUSE BOX

The D. & W. Fuse Co., Providence, R. I., has brought out a new line of fused switch boxes for 250-volt, direct-current circuits. These boxes are particularly adapted for mill service since they can be locked after the fuses are installed, thereby preventing any tampering with the connections or increasing the capacity of the fuses. They can also be used as a switch, as the circuit can be opened or closed at will, by simply moving the lever located at the side of the box, as shown in the accompanying views. When the cover is opened, as illustrated to the right, the circuit is also opened which makes it impossible to re-fuse the circuit when the switch is closed. The construction of these boxes is simple but substantial, and they will last indefinitely. They are provided with rubber gaskets which make them waterproof, provided the terminal wires are "taped in" at the bushings or protected by outlet hoods when conduit connections are made. To facilitate installing these boxes, removable porcelain bushings are used, through which the cable terminals can be readily passed.



D. & W. Combined Switch and Fuse Box with Safety Lock

THE HALE LOOSE PULLEY

The Cleveland Clutch Co., Cleveland, Ohio, is manufacturing a loose pulley that is quite different from the usual form. The pulley proper has a large hub which fits over a bearing sleeve that is locked to the shaft by a set-screw. When placing the pulley on a shaft, the bearing sleeve is first fastened in position. The pulley is then slipped over the sleeve and the side retaining cover or plate is screwed on. Fig. 1 shows the pulley assembled, and Fig. 2 illustrates the different parts, the retaining cover being to the left and the bearing sleeve to the right.

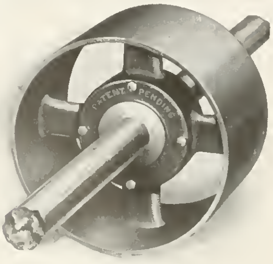


Fig. 1. Hale Loose Pulley

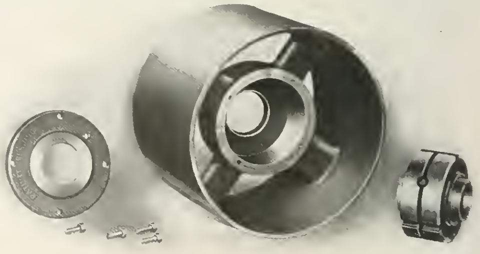


Fig. 2. Parts of the Hale Loose Pulley

One of the noteworthy features of this pulley is the efficient method of oiling the bearing surfaces. The oil is not wasted and the lubricant always remains on the bearing, regardless of whether the pulley is idle or revolving at high speed. The particular pulley illustrated is a 12-inch size and has an 8½-inch face, and the friction surface has the same area as that of an ordinary loose pulley of the same dimensions. The principal features claimed for this pulley are, that it is self-oiling; durable; dust- and dirtproof; oil-tight; economical in the use of lubricant; prevents oil from being thrown on the belt; eliminates wear of the shaft; keeps the lubricant constantly on the bearing; is easily mounted on a damaged shaft; and, when once oiled, requires no attention for months.

ELECTRIC PRECISION GRINDER

The portable, electric, precision grinder shown in Figs. 1 and 2, is the product of the Chicago Pneumatic Tool Co., 1014 Fisher Bldg., Chicago, Ill. This electric grinder is known as the "Duntley No. 6," and is adapted to a large variety of work, being designed for both external and internal grinding. A commendable feature is the adjustable frame, which is milled convex on its lower surface, and rests on a concave shoe, as shown in Fig. 1. When the grinder is applied to a lathe, this concave shoe rests on the tool-post base and is clamped to it by the bolt and nut shown. The center of the grinding wheel arbor is brought in line with the center of the work, by simply pushing the frame back or forth on the concave shoe and then tightening the clamping bolt when the grinder is set in the desired position. This adjustment makes it possible to use this grinder on lathes having a swing of from 16 to 42 inches, inclusive.

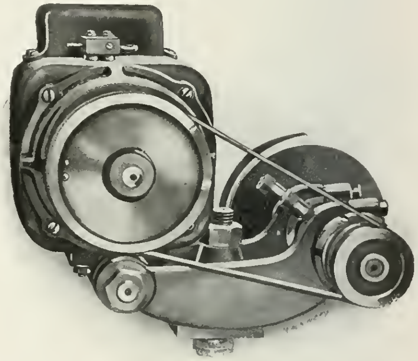


Fig. 1. Chicago Pneumatic Tool Co.'s Electric Grinder

The arbor for external grinding carries a 5-inch wheel (see Fig. 1) and is provided with a split-sleeve bearing, which is tapered on the outside, and can be accurately adjusted for wear. The heads of the cap-screws for fastening the straps which hold the arbor sleeve to the frame, extend only a slight amount beyond the arbor housing itself. This is an important feature, as it permits the emery wheel to be worn down to a small diameter, and allows sufficient clearance between the grinder and the tailstock of the lathe—this is a requirement not found in most grinders of the tool-post type.

The arbor for the internal grinder (see Fig. 2) runs in

Hess-Bright ball bearings, which are located at the ends of the arbor and provide a support close to the wheel and driving pulley. The arbors for external and internal grinding can be changed in a few minutes by simply removing the cap-screws of the straps which hold the arbor sleeve to the frame.

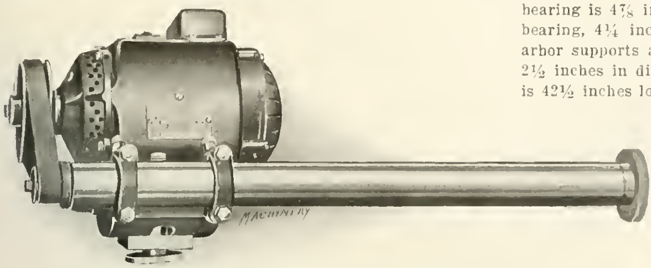


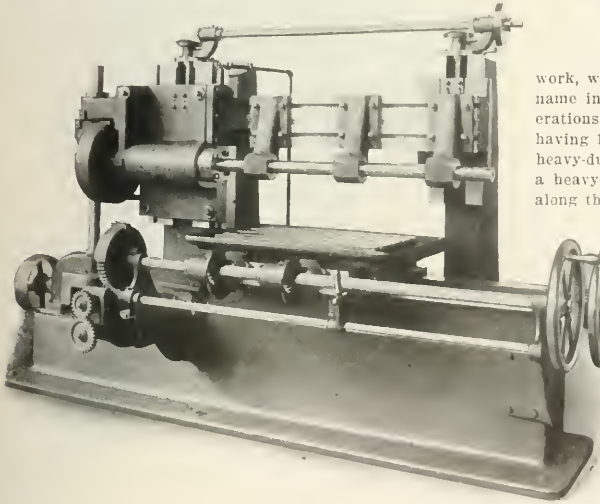
Fig. 2. Grinder illustrated in Fig. 1 arranged for Internal Grinding

The motor is mounted on a hinge-pin, permitting it to be swung back to tighten the belt. Pulleys of the desired size to give the proper wheel speeds are furnished, and the motors can be obtained in a variety of types for either direct current or alternating current of the single, two, or three-phase systems.

SPECIAL BEAMAN & SMITH MILLING MACHINE

The milling machine shown herewith has been designed by the Beaman & Smith Co., Providence, R. I., for milling the ends of crankshaft bearings on crankcases. It has a horizontal bed upon which is mounted a work-table that can be traversed laterally on its saddle and longitudinally along the ways of the bed. Two uprights are attached to the bed which support the spindle-saddle and cross-rail. The cross-rail is attached directly to the spindle-saddle and it can be raised or lowered by hand. The horizontal shaft connecting the vertical adjusting screws, carries at the right-hand end a dial graduated to thousandths of an inch to facilitate setting the cutters accurately to depth.

The spindle is driven by a single pulley seen at the left of the machine from which power is transmitted to the spindle through shafting and gearing. The table has a hand movement of 32 inches in line with the spindle, and a cross-movement of 11½ inches. There are positive geared feeds for the cross-movement and five changes are available, ranging from 1½ to 6½ inches per minute.

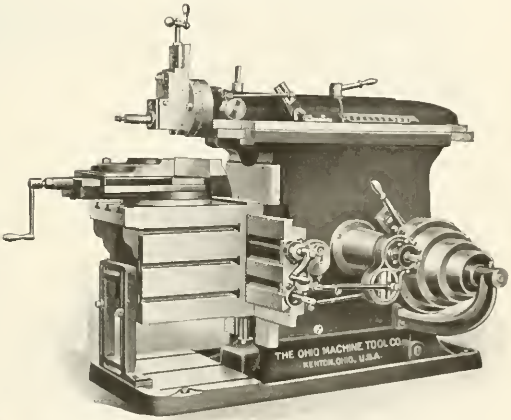


Special Machine for Milling End of Crankshaft Bearings on Crankcases

The table has a working surface 18 inches wide and 32 inches long, and it is surrounded by a large oil channel. The spindle is of crucible steel and runs in boxes of hard bronze which can be adjusted to compensate for wear. The front bearing is 4⅞ inches in diameter, 6 inches long, and the rear bearing, 4¼ inches in diameter and 5½ inches long. Three arbor supports are provided having phosphor-bronze bearings 2½ inches in diameter and 5¾ inches long. The arbor itself is 42½ inches long and 1⅞ inch in diameter. The machine is driven by a 4-inch belt, and the ratio of the gearing is 2.7 to 1, giving a spindle speed of 250 revolutions per minute. Lubricant for the cutters is provided by means of a pump. The distance between the uprights is 44 inches, and the minimum and maximum distances from the center of the spindle to the top of the table are 10½ and 16¾ inches, respectively. The weight of the machine is approximately 10,300 pounds.

OHIO STANDARD AND HEAVY-DUTY SHAPERS

The Ohio Machine Tool Co., Kenton, Ohio, has brought out two types of shapers. One is known as the "standard" shaper and is intended for ordinary tool-room and machine shop work, whereas the other is a "heavy duty" type which, as the name implies, is designed especially for heavy machining operations. These shapers, in both styles, are built in sizes having 16-, 20- and 24-inch strokes, and there is also a 28-inch heavy-duty machine. The accompanying illustration shows a heavy-duty 24-inch size. The standard type is constructed along the same lines but is lighter in weight.



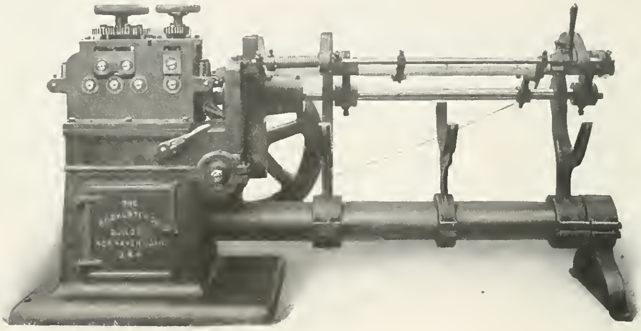
Ohio 24-inch Heavy-duty Shaper

The bull gears of these shapers are of large diameter and the crank-arms are extra long and heavy, in order to transmit power to the cutting tool with a minimum of vibration. The 20- and 24-inch sizes have a variable, automatic, vertical power feed for the table. The vertical power feed for the head, which is shown applied to the machine illustrated, is a special attachment. This device feeds the tool either up or down and gives feed variations ranging from 0 to 3/16 inch. It is actuated by a tumbler movement that is positive in its operation. The standard 20-inch machine has a keyseating capacity of three inches, and the heavy-duty type, 3½ inches; whereas the 24-inch sizes in both types have keyseating capacities of 3⅝ and 4⅝ inches, respectively. Motor drives are applied to any size shaper and on the 20- and 24-inch machines, the motor is attached to the back of the column. By having these two types, the manufacturers can supply a shaper adapted to the requirements of the shop in which it is installed.

SHUSTER STRIP-METAL STRAIGHTENER AND CUTTER

The accompanying illustration shows an automatic strip-metal straightener and cutter built by the F. B. Shuster Co. of New Haven, Conn. This machine is larger than similar types previously built by this company and embodies several improvements. It is designed for straightening and cutting to accurate lengths (from the coil) such metal as brass, copper, steel, iron, etc. The machine has a capacity for widths up to three inches and will take stock up to ⅛ inch thick. The particular machine illustrated will cut lengths up to four feet but it can be built for any length desired.

There are five straightening rolls and a pair of feed rolls, all of which are enclosed by the housing instead of being outside, which is the construction of the smaller sizes. All the rolls are geared and the upper ones are adjustable to suit the shape and temper of the stock passing through the machine. This adjustment is effected by the handwheels shown on the top of the housing and can be made while the machine is in motion. There are suitable guides at the rear for taking care of various widths and thicknesses of metal.



Shueter Automatic Strip-metal Straightener and Cutter

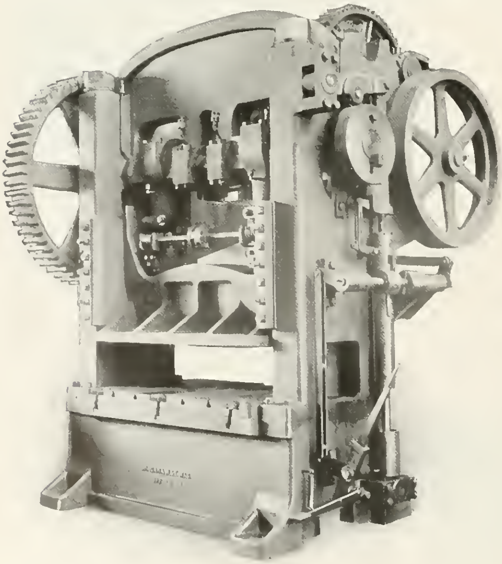


Fig. 1. Niagara Double-crank Press

This machine has a mechanism which stops the feeding of the material while it is being severed. When operating the machine, the metal is placed on a suitable reel at the rear, from which it passes through guides into the straightening and feed rolls. Continuing, it moves past the stationary dies and cutters out into the guide-bar until it strikes a gage previously set for the length to be cut. This throws the feed-releasing mechanism into operation, thus causing the feed to stop and the cutters to come into action. At the same time, the cover of the guide-bar is thrown off and the severed piece drops into the fork-shaped brackets shown. The extension of this machine is similar to that applied to the straighteners and cutters for round, square and hexagon stocks, except that the guide-bar is designed and grooved for strip metal.

LARGE NIAGARA DOUBLE-CRANK PRESS

The large double-crank press shown in Figs. 1 and 2 was recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y. This press is adapted for a wide range of work, such as heavy blanking, shearing, forming, embossing, and cold-drawing operations. It is equipped with the Niagara combination friction clutch and brake. The friction clutch is of the multiple-disk type and the friction surfaces are lined with end-grain, hardwood blocks. The clutch is entirely encased and all projecting rotating parts which might endanger the operator when oiling the clutch, are eliminated. The clutch is operated by four sets of toggles and links which are made of steel.

The brake, which works in unison with the clutch, consists of two brake levers which are actuated by a pair of toggles. An interesting feature of the construction is that the pressure on the brake blocks is always equalized, thus avoiding transmitting the pressure of the brake arms to the shaft bearings. The clutch can be started by a foot treadle actuating an automatic device which will stop the press when the slide reaches the highest position. This self-acting device can be quickly thrown out of action and the motion of the press controlled by a hand lever. This lever permits starting and stopping the machine at any part of the stroke.

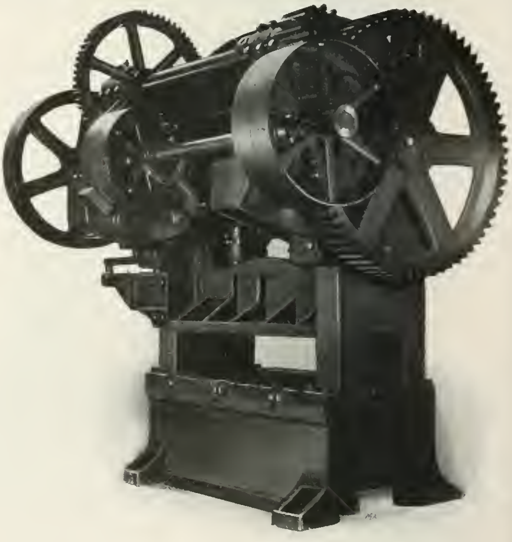
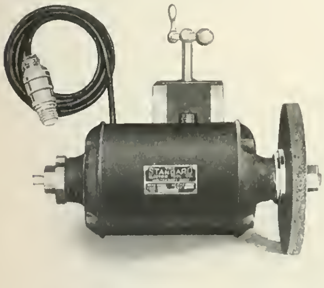


Fig. 2. Rear View of Niagara Press

To guard against breakage, in case the press is accidentally overloaded, there is a safety coupling on the pinion shaft. The housings and arch are held together by four steel tie-rods, 5½ inches in diameter, which are shrunk into place. The slide and gibs have the same means of adjustment common to all large presses built by this company. The press measures 72 inches between the housings and weighs 60,000 pounds. It covers a minimum amount of floor space, as the drive is located overhead and outboard bearings are eliminated.

PORTABLE ELECTRIC GRINDER

The portable electric grinder shown herewith is made by the Standard Electric Tool Co., Cincinnati, Ohio. This grinder is mounted on an angle-plate and is attached to a lathe by bolting this plate to the toolpost rest. A shank can be furnished instead of the angle-plate attachment, if desired. There is a vertical dovetail slide on the angle-plate which gives an adjustment of four inches for locating the grinding wheel in line with the lathe centers. This grinder can be used for grinding rolls, shafts, bushings, and similar work. It is also adapted for surface grinding on the planer and can be used to advantage on the boring mill for certain classes of work. The bearings are made of phosphor-bronze and are dust-proof and adjustable. The motor is force-ventilated or air-cooled by a special fan mounted on the armature shaft. The armature and poles are built up of the best grade of soft, electrical, sheet-steel laminations, uniformly insulated. This grinder is made in one-half and one horsepower sizes.



Standard Portable Electric Grinder

BAKER BROS. HIGH-SPEED DRILLING MACHINE

Baker Bros., Toledo, Ohio, have added to their line of drilling machines the powerful high-speed, heavy-duty type shown in Fig. 2. A glance at this illustration will give one a better idea of the massiveness and rigidity of the construction than a whole page of description. The machine has a heavy box column and also a box-type, screw-elevating table. It has a single belt drive and the driving train is composed of all hardened steel gears. The shafts are large and are mounted in Hess-Bright ball bearings. A minimum number of gears consistent with the necessary speed changes are in mesh at one time. On the four direct speeds, only three pairs of gears are meshed simultaneously, and there are never more than five pairs engaged at one time.

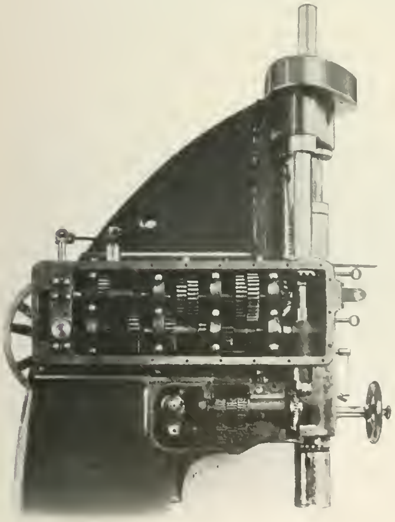


Fig. 1. Speed- and Feed-changing Mechanism of Baker Bros Drill

There are twelve changes of feed ranging from 0.006 to 0.032 inch per revolution of the spindle. In addition, the feeding mechanism has an attachment which enables any one of the drilling feeds to be increased 3½ times, when the machine is to be used for reaming. All of the control levers are centralized and in convenient positions.

There are eight speed changes controlled by two interlocking levers in such a manner that all of the speed changes can be successively engaged; that is, the machine can be run on each of the eight speeds, beginning at the slowest and increasing to the highest, in eight seconds. A detail view of the machine is shown in Fig. 1 with the gear-case cover removed in order to show the arrangement of the speed- and feed-changing mechanisms. The spindle speeds range from 35 to 351 revolutions per minute and the changes are effected by sliding gears controlled by a lever at the front. There are no dive keys or tumbler gears in the driving train, and the entire mechanism is enclosed in an oil-tight case.

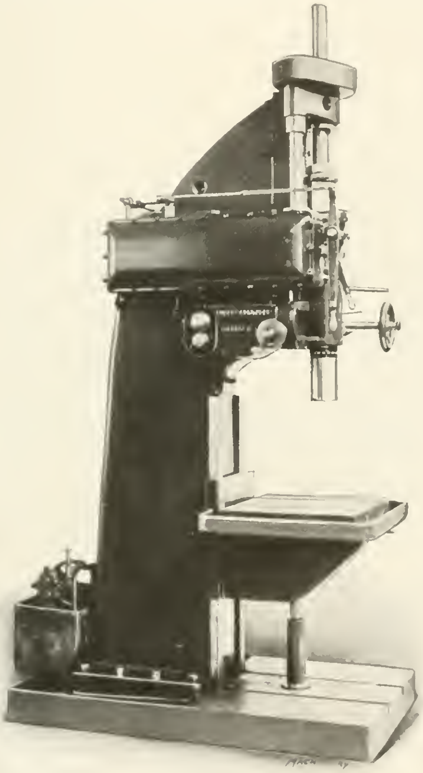


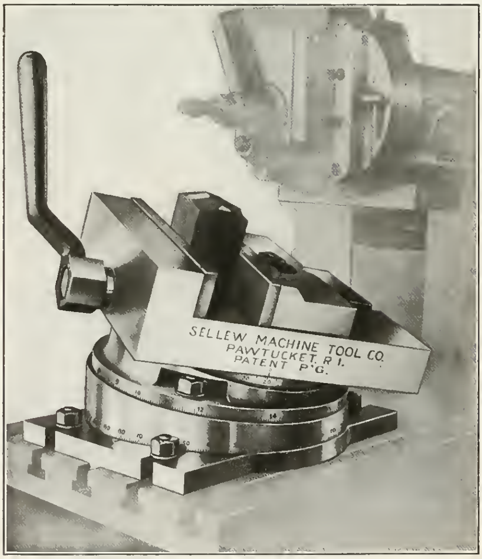
Fig. 2. Baker Bros. Heavy-duty Drilling Machine

The spindle has a vertical feeding movement of 20 inches and is equipped with a depth stop. All feed changes are obtained by means of a powerful dive key and quick-change slip gears. A safety device on the spindle feed shaft is provided to protect the feeding mechanism from injury and to provide uniform wear for the large worm-gear. The spindle has the usual hand lever feed and a quick-return movement. This machine has a capacity for driving 3-inch, high-speed steel drills in solid steel. The spindle is made from high-carbon, hammered, spindle steel forgings and has a minimum diameter of 3 inches and a maximum diameter of 4¾ inches. The thrust is taken on high-duty bearings having ¾-inch balls. The end of the spindle is bored for a No. 5 or No. 6 Morse taper.

The table has a working surface of 20 by 30 inches and a vertical travel of 30 inches. The maximum distance from the end of the spindle to the top of the table is 46 inches. The swing of the machine is 36 inches, that is, 18 inches from the center of the spindle to the column. The drive is by a 3½-inch belt running on an 18-inch pulley. An oil pump, tank and the necessary piping is provided in the equipment. The weight of the complete machine is about 4750 pounds. A compound table of the box knee type can be furnished if desired. The lateral and longitudinal screw adjustments of this type of table enable the work to be positioned quickly and accurately, the handles being so located that the operator can move both simultaneously. Micrometer dials are provided on the screws for accurate adjustment.

UNIVERSAL VISE FOR MACHINE TOOLS

The Sellew Machine Tool Co., of Pawtucket, R. I., is manufacturing a vise for use on shapers, planers, drilling machines, etc. This vise can be set in any plane within the range of its angular adjustment. It is exceptionally low and provides a rigid unyielding support for the work. The vise proper is mounted on two tapering or oblique disks, and by changing the relative positions of these disks, the angular adjustment is obtained. When the thin side of the upper disk is directly above the widest or highest part of the base, the vise is in a horizontal position. By turning the upper disk, any angle within the maximum represented by the combined angles of both disks, can be obtained. The entire vise can be adjusted about a vertical axis for machining compound angles in connection with tool and die work, and the vise proper can also be turned about an axis perpendicular to the top of the upper disk.



Universal Vise applied to a Shaper

The two oblique disks are graduated on the peripheries so that direct readings can be obtained for the angular adjustments, and radial readings for the adjustment about a vertical axis. Graduations are also provided just under the vise itself to permit adjusting the latter a definite amount regardless of the position of the base. The use of oblique disks for obtaining the angular adjustment makes the vise simple in construction and unusually low. The vise also has a solid metal support direct from the base which makes it rigid, and is conducive to accurate work. It has hardened and ground jaws and is made, at present, in 10- and 12-inch sizes. The 10-inch size has a capacity of 6½ inches, and the 12-inch, a capacity of 9 inches. The weights of the two sizes are 185 and 225 pounds, respectively. One of these vises is shown applied to a shaper in the accompanying illustration.

SHOP AND DRAFTING-ROOM LAMP ATTACHMENTS

A simple form of adjuster for regulating the height of the drop light, is shown in Fig. 1. This fitting can be attached to any flexible cord and it enables the light to be raised or lowered and automatically held at any desired height. This adjuster is made entirely of porcelain and is without springs, latches or winding drums. It operates on the double-pulley tackle principle, there being removable and stationary pulley blocks. The upper stationary member is a disk-shaped block, whereas the lower member is a ball-shaped counterbalancing device. The upper block is held by supporting chains, thereby relieving the rosette and intervening cord of all strain. Any lamp and shade not weighing over two pounds can be balanced by placing the proper number of removable lead weights inside the counterbalancing member.

This adjuster can be quickly attached to a flexible cord, either before or after the light is in place. The lamp cord from the rosette is clamped in the upper block and continues downward around the sheave of the pulley member, up over the sheave of the upper block and then through a central channel in the counterbalancing ball. Each adjuster is provided with enough removable weights to balance a lamp and shade weighing one pound. The all-porcelain construction insures good insulation and the well proportioned cord channels and sheave surfaces reduce the friction and abrasive action. This adjuster can be applied to any twisted or solid flexible cord.

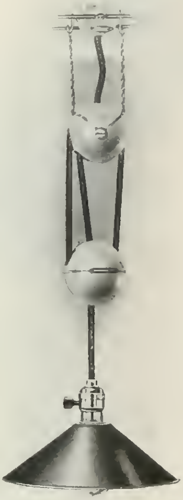


Fig. 1. Adjuster for Drop Lights

Another attachment for the electric lamp is shown in Fig. 2. This is simply a clip having a forked end engaging the neck of the socket, and a hook at the other end for catching the lamp cord (as shown in the view to the right) when it is desired to hold the lamp in a horizontal position. With this device, a drop-light having a side reflector, can be quickly set to throw the light downward as well as sidewise. The clip is made of a resilient insulating material and it can be applied by snapping the large end over the socket shell. This clip is made to fit any standard socket. Both of these devices are manufactured by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

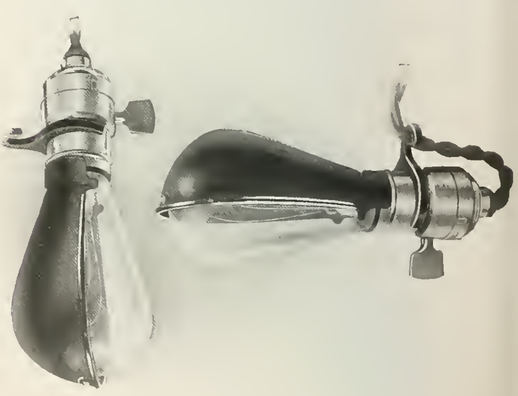
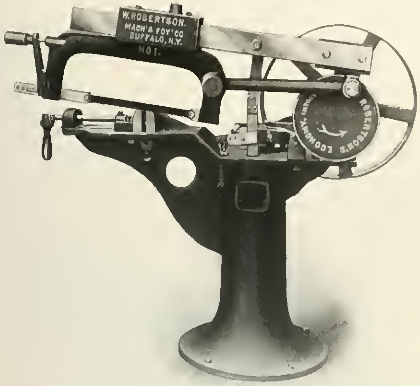


Fig. 2. Clip for Holding Lamp in Horizontal Position

THE ROBERTSON NO. I "ECONOMY" POWER SAW

The W. Robertson Machine & Foundry Co., of Buffalo, N. Y., is now building the hacksaw machine here illustrated. The compact design of the base of this machine will be appreciated in shops where floor space is at a premium. This is a No. 1 size, having a smaller capacity than the No. 2 power saw manufactured by this company. It cuts on the draw stroke and is equipped with the regular Robertson type of mechanical lift for the idle or return stroke. There is a quick-starting clutch and an automatic stop which comes into action when the cut is completed. The farme is mounted on a finished steel bar and has a bearing of 7 by 2 inches, which is provided with means of adjustment to compensate for wear. The machine has a capacity of 4½ inches in the vise and is driven by a 15-inch pulley of 2½-inch face. It uses either 10-inch or 12-inch saw blades and has a total weight of 180 pounds.



Robertson No. 1 Power Saw

REED-PRENTICE HIGH-SPEED GEARED-HEAD LATHE

The geared-head lathe shown in Fig. 1 is the latest product of the Reed-Prentice Co., Worcester, Mass. This lathe embodies several new and important features and is designed to give a high production with a minimum of power consumption. Formerly there was considerable friction in the bearing which supported the driving pulley, due to the high tension of the driving belt necessary because of the heavy cuts incident to the use of high-speed steels.

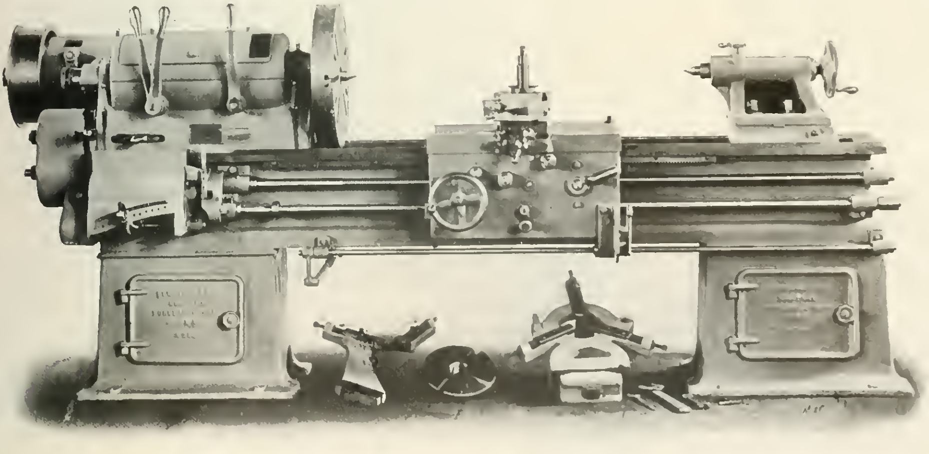


Fig. 1. Reed-Prentice 20-inch Geared-head Lathe

In the design of this new lathe, the hood *A* for the reversing mechanism (which is used principally for screw cutting purposes) and the support *B* for the pulley, are cast integral with the main head casting, as shown in Fig. 2. This gives a very rigid construction. The flanged pulley is mounted at the left end of the head, and ball bearings *C* of the "double purpose" type are used so that both radial and end-thrust loads will be provided for. The bearings are so designed that wear can be compensated for, although there is not likely to be trouble from this source. The bearings and balls are of the best alloy steel and are accurately made.

The pulley has offset or curved spokes in order to locate the rim and center of the belt, directly over the center of the supporting ball bearings. To prevent the driving belt from becoming oil-soaked and losing a large part of its pulling power, there is an annular ridge *D* on the hub of the pulley and in the center of the bearing recess, so that whether the pulley is at rest or in motion, the oil dropping into this recess will not work its way along the spokes to the face of the pulley and then onto the belt.

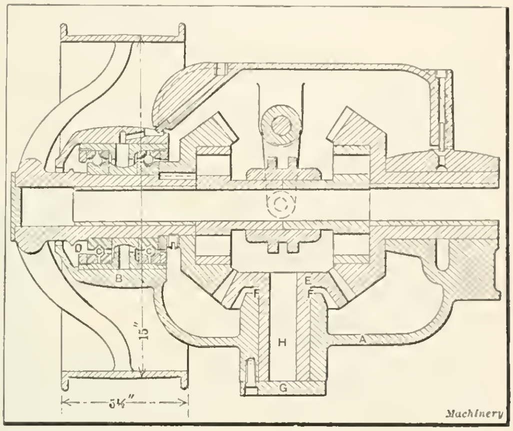


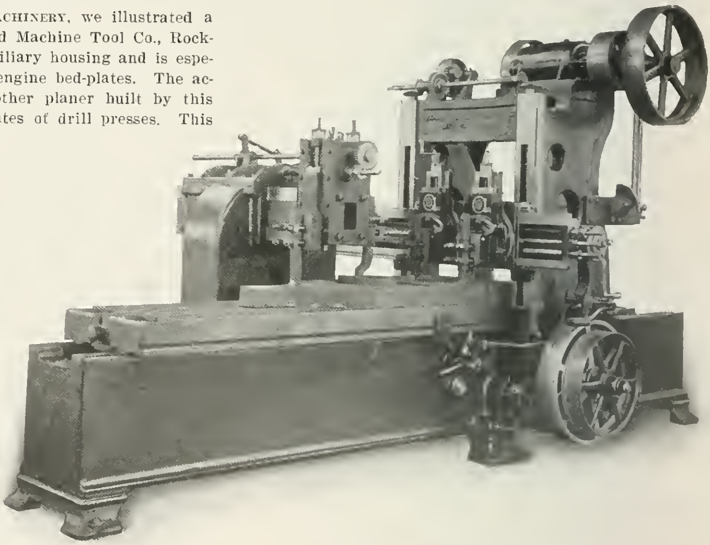
Fig. 2. Reversing Mechanism of Reed-Prentice Lathe

The method of mounting the intermediate bevel gear provides a very substantial support. When subjected to a working load, whatever tendency there may be for the bevel gears to crowd apart, is resisted by the bearing at a point *F*, close to the bevel faces and directly opposite the line of pressure. The thrust piece *G* is made oil-tight so that the hole *H* through the bevel gear can be filled with oil. This oil flows through a series of holes drilled through the hub of the gear and lubricates the bearing surface. The oil also forms a cushion between the walls and is said to eliminate, to a great extent, the metallic vibration between the revolving parts.

With this form of drive, any size or type of motor can readily be applied. The motor is fastened to a vertically adjusted bracket on the rear side of the leg and by means of the mechanical adjustment, the tension of the belt can be adjusted to any degree required. When equipped with a motor drive, the lathe is a complete unit having its power plant, reversing mechanism for thread cutting, and a complete range of thread and feed changes. The headstock is heavier than that of former designs and has several improvements. There is a larger hole through the spindle, larger centers and a heavier spindle nose, etc. There is also a better arrangement for overcoming the centrifugal force of the friction fingers, which has a tendency to open the friction at high speed and cause it to drag in its cup.

ROCKFORD FOUR-HEAD PLANER WITH SPECIAL HOUSING

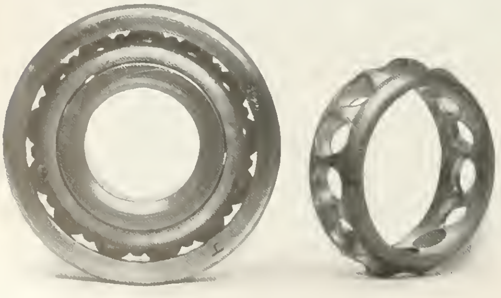
In the September number of MACHINERY, we illustrated a special planer built by the Rockford Machine Tool Co., Rockford, Ill. This machine has an auxiliary housing and is especially designed for machining gas engine bed-plates. The accompanying illustration shows another planer built by this company for machining the baseplates of drill presses. This planer also has a special housing, although the construction differs considerably from the machine formerly described.



Special Planer for Machining Upright Drill-press Bases

By referring to the illustration, it will be seen that there is a special housing carrying two tool-holders which are mounted on a ram of square construction. This ram is supported by the housing and has a lateral feeding movement, whereas the tool-slides are adjustable vertically. The power feed for the ram is obtained from a friction at the rear of the machine, which is mounted on the intermediate shaft of the planer. This friction transmits the motion to the horizontal shaft seen at the top of the housing, which connects through gearing with the horizontal feed-screw of the ram. The feeds are controlled and reversed by a trigger gear located in front of the head within easy reach of the operator. The machine is equipped with this company's standard four-speed drive giving four cutting speeds with a constant return. It is arranged for a belt drive direct from the lineshaft, eliminating the usual countershaft.

When a drill press base is being planed, the different surfaces are machined as follows: The flat T-slotted base is planed by the two heads on the regular cross-rail. While this is being done, the rear head of the special attachment planes the top surface of the hub for supporting the drill press column, while the front head planes the pad for the outer bracket at the rear end of the base. By the use of this special attachment, three separate surfaces which vary in height are planed simultaneously. This machine is said to handle this work very satisfactorily and the castings are planed in one-half the time previously required on a similar machine without the special attachment. Of course, when an ordinary planer is used, it is necessary to plane the work at three different settings, inasmuch as the surfaces are on different planes.



Gurney Ball Bearing and Alloy Retainer

GURNEY ANNULAR BALL BEARING

The Gurney Ball Bearing Co., Jamestown, N. Y., has recently placed upon the market the form of annular ball bearing herewith illustrated. The balls of this bearing are carried in a solid cast separator, which is shown beside the assembled bearing. In mounting these bearings, the inner races should have a light driving fit on the shaft, while the outer races are made a free fit in the housing. No filling slots are used and the method by which the balls are held between the races is such that the bearing is capable of carrying light thrust loads. The inner races are stamped with a number and the outer races with the corresponding number, and also the name "Gurney." The bearings are assembled in such a way that the markings on the inner and outer races are on opposite sides, and when a thrust load is to be carried the arrangement should be such that the thrust on either race comes against the stamped sides.

NEW MACHINERY AND TOOLS NOTES

Ink Wash: W. G. Bond, P. O. Box 229, Wilmington, Del. This wash is applied by dampening the surface to be erased with a moist cloth. The ink is softened in one or two minutes and can then be wiped off. The wash is put up in one-ounce and four-ounce bottles.

Rotary Chucks: Pratt & Whitney Co., Hartford, Conn. Double and quadruple rotary chucks for the vertical spindle surface grinder built by this company. The double chuck enables two pieces to be ground simultaneously and the quadruple chuck, four pieces. The double chuck is adapted to concave grinding.

Stand for Portable Drills: Chicago Pneumatic Tool Co., Chicago, Ill. Drilling stand built to hold the Duntley portable electric drilling machines. The drill can be attached or detached very quickly and the stand will take either of the standard portable machines having capacities for drilling 3/16 or 1/4-inch holes in steel.

Radial Drilling Machine: Fosdick Machine Tool Co., Cincinnati, Ohio. New design of radial drilling machines built in sizes having 2½- and 3-foot arms. These machines have a geared feed of the drive-key type, instead of the belt feed formerly used. The reverse and rapid traverse frictions have been made more powerful and the round table has been replaced by a box table.

Bench Filing Machine: Edge & Edwards, 34 N. 11th St., Newark, N. J. Bench filing machine, the table of which can be adjusted to any desired angle by means of two thumb-screws. The reciprocating file-holder slides in two bearings placed five inches apart. The upper bearing is bronze-bushed and can be adjusted for wear. The file-holder carries with it a cap which entirely covers the upper bearing.

Cutting-off Machine: The W. P. Davis Machine Co., Rochester, N. Y. Six-inch cutting-off machine having a geared scroll chuck on the rear end of the spindle, which is operated by a handwheel instead of a pin, as formerly. This handwheel enables the operator to make adjustments quickly. A splash guard has also been placed over the front chuck to prevent the cutting compound from flying about.

Aloxite Cloth Rolls: The Carborundum Co., Niagara Falls, N. Y. Aloxite rolls of abrasive cloth having widths varying from one-half to two and one-half inches. The cloth is tightly rolled on metal spools, each containing fifty yards. These rolls can be kept on a rack or in any convenient place in the shop. They prevent waste of material and loss of time. The Aloxite cloth is clean and sharp and cuts fast. It is made with various grades of grit.

Telpherage System: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Telphers for handling miscellaneous packages in freight terminals, transfer stations, etc. The telpher train runs on an elevated, single-rail track and consists of a motor-driven tractor with one, two or three trailers. Each trailer is equipped with a motor-operated hoist. The tractor motor and trailer-hoist motors are controlled by an operator stationed in the cab of the tractor.

Convertible Open-side Planer: Detrick & Harvey Machine Co., Baltimore, Md. This planer is primarily a double-housing type, but by removing the outer housing or post, the machine can be converted into an open-side planer, thus greatly increasing its range and adaptability. The note published in the September number relating to this machine, was incorrect in that it referred to the planer as an openside type which could be converted into a double-housing machine.

Belt Shifter: The W. P. Davis Machine Co., Rochester, N. Y. Belt shifter applied to this company's lathe countershafts for shifting the belt from one step of the pulley to another. The device is located on the shifting rod and it leads the belt from one step to another without injuring it. In shops where the ceilings are high, it is difficult, with the usual arrangement, to change the speed of a belt-driven lathe without the use of a pole. This belt shifter is now a part of the company's standard equipment.

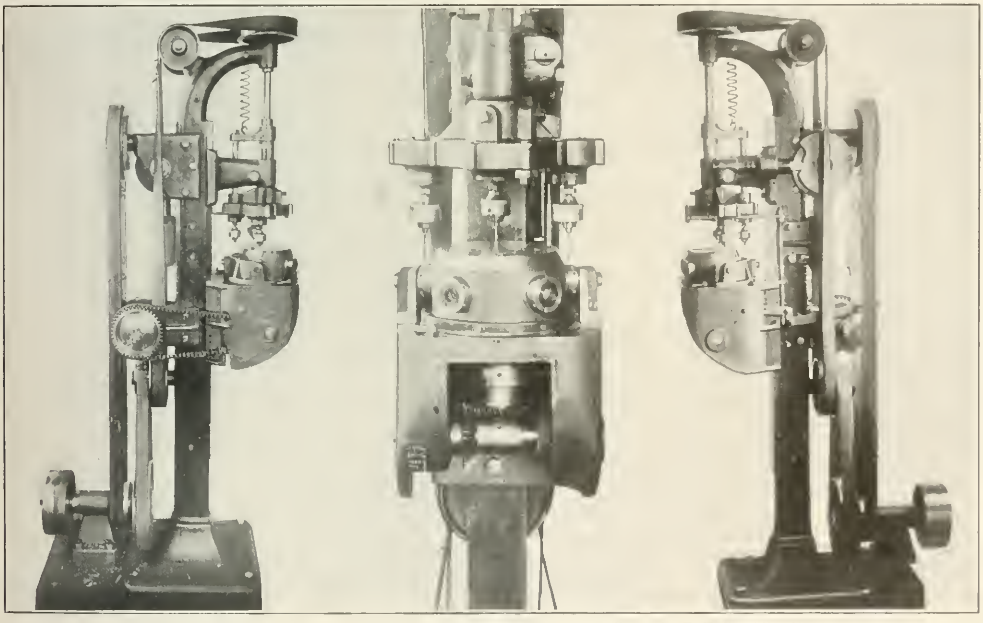
Portable Slotting Machine: Newton Machine Tool Works Inc., Philadelphia, Pa. Portable slotting machine driven by a ten horsepower Westinghouse reversing motor. The saddle has a power cross-feed of 48 inches, and if a greater traverse is required, the upright or vertical column can be adjusted by hand on the base. The length of the stroke is controlled by a master switch operated by adjustable trips or by hand. This tool has a cutting speed on the downward stroke ranging from 20 to 37½ feet per minute and a quick return varying from 42½ to 75 feet per minute. The complete weight of the machine is 23,000 pounds.

Thread-rolling Machine: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. Automatic machine for rolling threads on round shells having flanges or steps. It is also possible to handle straight, cylindrical pieces. The shells to be threaded are placed in a chute and are released by an automatic trip. The chute is made in two sections and the lower half swivels and carries the shells in line with the lower chuck. An automatic pusher forces the shell into the chuck where it is held by a retainer, while the upper chuck moves in and rolls the thread. At the completion of the thread-rolling operation the finished shell is automatically ejected. This machine has a capacity of 30,000 shells in ten hours, and will roll diameters varying from ½ to 3 inches.

* * *

FRANKLIN AUTOMATIC CAP-SCREW DRILLING MACHINE

An automatic cap-screw drilling machine, which reduces the work of four men to one, is the latest product of the tool-construction department of the H. H. Franklin Manufacturing Co., 203 So. Geddes St., Syracuse, N. Y. This automatic cap-screw drilling machine, three views of which are shown herewith, has the capacity of drilling holes in two thousand cap-screws a day. It is a continuously operating drill which drills three cap-screws at a time. Formerly the cap-screw holes were drilled on four separate machines. Each machine drilled one hole at a time, and two minutes was required to drill the holes in one cap-screw. This new machine not only drills three cap-screws at a time but, after the cap-screw is completely drilled, it is automatically forced from the machine and all the operator has to do is to insert another cap-screw. This one machine will take care of the drilling of all the cap-screws needed in the manufacture of Franklin automobiles.



Automatic Machine that will drill Holes in 2000 Cap-screws a Day—built by the H. H. Franklin Mfg. Co.

The turret in which the cap-screws are inserted, holds five at a time. There are three drills operating simultaneously and each one drills a hole through one cap-screw. After the holes have been drilled and the drills back out, the turret revolves and, at the same time, each cap-screw is turned over so that when it arrives at the next drill, a hole is drilled through another side. In this way each cap-screw has a hole drilled through it by each one of the three drills. After the third drill has finished its work and the turret revolves again, the screw is ejected from the machine automatically.

The turret revolves through an arc of 72 degrees for each indexing and the screws are revolved through an arc of 120 degrees. The turret is worked about by a cam. As the turret revolves, an automatic spring-plunger ejects the cap-screw which has been completely drilled. The drilling head is also fed by a cam which is shown in the view to the right. This cam engages a horizontal spring-plunger having a rack cut on the front end which meshes with a pinion connecting with the spindle quill. At the back of the turret there is a guide which holds the three cap-screws being drilled, firmly in their places. The machine uses 3/32-inch drills and will drill cap-screws from 5/16 inch to 1/2 inch in diameter.

These cap-screws are used in all parts of the Franklin motor and car. The object in drilling holes through the heads of the cap-screws is for locking them. When the engine has been assembled, a wire is drawn through the holes in the cap-screws, completely locking them and preventing their working out, thus providing a perfect safety device.

* * *

F. A. GEIER TWENTY-FIVE YEARS WITH CINCINNATI MILLING MACHINE CO.

Frederick A. Geier, president of the Cincinnati Milling Machine Co., gave a dinner on Friday evening, September 13, in Cincinnati to some of his friends and business associates to celebrate the twenty-fifth anniversary of his connection with the business. The growth of the Cincinnati Milling Machine Co., which operates one of the two or three largest and best equipped machine tool works in the world, has been coincident with the advance of the machine tool industry in this country, and illustrates in a striking manner what can be accomplished by energy, perseverance and business ability. For the steady and continued development of this great enterprise from small beginnings, Mr. Geier is responsible, although he has had the help of able mechanics from the outset; and it is fitting that his twenty-fifth anniversary should be celebrated in company with several of the men who helped him to achieve success, as well as others well known in the machine tool industry and in Cincinnati business circles. Those present at the dinner were: H. T. Atkins, Albert Bettinger, George H. Bohrer, E. M. Chace, George D. Crabbs, A. L. DeLeeuw, E. F. DuBrul, Lewis N. Gatch, Frederick V. Geier, Dr. Otto P. Geier, P. O. Geier, C. S. Gingrich, Louis J. Hauck, Prof. F. C. Hicks, J. C. Hobart, Robert Hochstetter, Fred Holz, Sr., F. W. Jaeger (New York), George H. Kattenhorn, Ernst Krause (Vienna), Louis S. Levi, William Lodge, P. G. March, Alfred Marshall, George E. Merryweather, James P. Orr, George Puchta, B. B. Quillen, H. M. Ramp, Sherman Schauer, Prof. Herman Schneider, Murray Shipley, Nelson W. Strobridge, Dr. C. W. Tangeman, A. H. Tuechter, C. Wood Walter, Dr. J. M. Withrow.

* * *

JOINT MEETING OF A. S. M. E. AND V. D. I.

The council of the American Society of Mechanical Engineers has accepted an invitation from the council of the Verein Deutscher Ingenieure to hold a joint meeting with them in Leipzig, June 23-25, 1913. The meeting will be followed by an official tour of the industrial centers of Germany and will include a trip on the Rhine and special opportunities for a comprehensive study of the Great Museum of the Technical Arts and Industries at Munich. Many establishments will be thrown open that could not be visited under other auspices, and extraordinary and unique opportunities will be afforded the members of the party to familiarize themselves with the latest developments in every industry. Invitations to visit firms throughout Germany have been received.

It is desired that the party be large enough to warrant chartering an entire steamer. This would afford a minimum expense with a maximum of pleasure and personal comfort. Past President E. D. Meier is chairman of the committee on arrangements.

DIE CASTING AUTOMOBILE MOTOR BEARINGS

The manufacture of die castings is one of the numerous lines of manufacture which has advanced rapidly with the growth of the automobile industry. The production of die castings originated with the H. H. Franklin Mfg. Co., Syracuse, N. Y., about nineteen years ago. As is generally known, die castings are produced in steel dies instead of sand molds. By the substitution of steel dies for the sand molds and the use of pressure for conveying the metal from the pot into the die, a degree of smoothness and accuracy is secured which equals, and often surpasses, that obtained by the usual machining operations. The result is that the castings are practically ready for assembling without additional machine work.

At first the die-casting process was confined to the manufacture of electrical instruments, phonographs, computing machines, etc., for producing small, accurate parts which were expensive to finish by the common methods of machining. When the Franklin Co. entered the automobile field, experiments were made with die casting in order to determine to what extent it could be used in automobile construction. For most automobile parts, either because of their size or intended use, the process was not practicable, but for the production of bearings it was found ideal. The accuracy of the die-cast bearings makes additional machining operations unnecessary and only such scraping and reaming as is customary in the assembling of machined bearings, is required. The high pressure of the die-casting process, combined with the chilling received from the die, gives a hard, close-grained bearing surface, which is of considerable value.

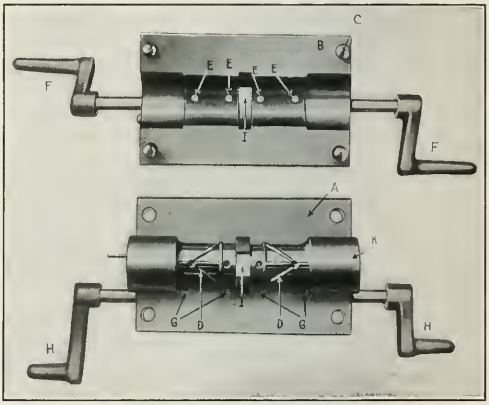
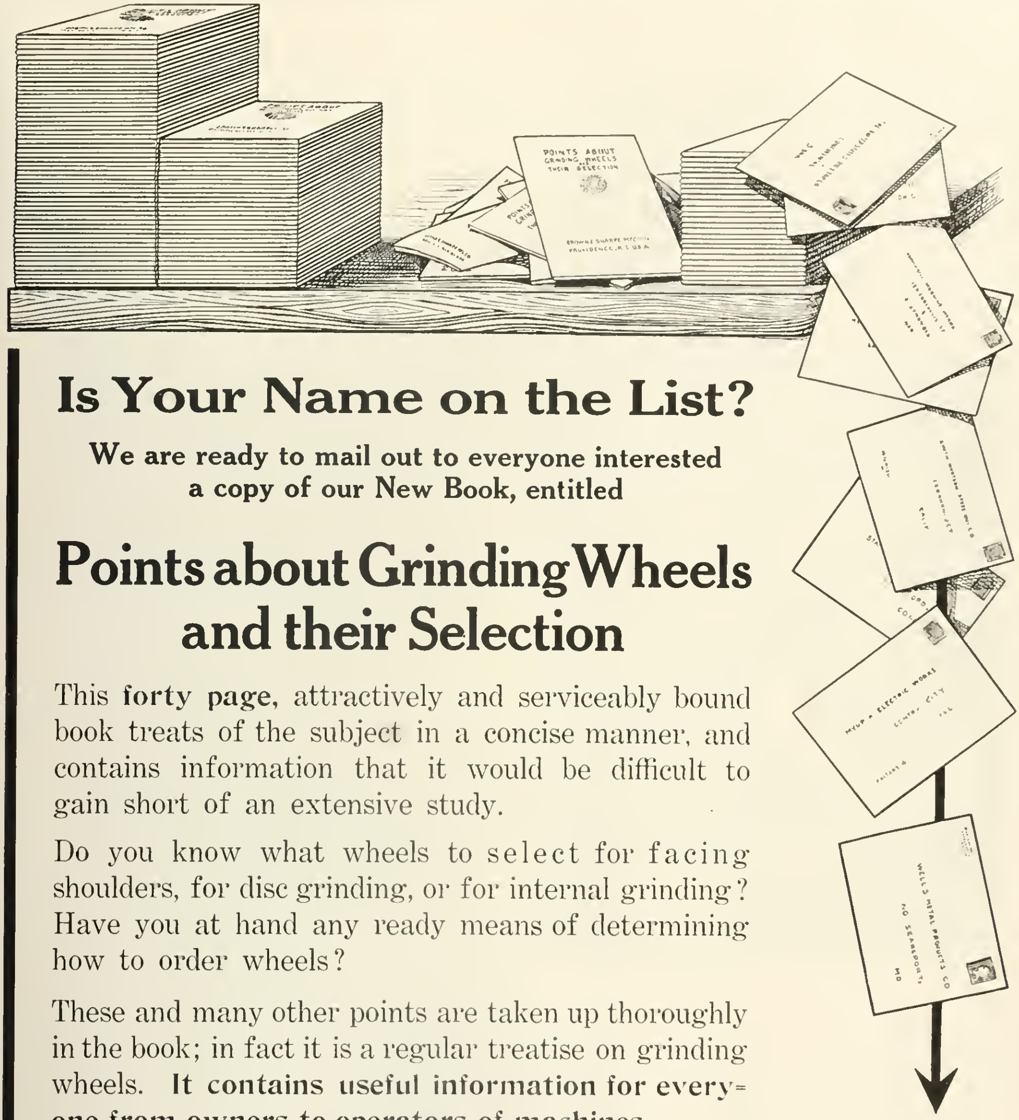


Fig. 1. Die used by H. H. Franklin Mfg. Co. for Producing Bearings by the Die-casting Process

The first die-cast bearings used in automobile construction were for the connecting-rods of the Franklin 1904 motors. These bearings were made of hard babbitt and replaced machined phosphor-bronze. Their success was so marked that babbitt has almost entirely replaced phosphor-bronze as a bearing material in the Franklin motor. It is probably true that one grade of babbitt will not meet all conditions, yet the range of babbitt metals would seem to be sufficiently wide to insure satisfactory results. For instance, in an engine where the heat generated is purely frictional, the addition of a small percentage of lead is probably an advantage, although in engines where the bearings are subject to external heat, a tin, antimony and copper babbitt, devoid of lead, is imperative.

The construction of one of the Franklin dies is illustrated in Fig. 1. The die consists of upper and lower plates which are held rigid by dowels *C*. On the lower half is located the main core *K* and in this are the cores *D* for the oil grooves. These oil-groove cores are either formed by cutting down the main core so as to leave the oil-groove cores raised in relief, or by slotting the main core and "letting in" small cores, which are then located securely. The lower half also contains a set of ejector pins *G* operated by levers *H*. The upper half is more simple. The depression conforms to the outside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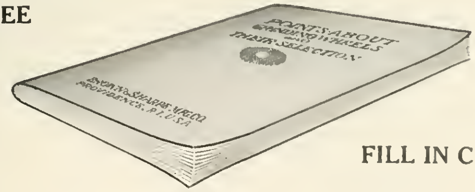
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of the bearing, and contains the cores *E* for the dowel holes. These cores are operated by levers *F*, and also act as ejectors in case the bearings stick in the upper half of the die.

Both halves contain corresponding gate holes *I* in which the gate operates. When in operation, the closed die is fastened between the upper and lower halves of the die vise, which is placed directly over the casting machine. The cores for the dowel-pin holes are thrust forward and the ejector pins are drawn back even with the face of the die plate, after which the gate is turned back to allow the metal to enter. The metal is then forced in, and when the die is full the gate is sheared off and only a slight mark (which is sometimes imperceptible) is left instead of the usual heavy sprue common in sand castings. The die remains closed only long enough for the casting to set. When it is opened and the ejector pins are thrust forward by means of levers *H*, the casting is loosened from the main core where it usually sticks somewhat. Fig. 2 shows a number of bearings produced by the die casting process.

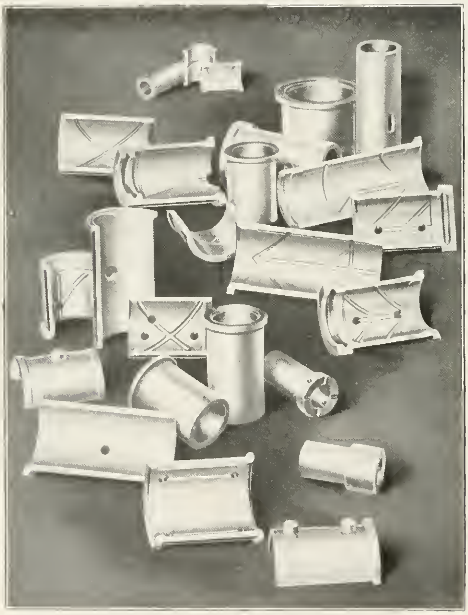


Fig. 2. Group of Die-cast Bearings

The construction and working of the various dies differ, of course, in accordance with the parts to be produced. On account of the effect of high temperature on the dies, the metals available are limited. At present, lead, and tin and zinc base alloys are chiefly employed.

The accessory manufacturers have found die castings, especially of the harder alloys, well adapted to such parts as timer bodies, and the framework of magneto and lighting systems. In addition to the bearings, the automobile manufacturers are using die castings extensively for such parts as oil and water pumps. As the process is constantly being developed, both in regard to materials used and the size of the castings made, it is probable that die castings will in the future have an even greater place in automobile construction than at present.

* * *

MACHINERY'S tenth annual outing will be held on October 19, following the National Machine Tool Builders Association convention. It will be of a similar character to the previous outings, comprising a steamer trip in the waters around New York.

* * *

In selecting the number of teeth in a gear, care should be taken to select such numbers as can be obtained by ordinary indexing methods, without the use of special gears.

PERSONALS

Lucius I. Wightman, a well-known publicity man, recently joined with Joseph A. Richards & Staff, Tribune Bldg., New York, forming the firm of Wightman & Richards.

George W. Burley, instructor of machine shop practice in Sheffield University, England, and a well-known contributor to the British and American mechanical journals, sailed for home September 5, having spent a month in the United States.

F. G. Kretschmer of F. G. Kretschmer & Co., Frankfort-on-Main, representative in Germany of many well-known American machine tool builders, will visit the United States early in October. His address during his stay will be Hotel Astor, New York.

Louis L. Burghoff, lately connected with the New England Watch Co., Waterbury, Conn., as assistant superintendent, has taken a position with the Remington Arms–Union Metallic Cartridge Co., as assistant equipment engineer of the gun works at Ilion, N. Y.

Dr. Conrad Matschoss, lecturer at the Royal Technical Institute (dozent der Konigliche Technische Hochschule) Charlottenburg, Berlin, Germany, and a writer on industrial science, is making a tour of American manufacturing centers as representative of the Verein Deutscher Ingenieure (Society of German Engineers). Dr. Matschoss is keenly interested in the comparative average intelligence and educational qualifications of German and American workmen.

Prof. George B. Thomas of Colorado College, Colorado Springs, Colo., was selected by the Westinghouse Electric & Mfg. Co., to take charge of twenty-eight representatives of the engineering faculties of twenty-four colleges in the United States who were on the payroll of the company at the works during the past summer. These instructors were studying the practical side of engineering so as to be better fitted to instruct their students. They were engaged as regular employes and were assigned check numbers the same as other workmen. The work made them familiar with the requirements of engineering work and the advances that are being made in the design of electrical apparatus.

* * *

OBITUARIES

Milton G. Puffer, inventor of the machine for making envelopes, died recently at Willimantic, Conn., aged ninety-three years.

John Hope, inventor of the pantograph engraving machine and other devices used in engraving, died at his home in Providence, R. I., September 8, aged ninety-two years.

William S. Lamson, inventor of the Lamson carrier system for store service, and treasurer of the Lamson Consolidated Store Service Co., died at his home in Lowell, Mass., August 16, aged sixty-six years.

Charles F. Putnam, president of the Putnam Machine Co., Fitchburg, Mass., and one of Fitchburg's best known business men, died August 29 at Massapequa, L. I., aged sixty-seven years. Mr. Putnam had been in poor health for a year and a half but attended to his daily duties with the Putnam Machine Co., up to the time of going to Brooklyn, N. Y., in May, where his daughter lived. His entire business life was devoted to the Putnam Machine Co., with which he was connected in various capacities during his earlier life. Shortly after the death of his father, Salmon W. Putnam, in 1872, the company was reorganized, at which time the deceased was elected president, his brother Salmon W. Putnam, Jr., vice-president, and the late Henry O. Putnam, treasurer. Mr. Putnam was married in 1872 to Miss Coralie J. Lawrence of Pepperell. A daughter, Mrs. Edith Ormsbee of Brooklyn, a brother and four sisters survive him.

WILLIAM J. FLATHER

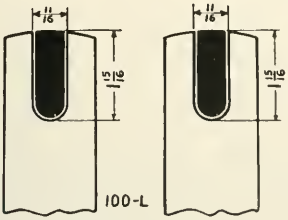
William J. Flather, one of the founders of the Flather machine tool companies of Nashua, N. H., died at his home in Nashua, September 10, 1912, of heart failure, following a short illness caused by arterial sclerosis.

Mr. Flather was born in Norwich, England, in 1841. The family moved to Bradford in 1849, where, after receiving a common school education, he entered the employ of his uncles, William and Henry Hodgson, manufacturers of worsted machinery. His father being in poor health was advised to come to America, which he did, sailing for Philadelphia in 1856. The following year William followed with other members of the family, soon after settling on a farm near Rainsboro Highland County, Ohio. During the next few years he was employed as a machinist at Harpers Ferry, Va.; Lowell Machine Shop, Lowell, Mass.; Chase & Co., Nashua; and the Grover & Baker Co., Boston. After the Civil War broke out he enlisted in a Pennsylvania company, but on account of his mechanical ability was transferred to the Frankfort Arsenal at Bridesburg, Philadelphia, where he remained throughout the war.

In 1866 Mr. Flather with his brothers moved to Parkersburg, W. Va., and established a shop for the manufacture and

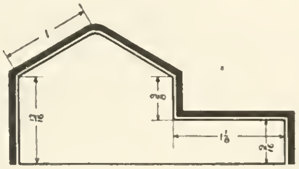
Some Examples of Work done on the

No. 2 Plain Cone Driven Cincinnati Miller



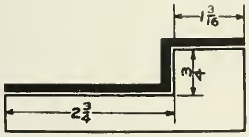
100-L

Material, 40 Carbon Steel.
Size of cut, 11-16" wide, 1" deep, 1 15-16" long.
Cutters, 6" in diameter.
Two Pieces are milled at one time.
The work is held horizontally and fed directly into the Cutter at a travel of 1" per minute.



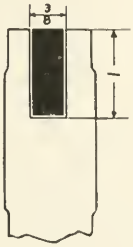
148-L

Material, Cast Steel.
Total width of cut, 5".
Depth of cut, 1-16" to 3-32".
Thickness of piece, ⅞".
Largest Cutters, 5½" diameter, 53 revolutions.
Feed, 2.9" per minute.
Four Pieces are held in a jig at one time.
Total time per piece, 1¼ minutes.



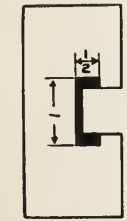
190-L.

Material, Cast Iron.
Total width of cut, 4 11-16"; depth of cut, ⅛"; length of cut on each piece, 1⅛".
Cutters, 4½" and 3" diameter.
Twenty-four Pieces are held in a string jig at one time.
Feed, 1⅞" per minute.
Finished surfaces are accurate within .001."



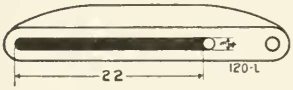
169-L

Material, Steel Forgings.
Cut consists of a slot 1" deep, ⅜" wide at a table travel of 4" per minute.
Cutter, 3½" in diameter, ⅜" face, 53 revolutions.
The pieces are of irregular form and 5 of them are held in a string jig at one time. The length of cut in each piece is approximately 1".



168-L.

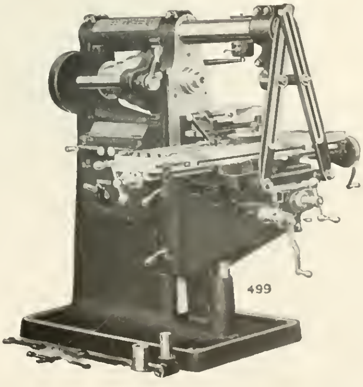
Material, Cast Iron.
Cut consists of undercutting T slots, with a Cutter 1" diameter, ½" face, running 286 revolutions. Our average rate of feed on this work is 15¾" per minute.



120-L

Material, Cast Iron Bars. 1" thick.
A slot ¾" wide is cut through the solid at one cut, starting from a drilled hole with a ¾" diameter, 3 fluted end mill at 3⅝" table travel per minute.
Metal removed per minute is equivalent to a bar 1" x ¾" x 3⅝" long. Actual cutting time for slots 22" long, 6 minutes.

For the usual Tool Room work; for repair work; for manufacturing small machine parts—in fact, for all work on which the cutting is light, a modern Cone Driven Miller will bring you bigger returns for your investment than a Single Pulley Drive Machine.



We have redesigned ours, brought them up to date, made them handier than ever before, and we are offering a full line for all that work for which they are especially adapted. we also make a full line of single pulley High Power Millers for the heavier classes of milling.

The Cincinnati Milling Machine Company

CINCINNATI, O., U. S. A.

repair of oil-well tools. As this venture did not prove remunerative he returned to Nashua, and with his brothers entered a partnership with the late J. K. Priest who at the time manufactured sewing machines but who later established himself under the title of The American Shearer Co., as a manufacturer of clippers of all kinds. It was the intention of Mr. Priest and the Flather brothers to build lathes also, but the lines were so dissimilar that the partnership was soon dissolved, the Flathers taking over the manufacture of lathes under the firm name of Flather Brothers. Later the name was changed to Flather & Co., the concern consisting of Mr. Flather and his brother Joseph, as active members, and Edward Flather as a silent partner. The high quality of their hollow spindle engine lathes, then somewhat of a novelty, secured them such agents as Hill, Clarke & Co., of Boston, and a certain amount of success. In September 1876 their factory was destroyed by fire, being practically a total loss. With the small amount of insurance received, it was with difficulty that they rebuilt. They had, however, exhibited their lathes at the Centennial Exposition in Philadelphia, which attracted favorable notice from several European manufacturers, resulting in their initial foreign business. After the panic years of the late 70's, their success was firmly established and the business steadily grew in size to its present capacity.

Mr. Flather was also one of the founders of the Mark Flather Planer Co., Flather Foundry Co., and the E. J. Flather Mfg. Co., withdrawing in 1901 from Flather & Co., and the Mark Flather Planer Co. At the time of his death he was president of the Flather Foundry Co., and was actively identified with the E. J. Flather Mfg. Co. He had marked mechanical ability, sound judgment and a faculty of quietly impressing his convictions on his business and other associates. Although a man of retiring disposition, he had an extensive acquaintance in this country and Europe. He was much interested in civic and state affairs, having served as a member of the city government, board of education, state legislature and constitutional convention. He was also a thirty-second degree Mason and prominent in financial circles, being a director of the Indian Head National Bank for twenty-five years. Mr. Flather was actively interested in religious work, being an officer and trustee in several Methodist Episcopal church societies and institutions, including Tilton Seminary. In May of this year he was chosen one of the two lay delegates from New Hampshire to the Methodist Episcopal General Conference at Minneapolis, at which he took an active part. While his early education was interrupted by the migrations of his father's family he was a student all his life, attending evening schools when employed at Philadelphia and devoting much of his leisure time to study and travel, both in this country and Europe. He is survived by his widow; a daughter, and two sons, Ernest J. and Harry E. Flather.

* * *

COMING EVENTS

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

October 16-18.—Annual convention of the National Machine Tool Builders' Association in New York; headquarters, Hotel Astor. James H. Herron, general manager, Cleveland, Ohio.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Brooklyn, N. Y. Circular describing the evening technical courses conducted by the School of Science and Technology at Pratt Institute. These courses offer unusual opportunities to young men who would devote their evenings to studying mechanical drawing and machine design.

Michigan College of Mines, Houghton, Mich. Year book 1911-1912 and announcement of courses for 1912-1913. The year book contains the usual information relating to admission to the college, courses and departments of instruction. It also contains a map of the Portage Lake mining district showing the location of the college in the midst of an active mining territory. Another map shows the mineral district of the upper Michigan peninsula, with the various iron and copper ranges accessible from the college.

NEW BOOKS AND PAMPHLETS

Natural Gas: Its Properties, Its Domestic Use, and Its Measurement by Meters. By P. F. Walker. 38 pages, 6 by 9 inches. 10 illustrations. Published by the University of Kansas, Lawrence, Kans.

This engineering bulletin No. 2, published by the Engineering Experiment Station of the University, contains a report on the subject of natural gas prepared for the Public Utilities Commission of the State of Kansas. The most interesting part of the bulletin is that which relates to the meters for gas, showing the effect of different rates of flow and pressure differences on different makes of meters.

High Explosives. By W R. Quinan. 210 pages, 6 by 8½ inches. Published by Critchley Parker, Melbourne, Australia. Price, 21 shillings, net.

This book is a treatise on high explosives, mainly from a scientific point of view. The contents of the book are as follows: Historical; Velocity of Detonation; Industrial Explosives; Australian Conditions; Theory of Explosive Energy; Available Energy or Maximum Work; Useful Work; Strength of Explosives; Theories of Explosion; Dissociation; Detonation of Gaseous Mixtures; Dissociation of Explosives—Specific Heats Boyle's Law at High Densities.

Strength of Materials. By Mansfield Merriman. Sixth Edition. 169 pages, 5 by 7½ inches. Published by John Wiley & Sons, New York. Price $1.

This is one of the standard references on this subject which has become generally known to the profession in its previous edition. In the sixth edition a new chapter on combined stresses has been added. Numerous changes have also been made throughout the text and ninety new review problems added to illustrate the principles treated in each chapter of the book. The number of illustrations has also been increased from forty-eight to fifty-four and the number of articles from seventy-two to ninety-one. It is hoped that the book in its new form may be even more valuable in furthering the progress of technical education than it has been in the past.

Materials and Construction. By James A. Pratt. 196 pages, 5 by 7 inches. Published by P. Blakiston's Son & Co., Philadelphia, Pa. Price 90 cents.

The material in this book has been published with the view of presenting an elementary text for students in technical schools; also as a reference on the more simple problems of construction. Each chapter of the book concludes with problems of a practical nature which not only explain the preceding principles but give the student practice in applying them on the class of problems which he is likely to meet with in engineering practice. One of the notable features of the presentation of material in this book is the method of illustrating. In many cases rough sketches are used, the idea being to familiarize the student with this practice which is followed in many factories, rather than to let him rely entirely upon accurate working drawings.

Manual for Engineers. By Charles E. Ferris. 248 pages, 3 by 5¾ inches. Published by the University of Tennessee, Knoxville. Price 50 cents.

This useful pocketbook which has passed into the seventeenth edition was compiled with the view of interesting the controlling men of the South in technical education as a means of developing the undeveloped resources of their section. Following the pages devoted to the courses of study offered by the University of Tennessee and its equipments and facilities, the book is devoted to the presentation of useful technical data. This section includes mathematical tables, the properties of engineering materials and data pertaining to the transmission and generation of power, to electric wiring, to hydraulics, and to the effect of heat on various materials. Especial attention is called to the excellent presswork and binding which make it attractive to the user.

American Machinist's Grinding Book. By Fred H. Colvin and Frank A. Stanley. 383 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York City. Price $3 net.

The wide application of grinding machines of suitable forms to adapt them for a variety of operations in the manufacture of machinery and of finished metal parts in general, suggested the desirability of presenting material on the subject of grinding in the form of a reference book. The idea in so doing was to present reliable data on the machines, wheels and methods, that is likely to be of interest and service to those engaged in the grinding department. In presenting their subject the authors have dealt separately with the different types of machines in regard to their application in different classes of manufacture. The methods of mounting the wheels and of dressing them are then taken up, and later a number of particular classes of work are dealt with in detail. The authors have drawn upon the columns of different technical papers and also acknowledge assistance received from the manufacturers of grinding machines in securing the data which they have presented.

Shop Arithmetic. By Earle B. Norris and Kenneth G. Smith. 187 pages, 6¼ by 9¼ inches. Published by McGraw-Hill Book Co., New York. Price $1.50.

Many a good mechanic is held back by a lack of mathematical knowledge which makes it necessary for him to "ask the boss," whenever there is any figuring to be done. Such men find it difficult to acquire knowledge that is of much value to them from an ordinary textbook on arithmetic. This is largely due to trouble in applying arithmetical methods to practical problems. In the present book, the mechanic should be saved from this difficulty by the practical problems which follow the discussion in each chapter. Thus the treatment of addition of fractions is followed by exercises in finding the overall dimensions of drawings scaled off in the usual way. A discussion of the micrometer caliper follows the chapter dealing with decimals. Similarly the treatment of methods to find the areas and volumes of different shaped figures is followed by practical problems. The latter section of the book deals with problems occurring in the simpler branches of mechanics. Treated in this way, the mechanic should be able to acquire the knowledge of arithmetic he requires in his work without the aid of an instructor.

Practical Descriptive Geometry. By William Griswold Smith. 208 pages, 6 by 9 inches. 132 illustrations. Published by McGraw-Hill Book Co., New York. Price, $2.

The author of this book, who is assistant professor of descriptive geometry at the Armour Institute of Technology, has endeavored to emphasize the relation which exists between descriptive geometry and drafting. In preparing the book, his aim has been to present the subject in such a manner as to arouse the interest of the student. A large number of exercises are provided, the author believing that a thorough knowledge of the subject is achieved not through much study of the text, but through working exercises. The book is divided into four specific parts, the first dealing with definitions, notations, preliminary theories and exercises; the second, with problems relating to points, lines and planes; the third, with curved lines and surfaces; and the fourth, with perspective and isometric projection. The extent to which the idea of presenting a great number of exercises has been carried can be best understood by noting that there are 860 different problems presented, of which about one-quarter are of such a nature as may be met in actual practical drafting. Most of the exercises are dimensioned so as to require the student to make his drawing according to some predetermined scale.

Machine Design; Hoists, Derricks, Cranes. By Henry D. Hess. 368 pages, 6½ by 9⅜ inches. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $5.

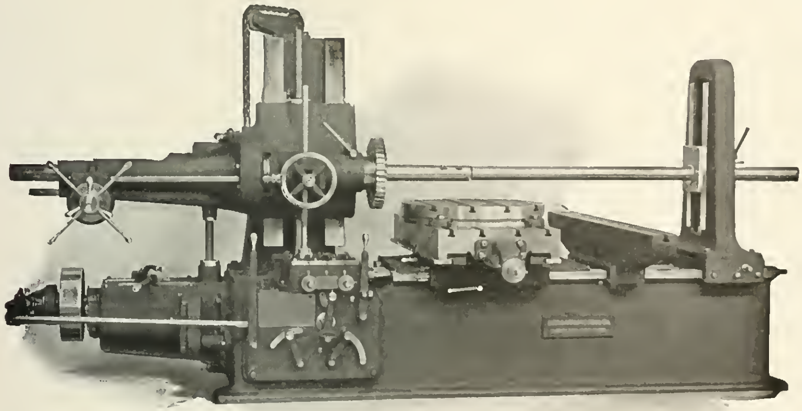
The details comprising the structure of a crane include a large variety of the simpler forms of mechanism met with in many classes of machinery. The stresses which occur in both the frames and machinery are also such that they are readily determined by analytical methods. These conditions have made the presentation of methods used in crane design valuable in two directions: The general reader can acquire accurate data on the design of the common forms of mechanism met with in most classes of machinery. Those seeking specific information on the subject of crane design will also welcome the book as a reliable source of information. The first four chapters are devoted to a discussion of the properties of various materials used in machine construction and to the design of the types of mechanism and structural members applied in cranes of the different forms that are treated. The eight succeeding chapters cover the standard practice followed by the designing departments of leading American crane builders. The book is expected to meet the requirements of the field of machine design covered in technical colleges. Drafting-rooms work-

Some Expert has said: "Don't Advertise the Obvious"
but we wish to break this rule enough
to say that the

"PRECISION"

Boring, Drilling and Milling Machine

was ALWAYS the BEST, and is now
BETTER THAN EVER



It has *feeds* in every direction and a *constant speed quick return* for every feed; *one* handle starts whichever feed is wanted, and the *reverse* motion of the *same* handle starts the quick return always in the opposite direction from the feed.

The constant speed Quick Power Movement is accomplished by separate mechanism and does not operate through the feed change gears.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

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ing upon general classes of machine design should also find it of value, and the careful attention to detail which has been observed in the preparation of this book should make it favorably received in a variety of designing establishments.

NEW CATALOGUES AND CIRCULARS

Geuder Paeschke & Frey Co., Milwaukee, Wis. Circular of "Cream City" electric butt and spot welding machines.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin No. 1026 entitled "The Youngstown Safety Limit Stop for Direct-current Motors."

R. D. Nuttall Co., Pittsburg, Pa. Supplement to catalogue No. 10 on forged steel motor gears and pinions, containing twenty-nine pages of gear lists.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue E of "Brownhoist" buckets and tubs for handling ore, coal, gravel, sand, earth and other materials.

Vulcan Engineering Sales Co., 2014 Fisher Bldg., Chicago, Ill. Circular of the "Mumford" jolt ramming machines for foundries, enumerating their advantages.

Electro-Dynamic Co., Bayonne, N. J. Data sheets Nos. 3, 4 and 5 on wiring diagrams of interpole motors with Cutler-Hammer compound non-reversible and reversible drum controllers.

Gurney Ball Bearing Co., Jamestown, N. Y. Catalogue of annular ball bearings having full complement of balls, unbroken raceways, and full depth of raceways; also ball thrust bearings of the plain and grooved types.

Foote Bros. Gear & Machine Co., 210-220 N. Carpenter St., Chicago, Ill. Catalogue and price-list No. R on "IXL" speed reducers which are made of the spur gear and worm gear types in a large number of sizes.

C. W. Hunt Co., West New Brighton, N. Y. Catalogue No. 12-8 on manila rope for transmission and hoisting, being a brief treatise for engineers on the manufacture and characteristics of ropes, with formulas, tables and data useful in mill engineering.

Walter B. Snow, 170 Summer St., Boston, Mass. Booklet entitled "Publicity Engineering," outlining the scope of Mr. Snow's activities in engineering publicity work and showing in what radical respects they differ from those of the typical advertising agencies.

General Electric Co., Schenectady, N. Y. Bulletin No. 4995 on direct current switchboards, double polarity, 125, 250 and 600 volts; No. 4996 on alternating current switchboards with oil switches, three-phase, three-wire 240, 480 and 600 volts, 25 to 60 cycles.

Racine Tool & Machine Co., Racine Junction, Wis. Circular illustrating No. 7 high-duty metal cutting machine of the hacksaw type, having capacity from 0 to 12 inches and using blades 17 to 24 inches long. The machine is especially adapted for structural work, being arranged for cutting I-beams, angles, channels, etc.

D. & W. Fuse Co., Providence, R. I. Leaflet describing D. & W. fused switch boxes, being an improved combined switch and fuse box particularly adapted for mill service, etc., inasmuch as it may be locked after the fuses are installed, thereby preventing tampering with the connections and increasing the capacity of the fuses.

National Tube Co., Pittsburg, Pa. Pamphlet entitled "Modern Welded Pipe" illustrating and describing the processes from the mining of the ore through the reduction of the ore to steel, rolling the skelp, lap welding, butt welding, testing, threading, etc. The illustrations are effectively printed in colors, thus showing the metal being worked in the hot state.

Davis-Bournonville Co., 97 West St., New York. Folders Nos. 6 and 7 illustrating examples of locomotive repair work and Davis-Bournonville style C oxy-acetylene welding and cutting torches. The examples of locomotive repair work comprise welding broken frames, firebox cutting and welding, welding firebox cracks, building up thin spots, welding broken driving wheel spokes, etc.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 2480 giving directions for ordering motors for driving machine tools. In addition to giving the characteristics of voltage of direct-current circuits and voltage, phase and frequency of alternating-current circuits, it is necessary also to specify the horsepower and speed. The Westinghouse engineers will advise regarding the power and speed of motors for any type of machine tool.

Standard Mfg. Co., Bridgeport, Conn. Catalogue of gear cutting, milling and slitting machines, consisting of twenty-four pages, 6 by 9 inches, with embossed cover. The catalogue illustrates and describes "Standard" machines Nos. 1, 2, 3 and 5, showing examples of typical commercial work performed; also machines with special attachments adapting them to cutting worms, racks, slitting dials, cylinders, etc. The special work to which these machines can be adapted makes them of unusual interest to manufacturers generally.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. "Besly's Modern Disk Grinding Practice," a treatise on the art of disk grinding, with special reference to reducing cost of flat surfacing in machinery construction, illustrating and describing the extensive line of grinding apparatus made by the company. The growth of the disk grinding art in the past few years and its present importance can be somewhat appreciated by referring to this comprehensive and interesting publication. The first edition containing 40 pages and 23 illustrations was issued two years ago. The present edition contains 111 pages and 103 illustrations

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 3516 listing machine tool motor applications and giving horsepower ratings and classes of motors used. This leaflet covers applications to bolt and nut machinery, boring and turning mills, bulldozers, buffing lathes, drilling and boring machines, cylinder boring machines, pipe threading and cutting-off machines, planing machines, rotary planing machines, hydrostatic wheel presses, punching and shearing machines, punches, shears, shaping machines, bending rolls, cold saws, horizontal boring, drilling and milling machines, multiple spindle drilling machines, emery grinders, grinding machines, gear cutting machines, engine lathes, milling machines, etc.

Hill, Clarke & Co., 125 N. Canal St., Chicago, Ill. "Machinery Bluebook of Modern Machine Tools," describing the line of boring machines, broaching machines, chucks, die heads, drilling machines, grinding machines, gear hobbing machines, key-seating machines, lathes, metal sawing machines, milling machines, patternmaking machines, pipe machines, planing machines, power hammers, presses, shaping machines, screw machines and turret lathes sold by the company. The descriptive matter is unusually complete for a comprehensive catalogue like this, being illustrated with halftones and drawings showing details to which references are made in the text. The book is too costly for general distribution, and will be sent chiefly to manufacturers, or their official representatives, using machine tools.

TRADE NOTES

Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes, are building a large addition to their plant and expect to have it completed January 1, 1913.

Charles H. Sawyer, 7 Lake St., Worcester, Mass., has been appointed New England representative for Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes.

Greenfield Tap & Die Co., Greenfield, Mass., has placed the contract for the erection of four reinforced concrete machine shops with the Aberthaw Construction Co., Boston.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, furnished about 400,000 square feet of "J-M" asbestos roofing to the Memphis Union Stock Yards, Memphis, Tenn.

Gardner Machine Co., Beloit, Wis., has been made the exclusive distributor and selling agent for the entire output of abrasive disks manufactured by Hermann Behr & Co., Inc., New York.

Pratt & Whitney Co., Hartford, Conn., has opened an office and salesroom for small tools and gages at 336 W. 4th St., Cincinnati, Ohio. The office will be in charge of Mr. C. M. Pond.

Van Dorn & Dutton Co., Cleveland, Ohio, has appointed William E. Rean district sales manager for its portable tool department with headquarters in the Plymouth Bldg., Minneapolis, Minn.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., makers of drop forgings, have opened an office and warehouse at 40 S. Clinton St., Chicago, Ill., where a large stock of drop-forged specialties will be carried.

Kerr Turbine Co., Wellsville, N. Y., has opened an office in Pittsburg to take care of its increasing business in that district. The office will be located at 2137 Oliver Bldg., and will be in charge of Mr. R. M. Rush, formerly with the Drave-Doyle Co.

MACHINERY

NOVEMBER, 1912

MAKING NEW DEPARTURE BALL-BEARINGS[*]

MACHINING AND GAGING METHODS EMPLOYED IN PRODUCING THE "TWO-IN-ONE" BEARING

BY CHESTER L. LUCAS[†]

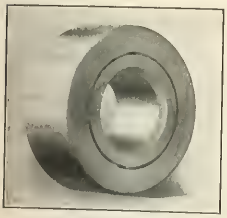

Fig. 1. The New Departure Two-in-one Bearing

THE factory of the New Departure Mfg. Co., Bristol, Conn., is now being operated to its full capacity in the manufacture of ball bearings. This healthy state of business is largely due to the increasing number of uses to which ball bearings are now being put and the realization of the economy effected by their use. But a few years ago, the principal use to which ball bearings were put was in the main bearings of the bicycle. From this, however, the field for the use of the ball bearing has broadened until it now is an important factor in the mechanism of automobiles, and is making rapid strides in the machine tool field. The future bids fair to see ball bearings in general use in machine tools. In order to give the readers of MACHINERY a general insight into the ball bearing industry, this article will describe briefly the machining operations connected with making the parts of a typical bearing.

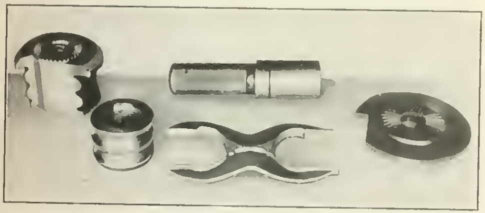

Fig. 2. Special Tools used in Machining the Cone

The New Departure Mfg. Co. makes three distinct types of ball bearings, namely: the single-row, the double-row, and the radax. These, of course, are made in numerous sizes, and as it would be obviously impractical for us to take up the description of the manufacture of more than one, the double-row ball bearing has been selected on account of its general utility as well as on account of the interesting machining operations connected with its manufacture.

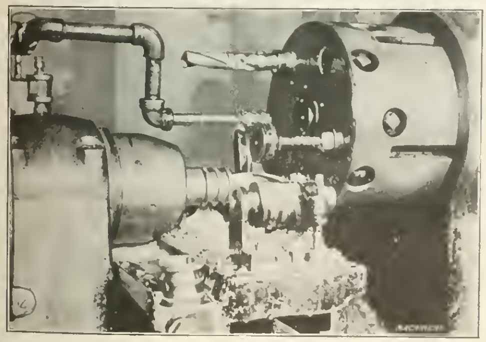

Fig. 3. Machining the Cone

The double-row ball bearing is illustrated in Fig. 1, and in Fig. 6 it has been shown in side elevation and in section in order to make the construction and relation between the several parts as clear as possible. It will be seen by a glance at the latter illustration that the bearing has been designed particularly to resist both radial and thrust stresses. Moreover, on account of the two rows of balls, its capacity for load-carrying exceeds that of any other type of bearing, and it is more efficient than two single-row bearings would be placed side by side. In the double-row bearing it is assured that each row of balls will carry a proportional part of the load, a condition mechanically impossible in two separate bearings. The parts of this bearing are, the cone or inner member, the two cups or outer members, the two bronze ball separators, the steel shell which holds the bearing parts together, and, of course, the steel balls themselves.

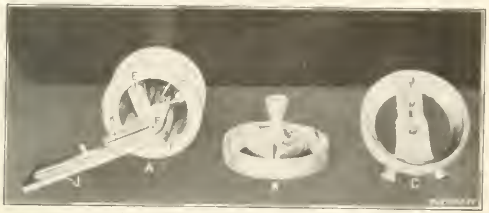

Fig. 4. Gages used on Bearing Parts

Turning the Cone

In taking up the machining of the parts of the New Departure bearing itself, the cone naturally comes first in order. This part is shown in detail in Fig. 8. By referring to the illustration Fig. 3 it will be noticed that the production of this cone is a simple screw machine job and is handled effectively on a Cleveland automatic. The working tools may be plainly seen in this illustration, and it will be noticed that circular forming tools are used. Attention is called to the fact that these forming tools are made from low carbon steel and carbonized. The cone is first formed, the forming tool being so shaped as to finish the end of the bar and partly sever the piece, as well as to turn the races for the balls. The piece is then drilled, reamed and cut off. Fig. 2 is shown to illustrate the forming tool, cut-off tool, plug gage and limit gage for the race section. It will be noticed that the sides of the cut-off and forming tool are radially serrated to facilitate holding in the forming tool fixture.

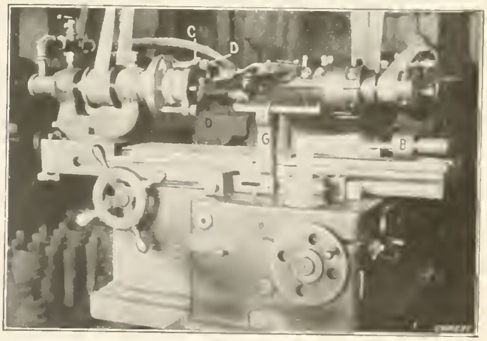

Fig. 5. Grinding the Cone Bore

Grinding the Cone

The cone and the cups which will be subsequently described are, of course, hardened. The first operation in grinding the cone after hardening is shown in Fig. 5, in which is illustrated a special grinding machine for grinding the bore of the cone. For this purpose, the cone is held on the faceplate *A* of the machine illustrated, and it is located thereon by means of plug *B* shown on the end of the table. As will be noticed, this locating plug has a pilot which fits into a corresponding hole in the body of the faceplate. By means of the larger section of the locating plug, which is a close fit for the bore of the unground cone, the work is located centrally under the clamping plate *C*. This clamping plate is held against the work by two retaining screws *D*. When released, the clamping plate is held back against the heads of the screws by means of spiral springs. A test indicator *F*, mounted on the bracket *G*, may be swung into position to prove the alignment of the work before grinding. For this and succeeding grinding operations on this class of work which will be described, the speeds used are 300 R. P. M. for the work spindle, and for the grinding wheel a peripheral speed of 5000 feet per minute is employed.

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[*] For additional information on this subject previously published in MACHINERY, see "Ball and Roller Thrust Bearings," August, 1912, engineering edition, and articles there referred to.

[†] Associate Editor of MACHINERY.

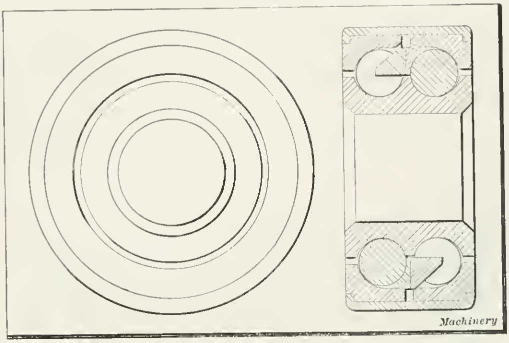

Fig. 6. Details of Bearing

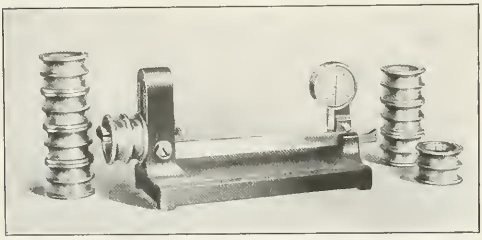

Fig. 7. Gaging Fixture for Cone Bores

The accuracy of the grinding of the bores of these cones is held to 0.0005 inch, and this accuracy is tested from time to time by means of the special gaging device which may be seen within the bore of the cone in front of the machine. This gage is shown in another position at *A* in Fig. 4. In this illustration it will be seen that the gage consists of a body *D*, supporting at its outer ends two hardened steel bearing pins *E*, and hinged at a central location is gaging arm *F*, fulcrumed on stud *G*. The short end of this bent lever terminates in a ball *H*, while the long arm ends in a needle point which indicates the size of the bore upon the graduated surface *J*. By means of spiral spring *K*, the gaging lever remains normally at its outermost position. Thus, by merely inserting the gage in the bore of the cone, the exact size is at once indicated upon the graduated section. By gaging from a three-point bearing, maximum accuracy is secured.

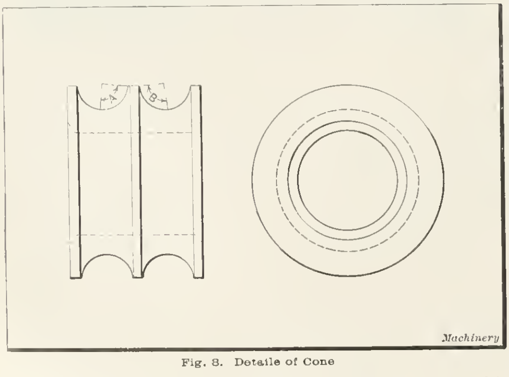

Fig. 8. Details of Cone

The grinding of the races in the cone is illustrated in Fig. 10, in which the cone *A* may be seen upon the arbor *B*. The grinding wheel *C* has a formed face and is used for finishing the races. By referring back to Fig. 8, it will be noticed that the balls bear only upon the two inner sides of the races along the section indicated by *A* and *B*. This, of course, facilitates meeting the requirements demanded in grinding the races, and the operation resolves itself into grinding these two sections of the cone races at correct radii whose centers are located at proper distances from each other. Referring again to Fig. 10, indicating gage *D* is used to locate the cone at the proper position upon the arbor *B*, after which one of the races is ground. Then by moving the wheel the proper distance to the left, the other radius is ground, which completes this part of the work.

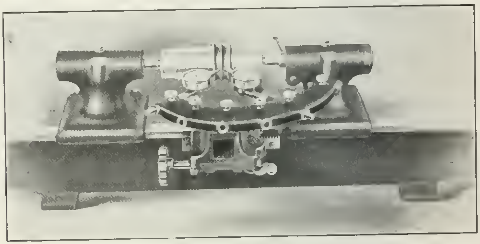

Fig. 9. Gaging Fixture for Cone Races

Gaging Fixtures for Finished Cones

The grinding of the cones is held within close limits of accuracy. To assist in maintaining proper standards, the two gaging fixtures shown in Figs. 7 and 9 are made use of. In Fig. 7 is shown the method of gaging the cone bores. This fixture is similar to the one shown at *A* in Fig. 4, but it is far more accurate. The cones are slipped over the stud which may be seen at the left-hand end of the fixture. This stud is fitted with a two-point bearing, and the gaging arm forms the third point. A multiplying lever extends to the other end of the fixture and the end of this lever bears against the plunger of the dial gage shown. Any variation in the size of the bore is thus multiplied ten times and an error of 0.0001 inch is thus indicated as 0.001 inch on the dial.

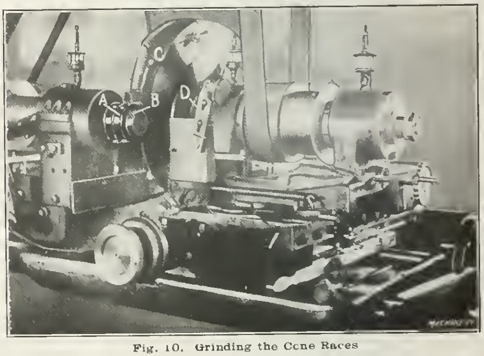

Fig. 10. Grinding the Cone Races

The machine shown in Fig. 9 is used for determining the accuracy of the ball race grinding. This machine is fitted with two indicators connected with the dial gages shown, each of which acts upon one of the ball races. The cone is held upon an arbor centering it, and the machine indicates errors of 0.0001 inch in either parallelism or concentricity of the races.

Machining the Cups

The cups of New Departure ball bearings are made from drop forgings, and the general lines of the finished cup are shown in Fig. 11. The first operation in the machining is shown in Fig. 12, being done on a Fay automatic lathe. In this illustration, the work *A* is shown gripped in a universal chuck, the jaws *B* holding the work firmly from the outside. Mounted on carriage *C*, is the forming tool, which is fed into the work, producing the shape required for the ball race. At the same time, facing tool *D* is at work finishing the edge of the cup. Referring to Fig. 11, the surfaces indicated at *A* are finished in this operation. Two of the gages used in checking the turning operation of the inside of the cups are shown at *E* and *F*, *E* being the plug gage for testing the interior diameter, while *F* is the radius gage for checking the internal diameter and radius of the turning of the race.

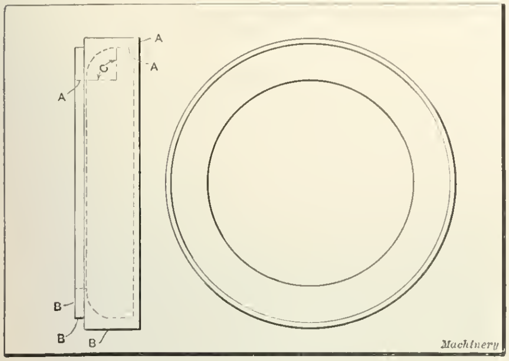

Fig. 11. Details of Cup

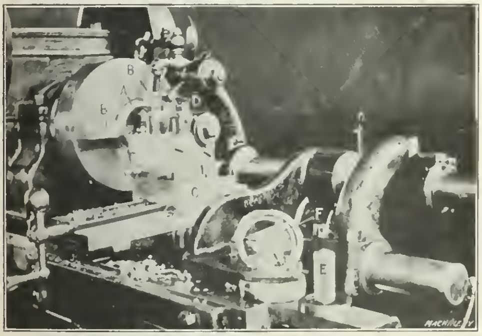

Fig. 12. Machining the Inside of the Cup

The semi-machined cups next go to another Fay automatic lathe, where the outside parts of the work are machined. This operation is clearly shown in Fig. 14. The work is held in a special chuck *A*, the principal parts of which are the expanding jaws *B* which grip the work by the inside edge and are expanded when the operator turns in the central tapered screw *C*. The work being thus securely held, the outside face is turned by a combination of turning tools on the carriage *D*. These tools are located at a fixed distance apart on carriage *D* and operate simultaneously upon the work. While the edge of the cup is being turned, facing tool *E* is at work finishing the face of the cup. The accuracy of these turning operations is checked by three gages, of which the one shown in part at *F* gages the outside diameter, the one shown at *G* checks the turning of the face and edge, while that shown at *H* controls the thickness of the cup.

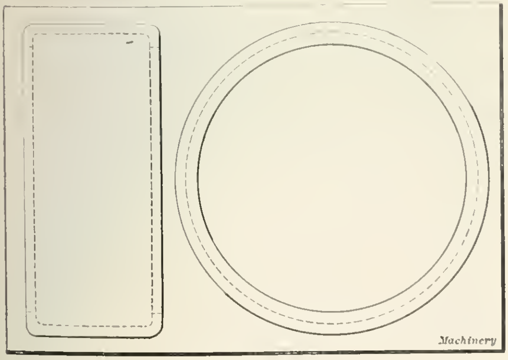

Fig. 13. Details of Shell

Grinding the Cups

The Norton automatic grinding machine shown in Fig. 19 is used for grinding the outside edges of the cups. The operation of the machine is extremely interesting, and is essentially as follows: The cups are fed into the chute *A*, dropping down against a pin whose movement is controlled by slide *B* automatically operated through link *C*. This slide is withdrawn, allowing one cup to drop between the spring plungers of the grinding machine. These plungers correspond to centers, and their purpose is to locate and drive the work. After being chucked, the grinding wheel is passed across the face of the work, the number of times having been previously determined in accordance with the finished size desired. After the cup has been ground, the plungers automatically open, allowing the ring to drop upon an endless belt while a new piece is being received by the plungers. The ejected piece is carried by the endless belt to the box containing the completed work, which may be seen at the left of the machine.

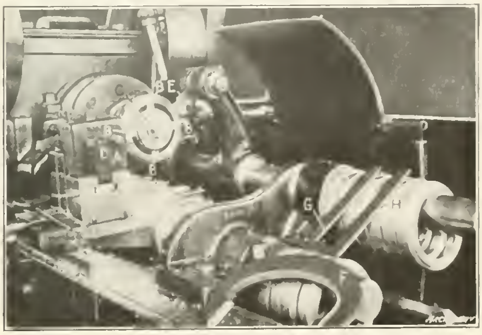

Fig. 14. Machining the Outside of the Cup

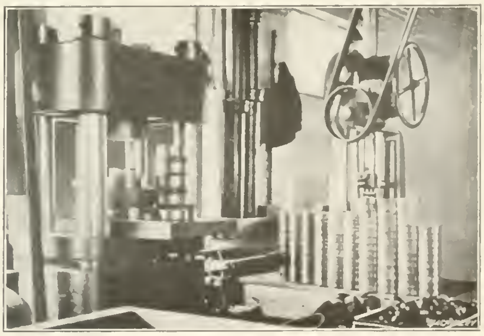

Fig. 15. Presses for Assembling Bearing Parts

From time to time, the grinding of this automatic machine is checked on the Ames gage, shown on the standard at the left of the machine. The cups are slipped under the gaging arm until they reach the stop at the left. Errors of 0.0001 inch are magnified on the dial and thus easily perceptible

Grinding the Cone Races

From the automatic grinding machine, the cups go to the oscillating machines which grind the races. Working parts of one of these machines are shown in Fig. 18. The cup is held by a magnetic chuck *A*, being located centrally thereon by means of fingers *B*. The current is supplied to this magnetic chuck by means of feed wires *C* which run to a contact constantly bearing on a similar contact flange on the rear side of the chuck spindle. The wheel spindle *D* carries a grinding wheel whose edge has been shaped to a radius slightly smaller than that of the race to be ground. The oscillating head of the machine, which carries the chuck and work, is located so that the path traversed by the work coincides with the radius of the race. This location is reached by moving the head to or from the oscillating center upon the slide. The oscillating mechanism consists of a crank and arm at the rear side of the machine (not shown) which causes the head to traverse a path extending over 120 degrees of a circle. Two gages are used continuously upon this work, these being shown at *E* and *F*. These two gages are shown on a larger scale in the illustration Fig. 4, where they are indicated as *B* and *C*. Gage *B* is for testing the accuracy of the diameter and radius of the ground race, and consists of a central triangular body from which three hardened and ground steel disks are supported. These disks are ground with knife-edges, and are of proper diameter to coincide with the curve of the race. The gage shown at *C* in Fig. 4 is used more especially as a check on the size of the radius and consists principally of a base with two locating lugs and a hardened steel disk similar to those before described, but in this case the disk is mounted on the end of a lever fulcrumed in the body of the gage. Referring again to the gage as shown at *F* in Fig. 18, which illustrates the other view of the gage, a spring may be seen which tends to keep this disk as far as possible from the locating lugs at the other end. In Fig. 4, the gage is shown in use, and by this means it is possible to see if the race is being ground to the correct radius.

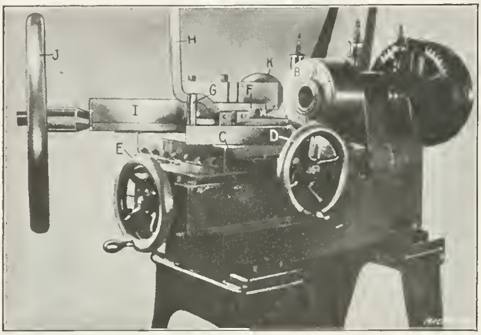

Fig. 16. Spinning the Edge of the Shell over the Assembled Bearing

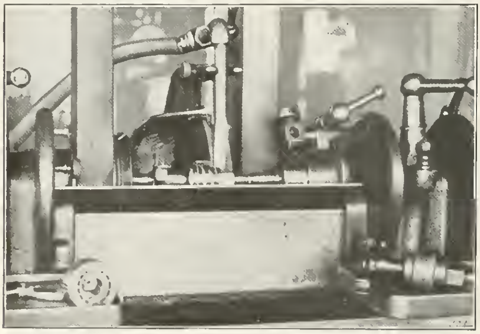

Fig. 17. Finish-grinding the Outside of the Bearing

Assembling the Bearing

The parts of the bearing are kept in the proper relation to each other by means of an enclosing shell. This shell, shown in Fig. 13, is of soft sheet steel, and made by a series of ordinary press operations, consisting of cutting and drawing in combination press tools. As it leaves the press, the cup has a bottom at one end and the edges are, of course, straight and more or less irregular. The bottom is therefore punched out, leaving a flange of the proper width to complete this end of the shell. The reverse end is trimmed for a distance that will permit of its being rolled in to form the second flange.

In assembling the bearing, forcing presses are used of the two types shown in Fig. 15. The press in the foreground is a hydraulic press, and the one in the background is operated by a friction drive. A cup is first forced into the shell, after which the cone, a set of balls and a separator are dropped in; then comes the second separator, the second set of balls and the second cup. As the cups fit tightly within the shell, they are forced into their respective places by means of the presses, the second cup being inserted to a point where it just touches the second row of balls.

Rolling the Flange

The rolling-in operation now follows, being done in the machine shown in Fig. 16. The rolling-in operation, or as it is called, the spinning-over of the shell, is accomplished in three operations, all of which are performed on this machine. Referring to Fig. 16 in connection with the line engraving Fig. 21, the work done in these three operations may be followed. The bearing *A* is held within the collet chuck *B*, which is mounted on the spindle of the machine. The carriage *C* of

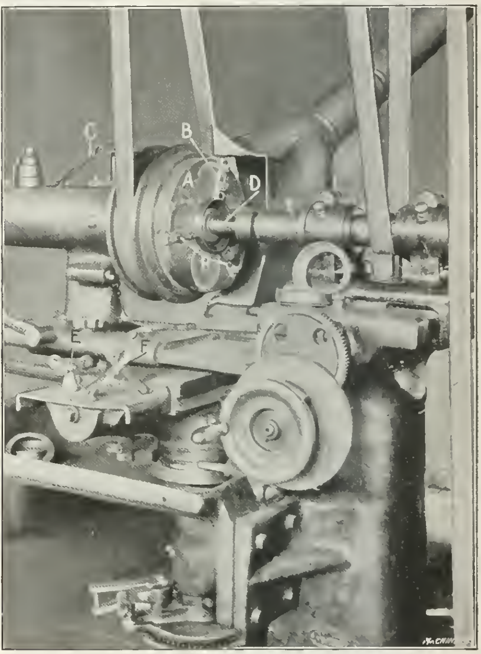

Fig. 18. "Oscillator" Grinding Machine for Cup Races

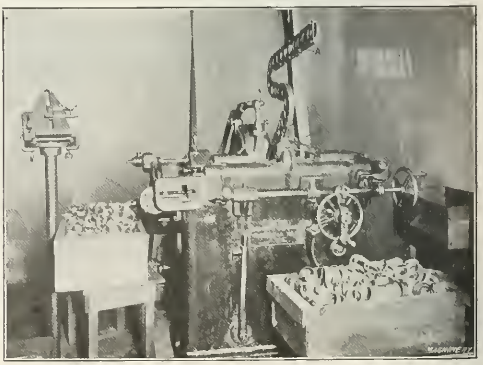

Fig. 19. Norton Automatic Cup-grinding Machine

the machine is operated in a lateral direction by handwheel *D*, and in a longitudinal direction by handwheel *E*. Mounted upon this carriage is the rolling fixture *F* which may be swiveled to any one of three positions, being held in any of these positions by means of the index pin *G*, which is lifted by handle *H*. Corresponding index-pin holes are, of course, located in the body of the carriage. A slide *I* operates on this carriage by means of the large handwheel *J*. On the forward end of this slide the roll *K* is mounted. This roll is of hardened steel and has a face approximately 1½ inch wide.

In operation, the carriage is indexed to a position sixty degrees from the center line of the bearing, as shown at *A* in Fig. 21, at which position the roll is brought up to the flange, causing it to turn inward to an amount corresponding with this angle. In the meantime, the bearing is being rotated against the roll. The result of this operation is shown at *B* in the line engraving Fig. 21. This being done, the ratchet is indexed to the second position. In this second position, the slide on the carriage stands at a position of thirty degrees to the center line of the bearing, and, consequently, when the roll is brought into conjunction with the work by means of the large handwheel *J*, the flange of the shell is turned inward a corresponding amount, leaving the bearing and shell in the condition shown at *C* in Fig. 21. As soon as this part of the work is done, the roll is again withdrawn and the carriage swiveled to a position in line with the center line of the bearing, after which the edge of the shell is rolled down into the recess in the outer cup of the bearing, leaving it finished as shown at *D* in Fig. 21. During the three rolling operations, the roll is fed from the outside of the shell inward, by means of lateral feed-screw handle *D*.

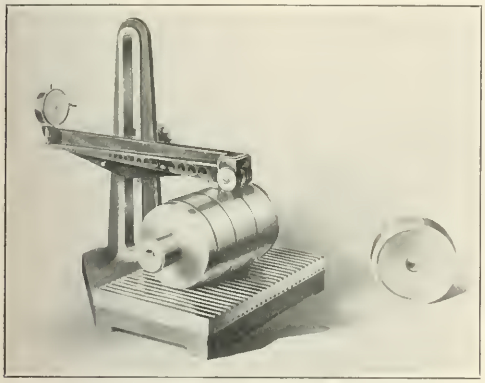

Fig. 20. Testing the Diameter of the Finished Bearing

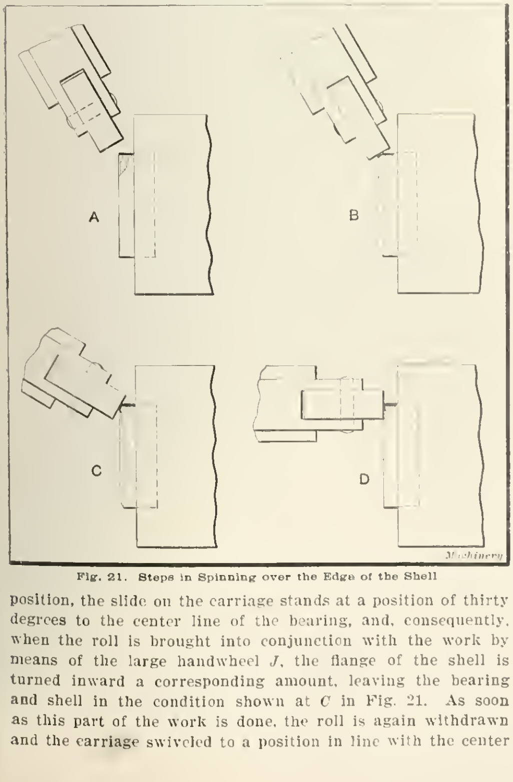

Fig. 21. Steps in Spinning over the Edge of the Shell

Finish-grinding

In order to give the bearing a finished appearance, as well as a truly concentric exterior, it is ground all over after it has been assembled. These grinding operations, which face off the ends and periphery of the bearing, are comparatively simple, the first being performed in ring grinding machines, and the second upon plain grinding machines, as shown in Fig. 17. For this latter grinding operation, the bearing is held upon an arbor having a fixed collar against which the bearing is clamped by means of a washer and nut.

Finish-inspection and Test of the Bearings

Fig. 20 illustrates a gaging fixture used by the inspectors who pass upon the finished bearings. The gage consists of a multiplying lever whose outer end acts upon an Ames gage. A master testing disk is shown at the right, by means of which the reading of the gage is checked from time to time. In the illustration, three bearings are shown under test.

The master measuring machine shown in Fig. 22 is used for miscellaneous inspecting, but more particularly for the checking of the master plugs, disks and ring gages which are examined every day to insure that they are accurate. This machine is fitted with a microscope to facilitate the proper setting of the vernier. In this illustration it is shown with one of the cups between its measuring points.

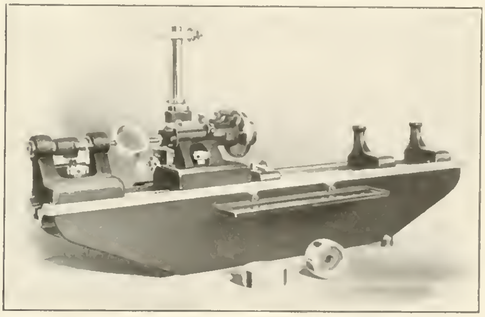

Fig. 22. Master Measuring Machine

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LUBRICATION OF MACHINE TOOLS

In an article on machine tool lubrication abstracted from *L'Industria* in the foreign review of the *Journal of the American Society of Mechanical Engineers*, attention is called to the fact that inefficient lubrication in machine tools is the principal cause of the rapid deterioration of this class of machines. It is the minor or secondary working parts, it is stated, which most easily get out of order. The main parts are provided with sufficient and continuous lubrication, while the secondary parts are left to be lubricated by the workman squirting oil through an oil hole from time to time. These oil holes, however, often become clogged with dirt; besides, the lubrication of the minor working mechanisms of the machine is often neglected. This was of little consequence as long as the speeds of machine tools, in general, were low and the power small, but it has become a very important factor under present-day conditions. Some American manufacturers, says the writer, are beginning to design machine tools with automatic lubrication throughout, but this practice is not yet as general as it ought to be.

* * *

RESTORING OVER-EXPOSED BLUEPRINTS

C. J. Kranz of Chicago, Ill., writes that over-exposed blueprints can be restored if immersed in hot water. He has used hot water successfully for restoring blueprints when the white lines were blue and the portions that should normally be blue were steel gray.

DON'TS FOR THE MANAGER[*]

BY JOHN S. MYERS[†][‡]

Don't discourage suggestions.

Don't tolerate insubordination.

Don't fail to supply pure water for your employes.

Don't build a plant without allowing for expansion.

Don't take credit that belongs to your subordinates.

Don't have favorites, as they seldom respect you for it.

Don't be tight across the chest; penury is not economy.

Don't forget that there are always at least two sides to a story.

Don't be content with mediocre ability—the best is cheapest.

Don't pay men for doing work that can be done on a machine.

Don't allow a clique of men to dominate a plant or a department.

Don't lie to your customers—sooner or later they'll find you out.

Don't buy outside patents and discourage invention in your own men.

Don't compel someone to be a watch-dog—better put in a time-clock.

Don't accept matters of opinion when matters of fact can be shown.

Don't hesitate to scrap a machine when its period of usefulness is past.

Don't permit inaccurate machine work to run up the cost of assembly.

Don't distrust your employes—if they are not to be trusted fire them.

Don't imagine money spent on accurate records is not paying dividends.

Don't forget that a sure way to kill almost anything is to make a joke of it.

Don't be anything but a man and a gentleman if you wish loyal, faithful service.

Don't call down your department heads in the hearing of their subordinates.

Don't permit discord between departments; non-cooperation is a woeful state.

Don't be unreasonable if the men have a grievance; adjust it if possible.

Don't be without proper fire protection or you may soon be without a plant.

Don't get cold feet and shut down in hard times; it breaks up your organization.

Don't believe that system can be run without a little "brain fat" as lubricant.

Don't imagine two fifteen-dollar men are always worth more than one thirty-dollar man.

Don't buy poor materials because they're cheap—they may be expensive in the end.

Don't build things if it's possible to manufacture them—there's a heap of difference.

Don't follow the path of least resistance unless morally certain that it's the correct one.

Don't measure a man's performance by his talk; someone else may be pulling his load.

Don't harass your department heads by undue interference or criticism of trifles.

Don't allow the engineering department to be without a stock-list; make them use it.

Don't expect an undermanned department to get out huge volumes of work on short notice.

Don't get your subordinates all worked up about trifles—it reduces their efficiency.

Don't be curt to a new employe; he probably feels like a cat in a strange garret anyway.

Don't abolish a thing or method unless you supplant it by something actually superior.

Don't use antiquated methods—of course you think you do not, but do you know it?

Don't address English correspondents as Mr.—they write thusly to their underservants.

Don't imagine anyone, not even yourself, to be infallible, and consequently don't expect it.

Don't make the drafting-room the goat all the time; it's a senseless habit far too prevalent.

Don't have an inadequate system of artificial light or of ventilation—it's poor economy.

Don't advertise spasmodically or semi-occasionally; steady conservative campaigning, is better.

Don't take orders you can't deliver on time or your shipping dates will become a joke in the plant.

Don't tolerate lying or crawling out of it; show that you appreciate frank confession of errors.

Don't engineer a strike in order to break a contract—there are too many unknown possibilities involved.

Don't build a great variety of things varying but slightly from one another—standardize and concentrate.

Don't cast lightly aside the understudy idea; if you don't understand it, visit some plant where they do.

Don't forget that the man on the job probably knows ten times the amount of detail concerning it that you do.

Don't take all your own and your wife's relations into the company's employ—a moderate sprinkling will suffice.

Don't expect to evolve from your inner consciousness all innovations; see what the other fellows are doing.

Don't be without accurate costs, but don't let it cost more to find out what it costs than it does to make the part.

Don't find fault all the time and commend nothing; it's only human to desire a little commendation for extra effort.

Don't give orders direct to the men; it disorganizes the force, and besides, what are you paying your department heads for?

Don't ship a new machine without a thorough tryout; doing so may ruin your reputation in the locality where it lands.

Don't believe that the man who's always ruuning to you with complaints is the man who is earning the most for the company.

Don't forget that things sometimes run "bumpily" instead of smoothly because you, yourself, have strewn the way with boulders.

Don't underrate years of service; it's a mighty poor return for faithful service to fire a man who has become old in your employ.

Don't make your plant an experimental station for a horde of systematizers, but if you need system get the best and get it quick.

Don't look at errors in the aggregate just because *you* hear of all of them. Treat them as percentages per individual; it's more just.

Don't make monkeys of your department heads by needlessly reversing their decisions. It's often best to back them up even when wrong.

Don't be given to snap judgment or arbitrary decisions, especially if at variance with the opinion of an employe who should know.

Don't send cigars to your customers at Christmas, and forget your employes. If the customers knew it they would probably return the cigars.

Don't imagine that any old dub can run the assembly department. There are modern methods and equipment needed here as well as in the machine department.

Don't consider the draftsman an expensive, non-productive, necessary evil; proper design is the first requisite for a money-making output.

Don't disregard instructions for boxing and marking foreign shipments; what is good for U. S. A., doesn't count in some localities.

Don't be afraid to get up designs in advance of orders, for hurry-up designs are generally poor designs, and poor designs are not money-makers.

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[*] For Don'ts previously published in MACHINERY, see "Don'ts for Gear Hobbers," April, 1912; "Don'ts for Toolmakers," December, 1911; and "Don'ts for Machinists," February, 1911, with accompanying references.

[†] The writer is not a manager but has observed that the interesting stories about bees and ants have been written by representatives of another species; he would like to read the story if written by the bees and ants themselves, and, with the idea of "stirring up the insects" has perpetrated these "Don'ts."

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Don't raise the merry devil about getting a job out quick and then let it lie around the place when done—remember the story of "Wolf, Wolf!"

Don't throw down your representative; by so doing you throw down your own company's pledged word, which is poor policy to say the least.

Don't let it be everyone's duty to fix the belts or oil the shafting, or attend to anything that requires attention; everyone's duty is no one's duty.

Don't make overtime a regular thing—it only pays for emergency jobs; a man's nervous energy is considerably like a bank account, liable to be overdrawn.

Don't have death-traps in the form of unguarded gears, broken railings, unannealed crane chains, weak slings, poorly designed, home-constructed jib cranes, etc.

Don't be a worshipper at the shrine of precedent; if you really have anything good, put it in motion—but don't turn the grindstone backwards just to be different.

Don't surround yourself by incompetents simply because they are friends; loyalty is a jewel, but if coupled with the flaw of incompetency, its value is questionable.

Don't enter orders for a special machine when a little plain talk would show the customer that a standard machine would fill the bill and could be shipped sooner.

Don't forget that it's poor policy to make an employe assign a patent for a dollar; if you pay him a small royalty it encourages the production of still better things.

Don't sell at a loss; abandon a line if it can't be made to pay. (Any boy knows this much but the trouble is that some managers don't know when they are selling at a loss.)

Don't lend but half an ear to the cry for help from your distant representatives; they are on the ground and their troubles are real—put yourself in their place.

Don't be eternally changing department heads; it makes everything unstable, breeds discontent, and each new one is sure to undo much of the good that his predecessor accomplished.

Don't go outside your own organization every time a responsible man is needed; if they're not growing up with you there's something radically wrong with the management, and folks on the outside know it.

Don't leave the stock list to the tender mercies of a twelve-dollar clerk; you have good money tied up in it and good brains should be expended on eliminating all odd sizes, dead wood and remnants of antiquity.

Don't neglect the South American trade; there is a big field open there and when the canal opens it may be bigger. We are the nearest. Why don't we get their trade? It's up to the manager to answer this question. Are you on the job?

Don't let mail to foreign countries be posted without sufficient stamps—the thoughtlessness of your office boy may become an index of your company's methods. In some countries the receiver of such mail has to pay double the amount that is lacking.

Don't hold a man down to a small salary who can make more elsewhere but has private reasons for not wishing to change; it's not a square deal to say "Brown won't leave—he owns his home here," or "George is worth more but he likes the work."

Don't forget that a worth-while man is generally employed, and that to get him you have to pay more than his present employer feels him worth; you are, therefore, counting on the short-sightedness of the other fellow, who is probably playing the same sort of game. You each think you are the sharpest, but he who trains and promotes from his own force does not take part in this foolish competition, neither is he a purveyor of lemons.

* * *

A uniform system for the painting of patterns for steel castings has been adopted at a joint meeting of the Steel Founders' Society and the American Society for Testing Materials. The surfaces to be finished on the casting are to be painted red on the pattern, the rough surfaces are to be painted yellow, and all core prints are to be black.

AIRSHIPS OF THE FUTURE

BY F. E. R.

We were talking about aeroplanes and airships down at the works one noon hour last week. Most of the boys thought the flying machine would be so improved with automatic balancers in a year or two that an aviator could go up in one without feeling that the undertaker was getting the coffin ready for the grease spot he was about to make over in the next township. They said that the heavier-than-air machine was the only practical thing in aircraft, and that the airship was a totally foolish contrivance. You could go up in an airship, but when you were up the wind took you everywhere except to the place you wanted to go. When you tried to land you were likely to knock down a barn or two and muss up the landscape generally. Fritz, the big diemaker, who is American in everything but name and reverence for the Fatherland, listened awhile in silence, but when the airship had been kicked all around the lot, he got mad and surprised us.

"Say, you fellers don't know a thing about airships. You're just like all the rest of the Yankees—think you know it all and that the rest of the world is dead slow. I'll bet you a thousand dollars that Count Zeppelin will sail into New York some fine morning and give them New Yorkers, and the whole country for that matter, something interesting to talk about. Do you know what he has done?"

One of the boys said he knew "Old Zep" had smashed up eight or ten machines, every one worth a barrel of money, and that he would have gone broke long ago if the Kaiser hadn't the war bug so bad he was willing to back anything that could be used to make a bluff with.

"That's just where you are wrong," said Fritz. "The Kaiser is a soldier all right and hot in the war game, but he's a big business man, too. He sees the idea the Count has in his head all right. It's all a matter of size in the airship game—the little ones are no good. The measly gas bag airships you've built over here can hardly lift their own weight, and they're so slimpsey and rickety the wind blows them to pieces when they try to go against it. The Zeppelins are built scientifically with aluminum frames that hold their shape and strong engines that push them where they're steered. They are big—between five-hundred and six-hundred feet long. The bigger they are the more freight and power they can carry, and the stronger they are to stand the wind. You'll see them a thousand feet long—yes, two thousand feet long if you live ten years."

"Say, Fritz, you're crazy," said Frank. "Even if they can be built as big as you say, they wouldn't pay. An idea that can't pan out in dollars and cents won't be carried out. Patriotism is all right, but there's a limit to it. It stands to reason that the Germans are not going to put up a million or two for an airship just to make a holler."

"There's just where you're mistaken again. The bigger the machine the faster it will go, and that's how they'll make money. A hundred and fifty miles an hour is what the Count is working for. Do you see what that means? Twenty-four hours to cross the pond. Say there's any number of rich guys that will pay a thousand dollars to get to Europe in a hurry and they'll pay just as much to get back again; and then, too, there's the mail contracts. Your aeroplanes may be all right to draw the crowds to the country fairs to see lofty tumbling and scrambled remains, but when it comes to doing something worth while in the flying and carrying line, the Count has got you skinned."

And then as the whistle blew I heard Frank mutter, "Maybe 'Old Zep' ain't so crazy after all."

* * *

A company has recently been formed in London, known as the Letters Patent Insurance Co., Ltd., the object of which is to offer insurance of patent rights. The insurance will protect the owner of patents, or other people who are in some way interested in a patent or a patent application, against losses due to legal expenses and infringement suits. It will also insure the cost of such legal procedures as may be necessary to protect a patent from infringement by others.

A BETTER MAGAZINE—A PLEA FOR COOPERATION

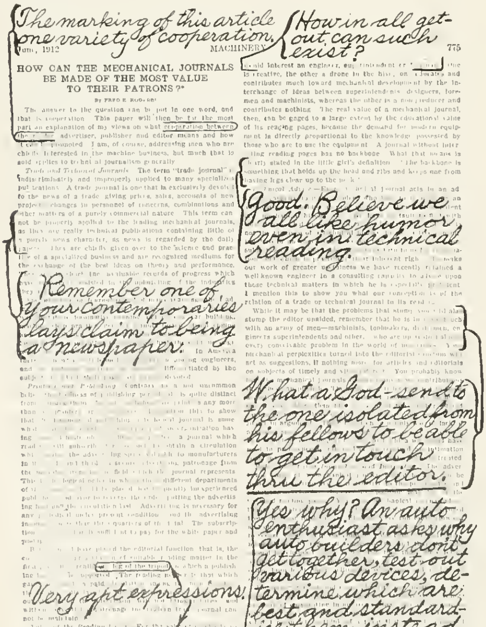
BY JOHN S. MYERS[*]

Am I an editor? No. Then why an editorial from my pen? Because I am a reader who understands that the reader is to a magazine what the common people are to a popular government—he's IT, or should be. Why is the reader IT? Because he is the person for whom the magazine is published. If the magazine appeals to a reader he is likely to interest his friends. This boosts the circulation, and enlarged circulation means more advertisers, hence more income for the magazine to spend on good articles.

Every triangle has three angles and three sides. In an equilateral triangle the three sides, and consequently the three angles, are equal. The conscientious publisher tries to make his enterprise an equilateral triangle, but he can do it only with cooperation. The three sides are the publishers, the readers and the advertisers; the three angles are the viewpoints of these three sides.

Now how can you obtain a better magazine? By cooperating, by making intelligent comments on the articles published, by contributing articles, by joining the staff of educators. Remember that if the magazine is not what you would have it, you are partly to blame.

One way of aiding the contributors to MACHINERY is to write your comments on the margin of the article and send them to the editor or the author. This shows at least that you have read the subject matter and were interested. Your suggestions may bring forth fruit. For example, see the accompanying reproductions of the pages of an article with comments.



The marking of this article one variety of cooperation.

How in all get-out can such exist?

June, 1912 MACHINERY 775

HOW CAN THE MECHANICAL JOURNALS BE MADE OF THE MOST VALUE TO THEIR PATRONS?

Good. Believe we all like humor even in technical reading.

Remember one of your contemporaries lays claim to being a newspaper.

What a God-send to the one isolated from his fellows to be able to get in touch thru the editor.

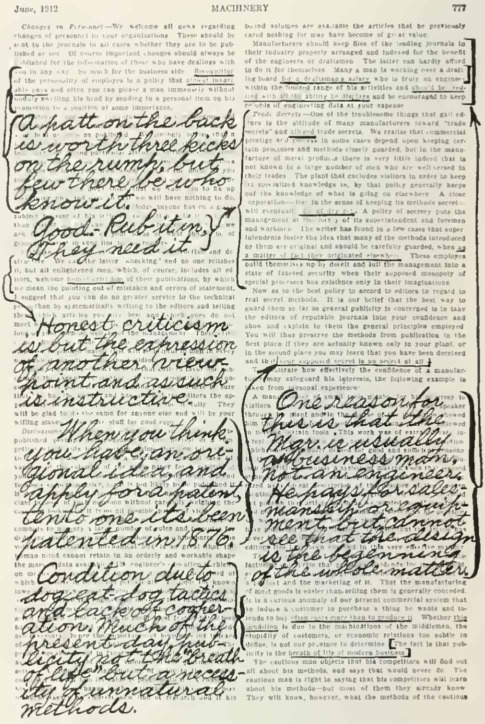
Yes why? An auto enthusiast asks why auto builders don't get together, test out various devices, determine which are best and standardize them instead of each advertising his device as best.

Very apt expressions.

The user of course foots the bill, in the ultimate, for this needless antagonism.

A scythe is whetted by a stone, but man's intellect is best whetted by contact with other intellects similarly trained and interested. You may be marooned on an intellectual oasis, as far as personal contact is concerned, yet you have freedom of expression and response through the technical press ever at your command. The main trouble is that you do not take advantage of your opportunity. You have a right to renew or discontinue your subscription just as the fancy strikes you, but you do not realize that you also have a right to suggest ways and means for making the magazine what you would have it.

It is a joy and stimulus to a writer to know that his articles have been carefully read. Comment and criticism thereon spur him to further effort and put him in touch with his readers' viewpoints. If you cannot write a good article yourself, you can offer intelligent comment in the manner indicated, and will find that such mental exercise is good for you—it will teach you to read appreciatively.



June, 1912 MACHINERY 777

A patt on the back is worth three kicks on the rump, but few there be who know it.

Good—Rub it on. They need it.

Honest criticism is but the expression of another viewpoint and as such is instructive.

When you think you have an original idea and apply for a patent, ten to one it's been patented in 1876.

Condition due to dog-eat-dog tactics and lack of cooperation. Much of the present day publicity not the "breath of life" but a necessity of unnatural methods.

One reason for this is that the Mgr. is usually a business man, not an engineer. He pays for salesmanship or equipment but cannot see that the design is the beginning of the whole matter.

* * *

NEW METHOD OF GALVANIZING IRON

A description of a new method recently patented of galvanizing iron is quoted in the United States *Daily Consular and Trade Reports* from a German publication substantially as follows: To protect iron objects from rust it is customary to coat them with zinc, deposited either electrolytically or by plunging them in a bath of melted zinc. The disadvantage of these methods is that real fusion of the two metals is not obtained, and as a result the zinc coating does not properly protect the iron surface underneath. The defect is avoided by the new process which consists in so preparing the iron that the zinc is intimately associated with the surface of the iron, being deposited into its pores. After steeping the parts to be coated in sulphuric acid, they are placed in a solution of mercuric chloride, and then heated, resulting in the decomposition of the mercuric chloride and precipitation of metallic mercury which forms an amalgam on the surface. The iron is then plunged into a zinc bath heated to 500 degrees F., where it remains three minutes. The zinc coating deposited by this method adheres very strongly to the metal. Microscopic investigation shows that the zinc penetrates into the pores of the iron, and in case a portion of the coating is worn or peeled off, the iron does not rust owing to the presence of sufficient zinc in the surface to protect the metal from the action of the atmosphere. In other words, there is a perfect alloy or association of the two metals at the point of juncture.

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HEAT TRANSMISSION THROUGH BUILDING WALLS

In considering the rate of transmission of heat through building materials, considerable uncertainty exists in regard to the accuracy of the results obtained, on account of varying conditions of wind and weather, leakage, exposure, and a number of other causes. The problem becomes especially puzzling when the engineer is called upon to deal with materials of construction with which his profession has not had experience.

The modern tendency to construct shops and manufacturing establishments with large window areas—where the concrete or steel frame frequently forms little more than a grid—has directed considerable attention to the calculation of the heating requirements of such buildings. The Green Fuel Economizer Co., Matteawan, N. Y., has recently installed hot-blast heating equipments in a number of concrete and glass buildings, and also in buildings covered with sheet metal. This installation recently afforded an opportunity to ascertain the transmission of heat through one of the sheet-metal buildings last referred to. This shop has a continuous window space on one side 15 feet high and on the opposite side 19 feet high. The walls of the building consist of corrugated iron of single thickness and without lining. The crevices at the eaves are filled with asbestos, the corrugated iron is cemented in at the bottom, and other precautions have been taken to make the building as nearly air-tight as possible. The exposure of the windows is east and west, the smaller windows being on the east side.

The coefficients given by different authorities for the rate of heat transmission through single windows vary somewhat. Prof. Homer Woodbridge gives this coefficient for single windows with a southern exposure as 1 B. T. U. per square foot per hour, per degree difference between the inside and outside temperatures. This figure is increased 35 per cent for northern exposures, 25 per cent for western exposures, and 15 per cent for eastern exposures. The only available figure for corrugated iron without sheathing is the one determined by Rietschel, which is 2.132, but no statement is given as to whether it refers to superficial wall area or to the actual surface of the iron.

In the case of the building under discussion, the total surface is made up of approximately 7538 square feet of window space which includes the sash, 8247 square feet of wall space, and 11,925 square feet of roof. The surfaces of both walls and roof are given in superficial area, and in order to account for the corrugation in the iron, this value must be multiplied by a factor of 1.35. This gives the total area of the walls and roof as 20,172 × 1.35 = 27,232 square feet.

The building is heated by a Green hot-blast heater with the assistance of an engine-driven centrifugal fan drawing through a "Positiv-flo" heater made up of six sections of four rows of piping. The sections measure 7 by 8 feet. The heater is ordinarily drained of condensate and air by a Dexter vacuum system. There are altogether 6816 lineal feet of one-inch pipe in the heater, which is equal to 2272 square feet of heating surface. The air is distributed throughout the shop by circular sheet-iron conduits with their outlets directed down into the zone occupied by the workmen.

The temperature of the building was maintained constant during the test which covered a period of three hours. The fan was run at 258 R. P. M., and received 22,416 cubic feet of air per minute, figured at a temperature of 50 degrees F; this air was actually received by the heater at a temperature of 73 degrees F., and delivered from the fan at 156 degrees F. The temperature of the steam in the heater was 212 degrees F, and the temperature of the air delivered from the furthest outlet was 141.5 degrees F. Under these conditions the temperature of the building, measured at a distance of three feet from the floor, was found to be 66 degrees F., and measured in the gallery, the temperature was 70 degrees F.; the temperature outside the building at the time of the test was 15 degrees F.

Two methods were employed for the determination of the total heat supplied. The first method consisted in calculating the heat from the rise in temperature of the air passed through the heater. By the second method, the heat was calculated from the condensation taking place in the heater. For the latter purpose the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B. T. U. per hour, and by the condensate method 2,029,730 B. T. U. per hour. Using these figures, it appears that the average rate of heat transmission through the superficial area of the building was 1.42 B. T. U. per square foot, per hour, per degree difference in temperature, and using the value obtained by the steam method, the value of coefficient is 1.38 B. T. U. per square foot, per hour, per degree difference in temperature.

Taking Prof. Woodbridge's figures for the rate of heat transmission through the windows, we would get 1 B. T. U. per square foot, per hour, per degree difference in temperature as the coefficient for a southern exposure. This value must be increased by 15 per cent for an eastern exposure, and 25 per cent for a western exposure, or an average value of approximately 20 per cent for the present case; this gives the value of 1.2 as the coefficient for the window surface. The value of the coefficient for the corrugated iron, merely figuring the superficial area, is 1.5. Figuring the entire surface of the iron gives the value of the coefficient as 1.13, which is less than an equivalent amount of glass surface. This result seems hardly correct, although it may be so, the explanation being that the corrugations in the iron protect the surface to a certain extent, thus making the heat transmitted from a square foot of corrugated iron less than it would be from an equal surface of flat metal.

Allowing for many indeterminate conditions, it would probably be safe in calculating the heat supply for buildings of this kind to provide for a coefficient of transmission of 2 B. T. U., per square foot, per hour, per degree difference in temperature for the whole wall and roof area.

* * *

TURNING LEFT SHOE LASTS FROM RIGHT MODELS

The conception of the average layman of the state of the material universe if the much-discussed "fourth dimension" of the mathematicians could be perceived, is the possibility of a solid body disappearing from the view of ordinary mortals into fourth-dimensional space; of turning spheres inside out without rupture; of converting right-hand gloves into left-hand gloves without turning them wrong side out, and so on. Whether or not the fourth dimension is merely a mathematical figment we may never know, but a practical and startling illustration of producing right forms from left forms can be seen any day in shoe-last turning shops. Most mechanics are more or less familiar with the general principle of the Blanchard lathe for turning axe handles, gun stocks, hat blocks, shoe lasts, etc. The general impression is that an exact model of the piece to be turned is rotated in unison with the work and a guide wheel pressing against the model transmits the necessary radial motion to the cutter to produce the shape desired. But in the case of "rights" and "lefts" one model will serve for both shapes. A right shoe-last model is used for turning a left last, the model and work being run in opposite directions and one-half revolution apart; the sole of one is up while the other is down, and so on. Thus, in a sense, the fourth dimension possibility is actually realized.

* * *

The Department of the Interior, Bureau of Mines, has issued a bulletin (No. 47) on mineral waste in the industries, which gives a startling statement of the loss of zinc in the Waterbury, Conn., mills. It is estimated that 7500 pounds of zinc passes into the atmosphere daily in the form of zinc oxide. Zinc boils at 930 degrees F. and the present melting practice does not prevent the loss of the vapors. The solution of the problem of eliminating these losses is some form of closed furnace, of which the electric furnace is a prominent type and perhaps tho only practicable form now known.

SAFEGUARDS FOR POWER PRESSES*

A NUMBER OF EFFECTIVE SAFETY DEVICES ADOPTED BY LEADING MANUFACTURERS

BY EDWARD K. HAMMOND

The problem of providing for the safety of power-press operators presents two possibilities of solution. The first alternative is to use presses equipped with some form of automatic feeding device that makes it unnecessary for the operator to put his fingers under the ram. The second is to adopt some form of safeguard that keeps his hands away from the die during the working stroke of the ram.

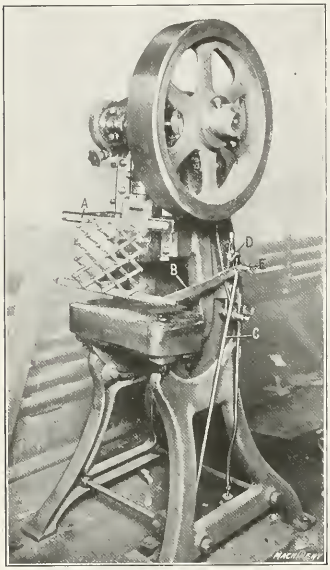

Fig. 1. The Cream City Accident Preventer made by Geuder, Paeschke, & Frey Co.

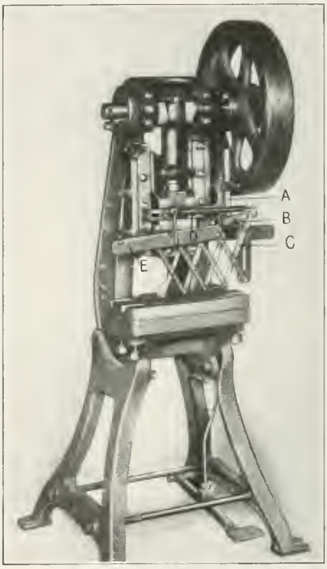

Fig. 2. Safeguard with Pantograph Gate which expands from Side

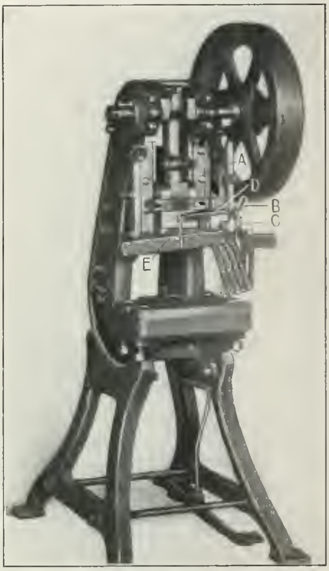

Fig. 3. Same Press as in Fig. 2, with Guard folded to One Side

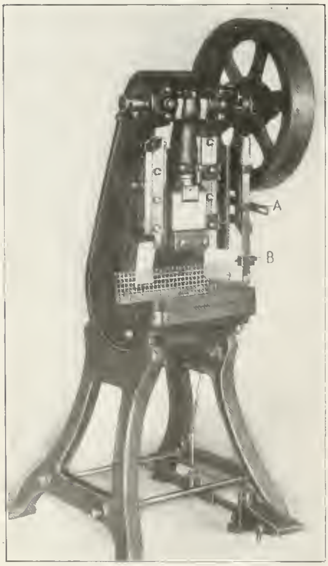

Fig. 4. The Jones Stamping Press Guard, Ram Descending

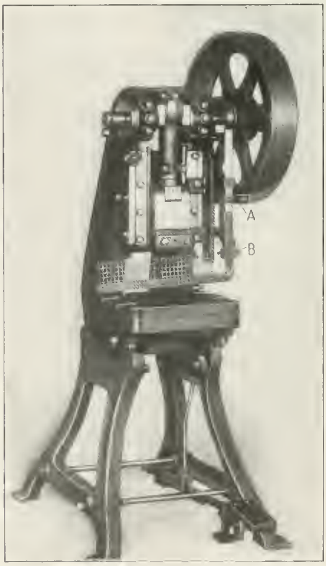

Fig. 5. The Jones Press Guard in Position before Treadle is tripped

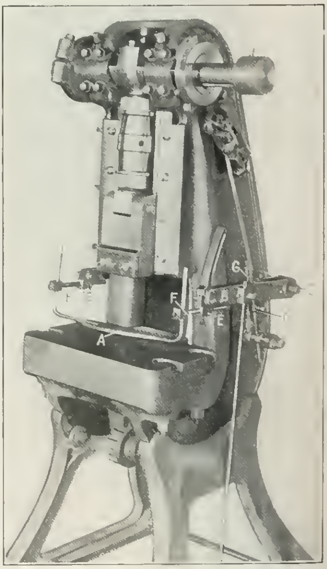

Fig. 6. Safeguard using a Bar instead of Gates

The different forms of automatic feeding devices which have been successfully applied in power-press work were fully discussed in articles published in MACHINERY October, 1911, and January, 1912. Owing to the fact that automatic feeding removes the necessity for the operator to put his hands under the ram, presses equipped with such feeding devices are as safe as they can be made for handling the class of work required of them. These devices do not reduce the operator's output, and the only argument against them is that the first cost of presses equipped with automatic feeding devices is higher.

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* For further information relating to the safeguarding of machinery and the prevention of accidents in shops and factories, see "Prevention of Industrial Accidents," MACHINERY, engineering edition, April, 1912, and "The Prevention of Industrial Accidents," in the engineering edition, November, 1911. See also the list of previously published matter referred to in connection with the article last mentioned.

In this article, different forms of power-press safeguards which have found successful application in well-known manufacturing plants, will be described. An important advantage in favor of their application lies in the fact that they can be used on the presses which a shop already has in operation, thus providing for the safety of the operator at a relatively small expense. Among the different types, one can almost always be found which will meet the requirements of any one class of power-press work.

The advisability of adopting every precaution to provide for the operator's safety offers little ground for discussion. Aside from humanitarian considerations, which constitute a sufficient reason, safeguards are well worth while when considered from a purely economic standpoint. The premiums charged for accident insurance for operators of power presses average about eight times the rates for operators of other classes of metal working machinery. Well designed safeguards reduce the risk involved and enable a considerable saving to be made in the cost of accident insurance.

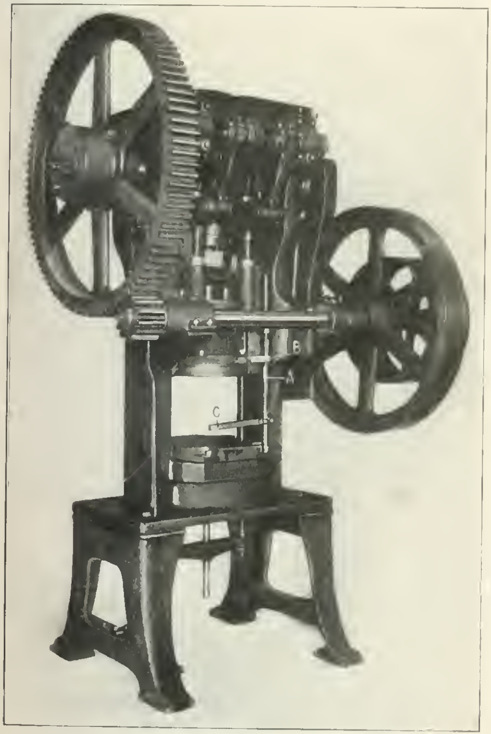

Fig. 7. Guard Bar swung over Die by a Twisted Rod

The Cream City Accident Preventer

The safeguard illustrated in Fig. 1 is manufactured by the Geuder, Paeschke & Frey Co., Milwaukee, Wis. In the manufacture of tinware and sheet steel ware, this company experienced great trouble from the injury of power press operators, and as the result of study given to the subject, the guard shown in Fig. 1 was developed. The original idea was merely to avoid power press accidents in the company's shops, but the guard was found to give such satisfaction that it was decided to place it upon the market. It is known as the "Cream City accident preventer," the first two words corresponding with the names of this company's other products.

The guard consists of an expanding gate, of the pantograph type, which opens before each down-stroke of the ram, thus blocking the approach to the die. It is attached to the press by means of two brackets *A*, which are secured to the press by means of the regular gib screws. The method of operation is entirely automatic. A lever *B* is fulcrumed to the side of the press where the driving clutch is located, and is connected with the treadle by means of rod *C*. When the treadle is tripped, this rod pulls down the lever, which, in its turn, expands the gate in advance of the descent of the ram. The guard is arranged in such a manner that the gate must be all the way down before the clutch can be engaged. This makes it necessary for the operator to remove his hands from the work before the press can be tripped, and should he attempt to adjust the position of a blank at the last moment—which has been one of the most frequent causes of accidents on unguarded presses—the descent of the gate is checked, thus preventing the engagement of the clutch and the downstroke of the ram. When the treadle is released, the tension of spring *D* causes the gate to return instantly to the folded position, so that it is out of the way for the next operation.

At the place where lever *B* is pivoted to the frame of the press, a screw *E* is provided, which enables the point to which the gate must descend before the clutch is engaged to be adjusted. For most classes of work, this screw is set to bring the gate to within at least 1/8 inch of the table before the clutch is engaged. Such a setting, however, would interfere with sheets that extend out in front of the press, and for such classes of work the gate is set to descend to a point just above the level of the die before the engagement of the clutch can be effected. In such cases, the bottom of the gate is practically in contact with the face of the work; consequently, the same degree of protection for the operator is secured.

The application of this guard does not require the construction of the press to be altered in any way, the only work necessary being that of drilling and tapping holes for the bolts which secure the operating lever *B* to the frame of the machine. The openings in the guard gate enable the operator to have his work in plain view at all times.

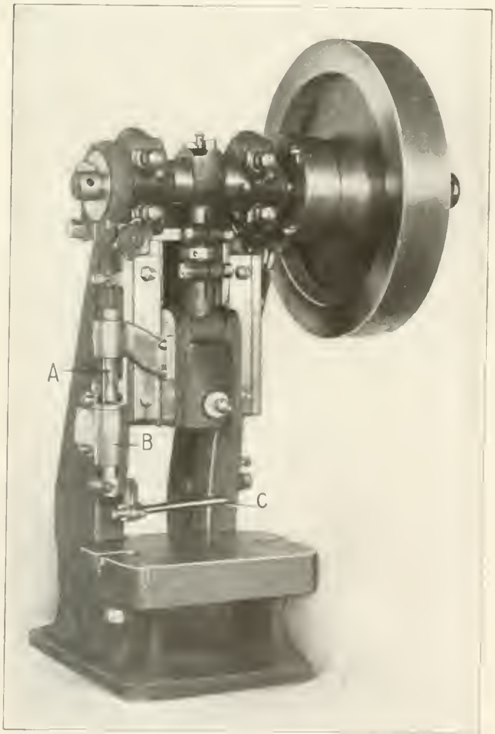

Fig 8. Guard Bar swung over Die by Pin in Spiral Groove

A somewhat similar, although less efficient guard than the one just described, is shown in Figs. 2 and 3. In this case the pantograph gate expands from the side, its movement being controlled by the bar *A*. As the slide descends, this bar, which is attached to it, engages a cam carried by the pivot on which lever *B* is mounted. This swings lever *B* down into a nearly horizontal position, as shown in Fig. 2, and expands the pantograph gate across the front of the die, through the leverage exerted by the extended arm *C* of the gate. The action of the mechanism is so timed that the gate shuts off access to the die before the punch has descended upon it. When the ram rises, bar *A* is carried up with it. This releases the mechanism, and the gate is closed by the tension of spring *D*; *E* is simply a guide in which the gate travels.

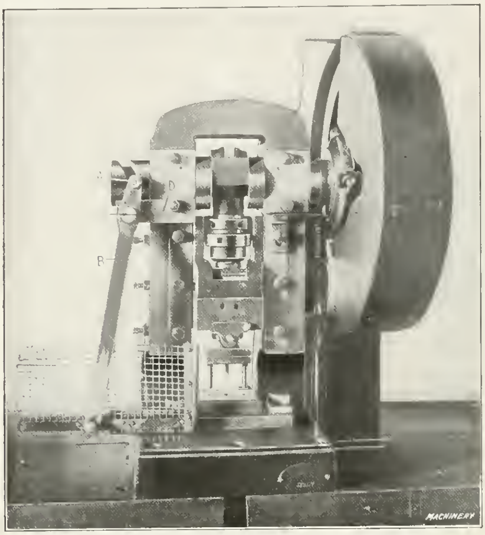

Fig 9. Safeguard with Gate which swings from the Side

The Jones Stamping Press Guard

The press illustrated in Figs. 4 and 5 is equipped with a safety device known as the Jones stamping press guard, which is manufactured by the Jones Safety Device Co., Chicago, Ill. When in operation, the wire-mesh gate drops somewhat ahead of the down-stroke of the ram, thus barring the operator's access to the die during the working stroke. The design is such that the gate must reach the bottom of its stroke, which brings it into contact with the table, before the clutch can be engaged.

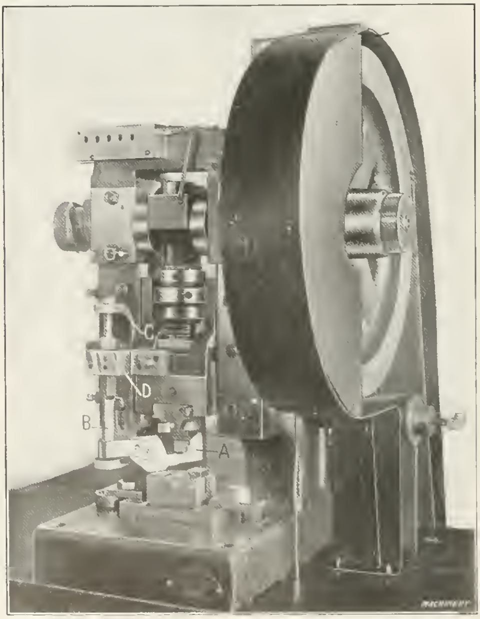

Fig. 11. Guard which sweeps over Die before Ram descends

The operation of the guard is controlled by lever *A*, which is pivoted to the frame of the press. Connection is made between the treadle and the clutch by means of two rods which are secured to this lever by adjustable clips. When the guard is to be applied to an inclinable press, the treadle rod is in two sections, which are threaded at their ends to carry an adjusting clip, so that the length of the rod can be varied as required.

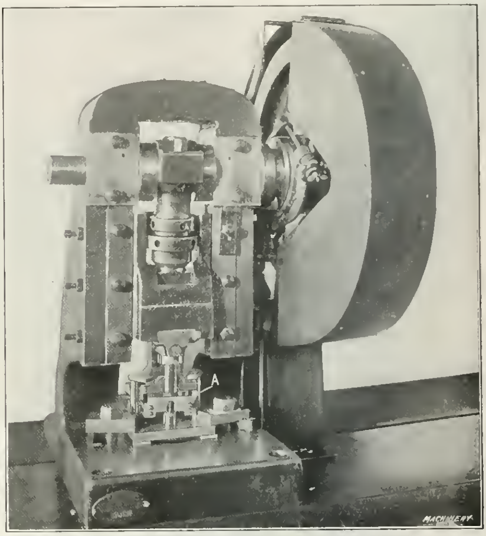

Fig. 10. Guard with a Plate operated by Cam attached to the Ram

When the treadle is pushed down to trip the press, lever *A* carries the gate down to the table. If the operator fails to remove his hand from the die, the descent of the gate is blocked and this prevents the press from operating, because the clutch cannot be engaged until the gate has reached the

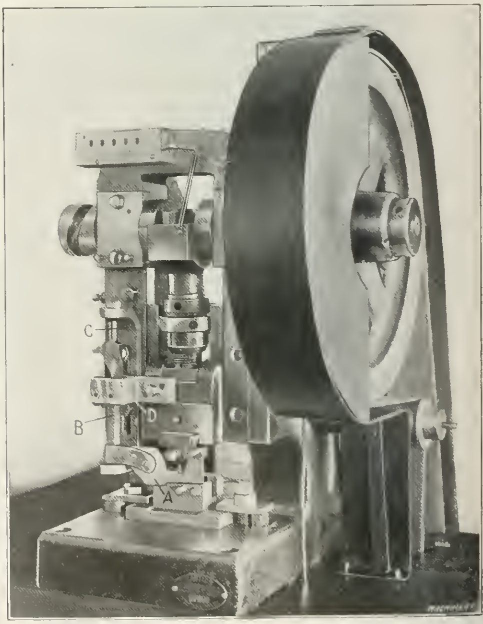

Fig. 12. Same Guard as in Fig. 11, in Position in Front of Die

bottom of its stroke. After the ram has completed its working stroke and started to rise, the gate is immediately lifted by the action of a spring which connects the rear end of lever *A* and the frame of the press. If it is more convenient, this spring can be attached between the treadle and the frame of the machine. The instantaneous action of this spring prevents the output from being reduced, as the guard is out of the way as soon as the ram has risen sufficiently to enable the operator to begin preparing for another operation.

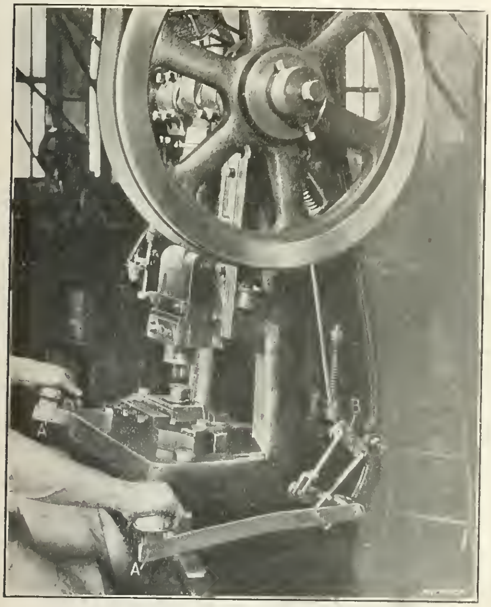

Fig. 13. Arrangement of the Benjamin Stamping Press Guard

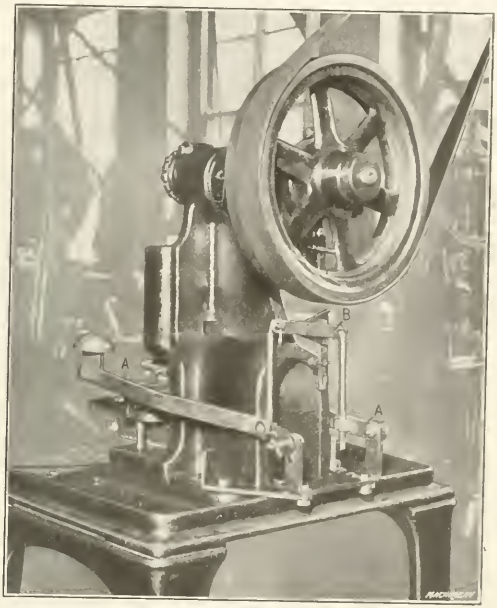

Fig. 14. Another Arrangement of the Benjamin Guard

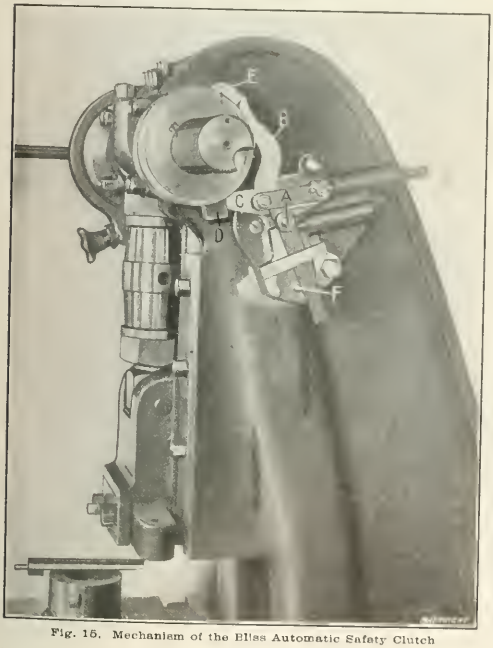

Fig. 15. Mechanism of the Bliss Automatic Safety Clutch

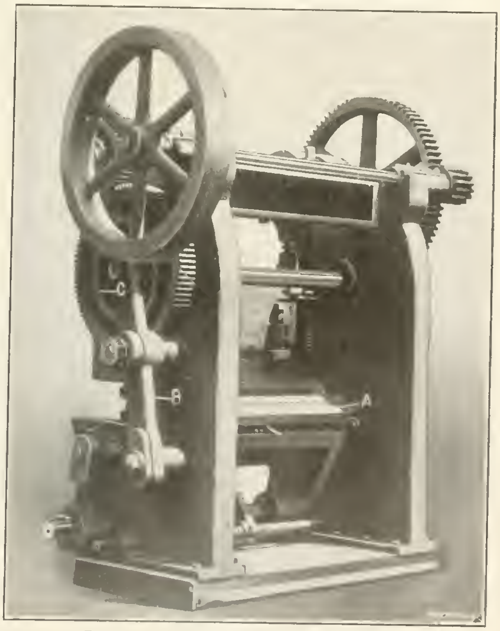

Fig. 16. The Improved Queen City Safety Press

Clip *B*, which secures the gate bar to lever *A*, enables the position of the guard to be adjusted to meet the requirements of different classes of work and dies. The gate should always be set to a point where it touches the table before the clutch can be engaged. This guard is easily attached to the press on which it is to be used. The only work entailed consists of drilling and tapping holes in the frame to secure the operating mechanism in place. In some cases, the wire mesh gate has been replaced by a flat rod, covered with leather, somewhat similar in shape to the one upon which the wire netting is mounted. The object of this modification is to allow the operator an unobstructed view of his work during the entire working period of the press.

In Fig. 6 a power press guard is illustrated which works on much the same principle that governs the operation of the ones shown in Figs. 1, 4 and 5. In this case, the guard bar *A* has been adopted in place of the gates used in the two other devices referred to. When an operator is working at a press equipped with one of these guards, his hands are beneath the bar *A* and this bar must drop to the die bed before the clutch can be engaged. This makes it impossible for the operator to trip the press and forget to remove his hands from the die, because, under these conditions, bar *A* cannot fall far enough to allow the clutch to be engaged.

The operation of this guard is controlled by lever *B* which is pivoted to the frame of the press at *C*. When the treadle is depressed, this lever carries the guard bar down with it. After the guard has practically reached the die bed, lever *B* engages the stop *D* on the clutch rod and pushes it down sufficiently to throw the clutch into action.

It will be seen from the illustration that the position of the guard rod can be adjusted horizontally at *E* and vertically at *F*, and that the stop *D* on the clutch rod may be adjusted to correspond with different settings at *F*. This enables the guard to be adapted to different classes of work. The stop *D* should, in all cases, be set so that the clutch cannot be engaged until the guard rod is almost in contact with the die bed.

After the press has been tripped, spring *G* throws the guard up as soon as the ram has begun its return stroke, so that the operator is not delayed in any way. This type of guard can be applied to any type of press without altering its construction, by simply drilling and tapping the holes in the frame of the machine necessary for securing the guard in place.

The two guards shown in Figs. 7 and 8 work on essentially the same principle. When the ram of the machine shown in Fig. 7 begins its down-stroke, the vertical rod *A* is rotated by means of the twisted section which runs through a bearing in *B*. This causes bar *C* to swing over the die, and in case the operator has neglected to remove his hands, they are struck by this bar, thus warning him of his danger. Bar *C* moves considerably before the ram has reached the bottom of its stroke, so that the operator is given plenty of time to get his hands out of danger if he has neglected to do so at the time of tripping the press.

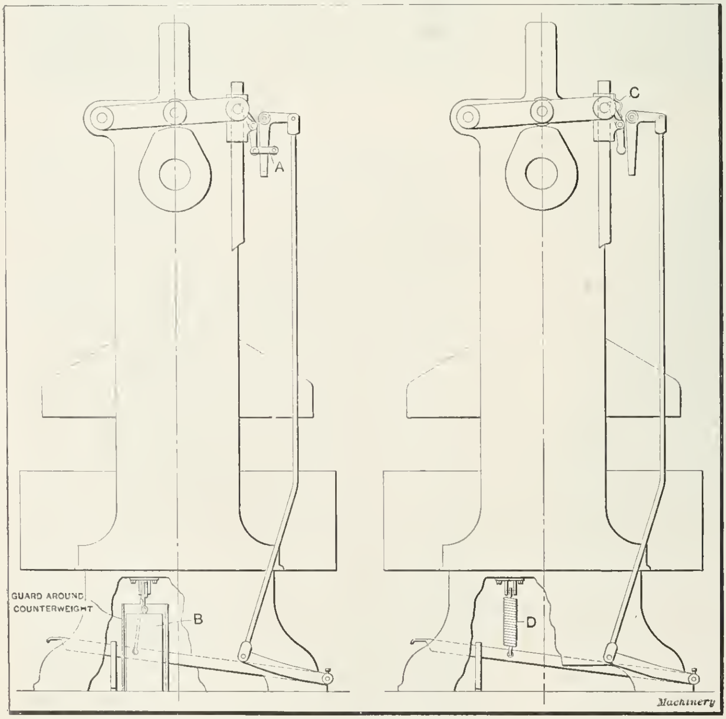

Fig. 17. A Modification of Design, replacing Springs by a Link and Weight

The action of the guard shown in Fig. 8 is similar to that of the one just described, but in this case the round rod *A*, with a spiral groove cut in it, has been substituted for the twisted square rod shown in the preceding illustration. The groove in this rod is engaged by a pin in bearing *B*, thus swinging the guard bar *C* as previously described.

Guards used in the General Electric Co.'s Shops

The guard illustrated in Fig. 9 was developed by the General Electric Co., for use in its power-press shops. When the operator sets the press in motion, the pin which runs in slot *A* swings lever *B* about pivot *C*. The shape of slot *A* is such that lever *B* carries the gate to the right a little ahead of the down-stroke of the ram. This shuts off access to the die during the working stroke of the press; should the operator fail to remove his hands from the work at the time of tripping the slide, he is warned of his danger by the movement of the guard. The gate runs on a guide on the die bed. The guard is secured to the press by bracket *D*, which carries the pivot *C*. This bracket is secured by one of the gib screws and a couple of small pins which prevent it from rotating.

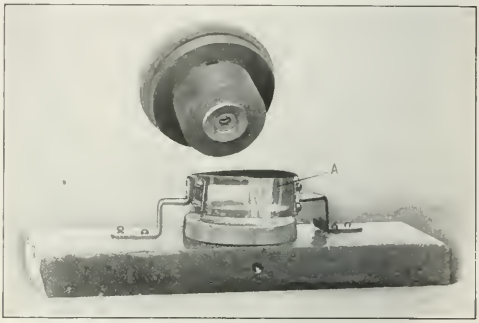

Fig. 18. Guard used for Operations on Thin Stock

Fig. 10 illustrates another form of power press guard which has been used in the shops of the General Electric Co. In this case, the guard plate *A* comes forward, ahead of the down-stroke of the ram, and pushes the operator's hands away from the die. The movement of the guard plate is controlled by a cam attached to the rear of the slide. When the working stroke has been completed and the slide commences its upward travel, this cam releases the guard and allows it to be returned to the rear of the die by the tension of a spring.

The guard illustrated in Figs. 11 and 12 has been adopted by the General Electric Co. to supersede the equipment shown in the preceding illustration. In this case, guard plate *A* swings on rod *B*, passing over the die far enough ahead of the ram to give the operator ample time to get his hands out of danger if he has neglected to do so at the proper time. The guard is attached to the press by means of bracket *C*, which is held in place by means of the regular gib screws. Rod *B* is a loose fit in this bracket, so that it is easily rotated by the action of *D* upon the twisted section of the rod.

When a press is engaged in stamping out parts from thin sheets, a guard of the type shown in Fig. 18 can be used to good advantage. In using a press equipped in this way, the operator slips the stock under guard *A*. The space between the bottom of this guard and the die is just sufficient to admit the stock, but will not permit the operator's fingers to get within reach of danger. The General Electric Co. uses guards of this type on presses for stamping mica insulations; they would prove equally serviceable on other classes of work where thin stock is being handled.

The Benjamin Stamping Press Guard

The stamping presses illustrated in Figs. 13 and 14 are equipped with a safeguard which has been designed and placed upon the market by the Benjamin Electric Mfg. Co., Chicago, Ill. This device was first developed to meet the requirements of the Benjamin shops, but proved to be so satisfactory that it has recently been placed upon the market. It is not intended for presses used for blanking from strips or ribbon stock, and when presses are used alternately for such operations and for stamping, the guard may be easily disconnected, and the regular treadle used. This change does not involve any particular risk, as blanking operations on ribbon stock do not require the operator to work with his fingers under the ram.

As shown in the illustration, the guard consists of two hand levers *A*, one at each side of the press. These levers connect with the equalizer *B* which is mounted on the clutch rod. This equalizer swings about a pivot at its center, so that pushing down only one of the hand levers does not have any effect upon the clutch. Both levers must be pushed down to trip the press, and as both hands are required for this purpose, the operator cannot get his fingers caught. The release of either lever allows the latch to return to its normal position, thus making it impossible for the press to repeat unless both levers are kept down until the second stroke has been started. In this case, the operator would not have time to get his hand under the ram before its downward travel was completed. Different arrangements of this guard have been worked out to adapt it for use on all standard forms of presses, two such arrangements being shown in the illustrations.

Experience has shown that it is poor policy to depend upon the tension of a spring to control the operation of any mechanism, the failure of which may inflict a serious injury upon the operator. The tension of a spring weakens with age, and may become inadequate for the service which is required of it.

Fig. 17 illustrates a power press that was originally equipped with the springs *C* and *D*, as shown at the right-hand side of the engraving. The danger of relying upon these springs to control the clutch was realized, and the design of the press was modified, as shown at the left-hand side of the illustration. Here link *A* and counterweight *B* have replaced the springs, so that there is no possibility of failure due to an inadequate tension, as the clutch is now controlled by the constant force of gravity.

The Bliss Safety Clutch

A large majority of power-press accidents are caused by the failure of the operator to remove his foot from the treadle after completing an operation. In such cases, the wheel is kept locked to the shaft and causes the ram to descend a second time when the operator is not expecting it. To avoid such accidents, the E. W. Bliss Co., Brooklyn, N. Y., and several other well-known builders of power presses, have designed clutches which require the treadle to first be released and then pushed down again in order to cause the ram to descend for the next operation.

Fig. 15 shows the Bliss safety clutch, which operates in accordance with this principle. When the treadle is pushed down, latch *C* is lowered by means of trip-hook *B*, thus allowing the end of the clutch-key *D* to spring out and throw the clutch proper into position to engage with the flywheel. The shaft now revolves, bringing trip-dog *E* against trip-hook *B*, disengaging it and breaking the connection between latch *C* and the treadle rod that connects at *A*. This allows the latch to spring up and throw the clutch out of action.

When the foot is removed from the treadle, trip-hook *B* re-engages with latch *C*, and the mechanism is ready to be tripped for the next operation. The press may be run continuously by sliding the trip-hook *B* ahead of the spring-pin *F*. In this position, the trip-dog does not strike against the hook, and no break is made between the treadle and the clutch. Consequently, the slide continues to operate as long as the treadle is kept down. The E. W. Bliss Co. is now putting these clutches on all of its presses.

The Improved Queen City Safety Press

The press illustrated in Fig. 16 is built by the Queen City Punch & Shear Co., Cincinnati, O., and has been designed along lines which provide for the operators' safety. The oscillating table *A* swings out from under the ram to permit the removal of finished work and the substitution of new blanks. Hence the operator does not need to put his hands under the ram. The oscillation of the table is controlled by means of rocker arm *B* and cam *C*. The machine shown in the illustration is equipped with a double set of dies and requires two men to operate it, one standing at the front and the other at the rear. After the working stroke, the die bed in which the work has been formed or pressed remains stationary until the ram is partly raised. It then moves forward to the operator and remains at rest long enough to give him ample time to remove the finished work from the dies and replace it with new blanks. During this time, the other die bed is under the ram, a working stroke of the press being made. The die beds thus receive alternate strokes of the press, allowing plenty of time for the operators to perform their work, while the dies are swung out away from the danger zone beneath the ram. Machines of this type are also built with a single die bed and only require one operator to run them.

* * *

LAPPING CRANK-CASES

In the best types of automobile engines, all the vital parts, such as the transmission gears, etc., are enclosed in cases to protect them from dust and dirt. Another point which is just as important as protection from dirt is proper lubrication. In some engines this is accomplished by filling the cases with lubricating oil, which, of course, necessitates that they be oil-tight.

Instead of using packing between the surfaces of the crank- and transmission-cases that come in contact, the White Co., Cleveland, Ohio laps all the contact surfaces. This operation is accomplished as shown in the accompanying illustration. A large surface plate is coated with oil and emery, and the cases, after having their contact surfaces milled, are moved back and forth on this plate until a true surface is obtained. This method makes an oil-tight fit which is superior to shims or packing. D. T. H.

Lapping the Contact Surfaces of Crank-cases to make them Oil-tight

* * *

Switzerland, the area of which equals about one-third of that of Pennsylvania, has about 2800 miles of railway, of which 103 miles or about 3.7 per cent of the total is in tunnels. No less than nine of these are more than five miles long, the total number of tunnels being 415.

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DEVELOPING MACHINE TOOLS TO MEET MANUFACTURING CONDITIONS

A well-known machine tool builder, whose product is of a specialized nature, has consistently followed a practice during the past five or six years that undoubtedly has helped greatly in perfecting his machines and selling methods. He took contracts for machining certain difficult pieces in large numbers, submitting prices in competition with other concerns doing contract work. The contracts obtained necessitated equipping a section of his plant on a manufacturing basis to handle this special work. His own machines were installed and fitted with appliances to facilitate the operations as far as possible, after a thorough analysis and time study had been made, and in filling the contracts, workmen were trained to handle peculiar machining propositions with facility and speed never before equalled.

The result was that the limitations as well as the capabilities of his line of tools became apparent as they never had before. Where weaknesses were discovered, the design of the machine was changed to eliminate them, but the most important result was in finding out just how the machine could be used in manufacturing work to the best advantage. This manufacturer now has a corps of salesmen who know exactly what they are talking about and can prove what they claim. They can go into a plant and size up the possibilities of machining almost any given part by their specialized practice, making estimates based on the data acquired in the home plant, and when the machines are installed, operators can be sent to instruct workmen in handling the parts to the best advantage. Consequently guarantees of production can be made and fulfilled that competing makers would not dare to offer.

* * *

THE VALUE OF A PROPER FINISH

A prospective purchaser forms his first impression of a machine largely from its appearance. Sometimes good points in the design are evident at a glance—although this is seldom the case—but whether these points of more intrinsic value show up or not, the care which has been taken in finishing the different parts of the machine contributes much to its appearance and the impression made.

In deciding upon the finish for each part, two points should be considered—the durability of a given finish under the conditions to which it will be exposed in service, and its effect on the general appearance of the machine. The argument is sometimes advanced that an outlay for unnecessary finish adds to the price which the customer must pay for his machines, without giving him any additional value. This is hardly accurate. Shop environment exerts a strong influence upon the ideals of a conscientious mechanic, and he will naturally strive for higher attainments in the quality of his work when it is produced on machines which are well finished.

From the builder's standpoint a good finish is obviously desirable, in that it constitutes an outward manifestation of the quality of the materials and workmanship put into the machine. For instance, where parts are poorly finished because the mechanical operation of the machine does not require them to be accurate, the conclusion naturally follows that the entire machine has been produced with a corresponding lack of care. In this connection, a clearly defined line must be drawn between the substitution of finish for quality in the materials used. The former cannot be regarded in any other light than a deliberate attempt at deception, but a finish that truly represents the quality of the machine, is one of the best means at the builder's command for expressing the care that has been taken in the selection of materials and in the process of manufacture.

* * *

MEASURING SCREW THREADS

Although much has been written on the characteristics of screw threads, screws and taps, and the methods by which they should be measured, it appears that there are many mechanics who are not as well informed on these subjects as they should be. Tap manufacturers constantly receive complaints that their taps are not up to size, when the whole trouble lies in the fact that the users do not know how to measure tap threads properly. Few people realize, it appears, that the outside diameter is of little practical importance, provided it is not under size. A tap is not defective if the outside diameter is considerably over size, provided the pitch or angle diameter is not above the prescribed limit. A tap should always be measured in the angle of the thread, the well-known Brown & Sharpe thread micrometer being the tool most used for this purpose. When using this micrometer, certain precautions must be taken, however, which those unfamiliar with its use are likely to overlook.

A tap manufacturer received several complaints from one of his best customers, that the taps supplied were under size. Now, as a matter of fact, while certain limits are necessary in tap manufacturing, as well as in other fields, no reputable tap maker would ever let a tap go out of his shop that was under size. Taps should always be a certain amount over size, in order to compensate for errors in lead and to provide for a reasonable amount of wear. Some tap manufacturers even instruct their inspection departments to reject taps that are exactly to size, because such a tap, having no provision for compensating for errors in the lead, is practically to be regarded as being under the standard size. Hence the manufacturer of the taps that were said to be under size, doubted the accuracy of the statement, and as the customer who had made the complaint was one well worth taking care of, he went to the latter's plant, several hundred miles distant, to personally investigate the methods and measuring tools used for testing the taps he had supplied. He found that the man who did the testing—apparently a good, all-around mechanic—measured the angle diameter of the threads with a Brown & Sharpe micrometer by holding the tap steadily in one position while he screwed down the micrometer point onto it. When measured in this way the point and anvil are likely to bear upon the surface of the thread at points below or above the actual diameter of the tap thread, so that the true dimension is not obtained, and most of the taps will appear to be below standard size. The angle diameter should be measured by passing the tap back and forth between the point and the anvil of the thread micrometer, so as to make sure that the largest dimension or the actual diameter is being measured. When the taps in question were measured in this way, they were all found to be a certain amount over the standard size, meeting all requirements.

A mistake sometimes is made in measuring threads in the angle with the B. & S. thread micrometer, by using the wrong anvil. The anvil is limited in its capacity to certain sizes of thread, and should agree with the number of threads per inch to be measured. The reason for this is that if made large enough to measure a four-threads-per-inch thread, it would be too wide at the top to measure, say, a twenty-threads-per-inch thread. If, again, it were designed to measure a twenty-threads-per-inch thread it would be so small that a four-threads-per-inch thread would not have a proper bearing in the anvil. Hence each screw thread micrometer is limited to the range of threads per inch that can be measured with the anvil furnished with the tool, and care should be used to employ these micrometers only with anvils designed for the particular numbers of threads per inch to be measured. Otherwise the readings obtained cannot be depended upon.

* * *

WIRE AND SHEET-METAL STANDARD GAGES

The confusion incident to the use of many gages is commonly experienced by all who have to specify wire and sheet metals. We have in common use the American or Brown & Sharpe gage, Birmingham or Stubs iron wire, Stubs steel wire gage, Roebling and Washburn & Moen gage, British Imperial wire gage, U. S. standard gage for sheet and plate iron and steel, Edison or circular wire gage, steel music wire gage, twist drill and steel wire gage and letter drill gage. These gages can be combined so as to give an ascending series differing approximately by thousandths or half thousandths inch, but any one of the standard gages taken by itself will be found to give a large number of sizes varying by small increments at certain stations. Between these stations there are wide gaps that the gage does not provide sizes for. If it is necessary to use sizes between those specified by a commonly used gage, other gages must be resorted to, in order to specify the desired dimensions.

The following extract from a letter received from a representative of one of the large machinery manufacturing concerns describes the situation clearly:

> I am chief draftsman at one plant of a company which operates four drafting departments. Each department specifies different gages for the same material. I find coil springs specified under four gages, and the same confusing conditions prevail with sheet metal, copper and brass. Sheet copper is specified by ounces and by the Stubs wire gage. Inasmuch as the various existing plants of our company exchange details and specifications, you can understand how confusing our drawing files are because of these conditions.

The need for a commonly accepted standard of wire and sheet-metal gages becomes more and more imperative as the manufacturing industries of the United States grow in importance and diversity. The American Society of Mechanical Engineers has appointed a committee to investigate the present systems of gages with the view of securing the adoption of some standard gage embracing the best features of all, which will be known as the standard wire and gage system recommended by the society.

The gage system, that is the system of referring to wire and sheet-metal diameters and thicknesses by numbers, is probably too firmly established to be changed. Nevertheless, it seems that we could profitably abolish the gage system in favor of a decimal system giving in every case the thickness in thousandths of an inch, instead of referring to it by an arbitrary number liable to be confused with the numbers of other gages.

* * *

The use of aluminum is constantly being extended into new fields. One of the latest applications of this metal, says the *Scientific American*, is for making foil to take the place of tin foil in wrapping up food products. Aluminum foil can now be made with a thickness of less than 0.002 inch. Aluminum powder is also coming into common use as the basis for a paint which is especially valuable for exposed metallic surfaces. Aluminum powder is very soft and adhesive, somewhat similar to graphite.

STEELS FOR TAPS, DRILLS AND MILLING CUTTERS

While any good high-carbon or high-speed steel can be used successfully for drills and milling cutters, when the requirement is simply that the steel shall possess good cutting qualities, the conditions met with in tap making make it necessary to select the steel to be used with great care. The best steel for taps must, in the first place, possess the same good qualities, as regards cutting properties and strength, as steel for other cutting tools, but, in addition, it must be so uniform in its composition that it is possible to cut the thread and harden the tap with the assurance that the lead of the thread of the hardened tool will be within certain specified limits. There are certain steels which, as far as strength and cutting qualities are concerned, would be excellent to use for taps, were it not for the fact that it is impossible to control the lead of the thread in the hardening process. Some of these steels will sometimes lengthen and sometimes become shorter in the lead, so as to make it impossible to compensate for the change in hardening by cutting the tap either long or short in the lead before hardening.

The Winter Bros. Co., of Wrentham, Mass., has experimented extensively to determine the best grade of steel to be used for high-class taps—that is, taps that after hardening will be as true to size, both as regards diameter and lead, as possible. During the last two years this firm has tried out twenty-six different kinds of steel and has finally settled upon using a steel made by an English maker, because this steel was found to be more uniform than any steel obtainable elsewhere. The results of the Winter Bros. Co.'s experiments are, in a general way, as follows:

The best steel to use for tapping cast iron and brass is one containing from two to three per cent tungsten, but otherwise having the same composition as an ordinary high-carbon steel, that is, with from about 1.15 to 1.25 per cent of carbon. This steel, if uniform in its composition, will contract or shorten 0.002 inch per inch in hardening, the same as most carbon steels. When hardening, it should be heated to a higher heat than a regular carbon steel, possibly to a temperature of 100 degrees F. higher (or up to about 1525 degrees F.) than that used for a carbon steel. It will also stand a greater variation in its hardening heat, and is hence, easier to handle than steels that require closer watching in this respect.

The best steel for taps to be used on steel, as far as strength is concerned, is vanadium alloy steel containing from 0.25 up to 1 per cent of vanadium. The greater the vanadium content, the greater is the strength of the steel. The objection to this kind of steel for taps, however, is that it is very uncertain as regards its change in hardening. It is likely either to shorten or lengthen up to 0.002 inch per inch, and, hence, it is practically impossible to secure taps of correct lead when using this steel. The carbon content is the same as in regular carbon steels used for this purpose—from 1.15 to 1.25 per cent. An advantage of the steel is that it is easily hardened as it will stand a variation in the hardening heat of about 100 degrees F. without showing any marked difference in the qualities of the hardened tap.

It should be mentioned, however, that while the vanadium alloy steel experimented with by the Winter Bros. Co., proved very uncertain as regards its change in hardening, it is possible that the vanadium had no influence in this matter. It may be that the mere addition of vanadium to a steel which without vanadium will change uniformly, would not injure it in this respect. This, however, is a matter that has not been decided, and further experiments would prove of value.

Expensive special steels are obtainable in the market that will show practically no change whatever in either the lead or diameter of a tap when hardened, but steels of this character, while excellent in special instances, are not commercially suitable for tap making on account of the increased cost. Hence, in order to meet the requirements of the trade the tap maker is forced to look around for a steel, the price of which is not prohibitive and which, at the same time, will meet the requirements as regards strength and uniformity.

These conditions are fairly well met in certain English and Swedish steels. These steels are more uniform as regards the change in hardening than are ordinary American tool steels, and they also differ from most of these steels in one particular: they nearly always lengthen, instead of shortening, about 0.002 inch per inch in hardening. The objections to English and Swedish steels are that the bars are not rolled as well as are those of American manufacture; they are rougher, they are not always round, and sometimes they are larger in diameter at one end of the bar than at the other.

High-speed steel is not used to any great extent for taps, one reason being the difficulty of hardening a high-speed steel tap with its fine cutting edges, which cannot be ground after hardening and which are liable to be injured by the extreme heat to which high-speed steel must be subjected in the hardening process. A high-speed steel suitable for taps should contain from 0.60 to 0.75 per cent of carbon and from 15 to 20 per cent of tungsten. This steel will harden at from 2100 to 2200 degrees F. The temper should be drawn at from 500 (in some cases) to 1000 degrees F. High-speed steel taps have been found especially advantageous for automatic screw machine work, particularly when tapping in brass or bronze. When used under these conditions, it has been found that the production per tap has been increased from five to fifteen times by the use of this material for the taps. The price of taps made from high-speed steel is, on an average, from three to four times that of ordinary carbon steel taps. The strength of high-speed steel drill rod, when properly hardened and tempered, is, on an average, slightly greater than that of carbon steel drill rod.

While, as mentioned, high-speed steel is not used to any great extent for taps at the present time, the Winter Bros. Co. states that the demand is increasing to a considerable extent. Although many tap manufacturers have had difficulty in hardening high-speed steel taps, this company has had no trouble in this respect, on account of the methods used for the purpose. A difficulty that has been met with, however, is that of keeping the cutting edges on the tools with which the high-speed tool taps and dies are threaded. The tools wear so fast that it is very difficult to cut smooth threads of correct form.

The superiority of the English and Swedish steel over the American made steel is very difficult to explain, because if a chemical analysis is made, it is often found that the American steel is freer from impurities—phosphorus and sulphur—than are these foreign steels; yet the latter will have greater strength, possess as good cutting qualities, and show greater uniformity after hardening. The cause, no doubt, is to be found in the different composition of the iron ores and the different processes to which American and foreign steels are subjected while being manufactured into tool steel.

While high-speed steel is not used to a great extent for taps, it is being used to a constantly increasing extent for milling cutters and drills. It is always advisable to use high-speed steel for these tools if they are used in regular manufacturing work. A high-speed steel cutter, for example, can be run at a cutting speed of from 100 to 125 feet per minute, while a carbon cutter should not be run at a higher speed than from 50 to 60 feet per minute. The high-speed steel cutter will also last from three to four times as long between grindings as a carbon steel cutter. Hence, it is safe to say that the output of the high-speed steel cutter between grindings will be from six to eight times that of a carbon steel cutter, while the price of high-speed steel milling cutters is only about three times that of carbon steel cutters.

Practically any good brand of carbon steel or high-speed steel is satisfactory for milling cutters or drills. Vanadium increases the strength and is, therefore, of special value in steel used for drills. High-speed steel drills have a capacity of from five to six times (in some cases up to ten times) that of carbon steel drills. For the larger sizes of drills, in manufacturing work, high-speed steel is of a decided advantage, as the price for drills larger than 5/8 inch in diameter is only about three times that of carbon steel drills. On the smaller sizes, however, the price of the high-speed steel drills increases proportionately to that of carbon steel drills, so that for a 1/8-inch drill the price is about seven times greater when using high-speed steel than when using carbon steel. Hence, the advantage in using high-speed steel for small sizes of drills is not as great, and, in some cases, the use of high-speed steel on the smaller sizes may be inadvisable.

While, as a general rule, it is advantageous to use high-speed steel cutters for all manufacturing work, there are some exceptions. Angular cutters, having a sharp corner, cannot be run at the high speed most advantageous for high-speed steels without danger of breaking off the weak points on the teeth, and, hence, in this case, the advantages of the better steel cannot be realized. There is also danger of burning the pointed cutting edges in hardening the high-speed steel cutters. Neither is high-speed steel particularly suited for gear-cutters or cutters used for work where the surface being cut is required to be especially smooth and of good finish. The high-speed steel cutter becomes dull at least as rapidly as does the carbon steel cutter, and in this state it will not produce a better surface than would a dull carbon steel cutter, but it has the advantage that it can continue to cut with its dull cutting edge on roughing work for a much longer time. Where a good finish is required, however, a sharp edge and a moderate speed are necessary, and as the advantages of the high-speed steel are not brought out under these conditions, there is no object in making cutters for this purpose from that material. The makers of milling cutters state that at the present time from 40 to 50 per cent of all milling cutters are made from high-speed steel.

Twist drills are made from high-speed steel to even a greater extent. Most firms making twist drills state that about 50 per cent, or perhaps slightly more, of their drills are made from this steel, while in the case of one firm, 75 per cent of all the drills made are high-speed steel drills. When carbon steel is used for drills, a steel containing as much as 1.30 per cent carbon is found to give the best results. A high-speed steel containing 18 per cent tungsten and 0.25 per cent vanadium is recommended for high-speed steel drills.

To illustrate the advantage of using a high-speed steel containing a high percentage of vanadium, the following example may be cited: A 3/4-inch drill made of a high-speed steel containing 1.25 per cent vanadium and 17 per cent tungsten was run at 600 revolutions per minute and with an 8-inch feed, drilling cast iron. The drill was used almost continuously and required to be ground but once a day. In a general way, it may be stated that high-speed steel drills containing this percentage of vanadium will last twice as long between grindings as ordinary high-speed steel drills. The price of drills of this material should not be more than 10 per cent greater than that of ordinary high-speed steel drills containing no vanadium.

When using high-speed steel for drills, it is necessary to allow a greater amount of stock for grinding after hardening than when using carbon steel. This is on account of the scale that is produced on high-speed steel tools in the hardening process. Ordinarily from 0.010 to 0.015 inch is allowed for grinding on ordinary carbon steel drills, while those made from high-speed steels have an allowance of about 0.025 inch.

In the making of reamers, there is no advantage in the use of high-speed steel, except in the case of chucking reamers. A high-speed steel reamer will not retain its size any longer than a carbon-steel reamer will, and with the slow speed at which hand reamers are used, there would be no other advantage to be gained.

* * *

According to an item in *Engineering*, the Russian Government has decided upon building a railway from Vladikavkas to Tiflis, right through the Caucasus mountains. The distance between these two cities by a straight line is only 125 miles, but, at present, it can be covered by rail only by making a long loop around the Caucasus chain, a journey of 990 miles long. The new project requires, however, the construction of a tunnel nearly 16 miles long, at a height more than 4000 feet above sea level. It is estimated that eight years will be required for the construction. Another interesting tunneling project of considerable magnitude is that being planned at Montreal, Canada, where it is proposed to construct a tunnel under the St. Lawrence River for the use of all Canadian railways.

DYNAMICS OF GAS ENGINE CAMS[*]—1

AN INVESTIGATION INTO THE RELATIVE MERITS OF DIFFERENT TYPES OF CAMS

BY M. TERRY[†]

To design a cam of proper shape for a given movement requires, in the majority of cases, only a general knowledge of the elements of mechanism. However, the timing cams of a gas engine—most notably a marine, automobile or aerial engine—where the parts in motion move at a high velocity, constitute an exception. To design this class of cams of the proper shape requires a full working knowledge of mechanics, and it seems that the correct design of these cams is a subject generally neglected by most draftsmen and designers. There is a great temptation to treat the timing cams as mere trips, intended to give a certain lift to their respective valves. When, therefore, a designer recognizes the importance of dynamic analysis of timing cams, he finds himself practically alone in his attempt to solve the problem, as there is no reliable data on this subject available. The discussion that has so far been published has been superficial; a volume would be required to thoroughly cover the subject and do it justice.

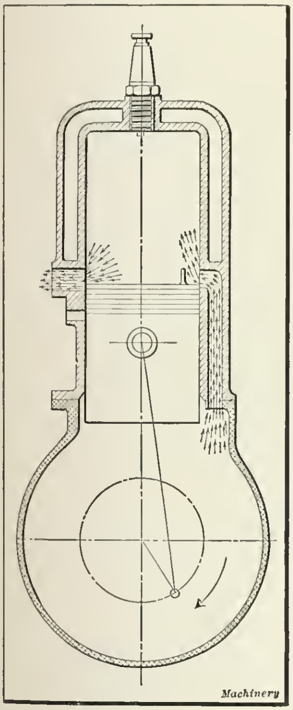

Fig. 1. Section through Three-port, Two-stroke Cycle Engine

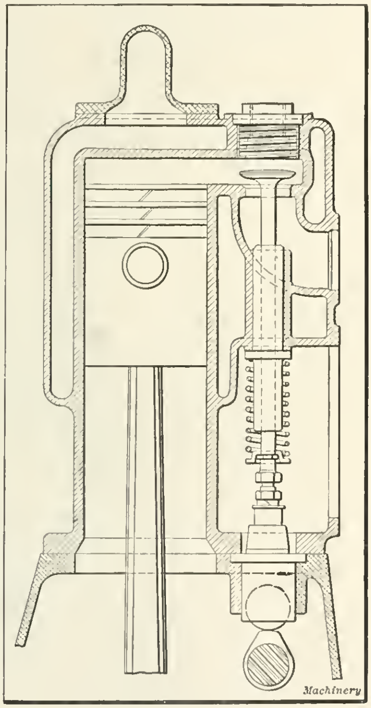

Fig. 2. Section through Poppet Valve Engine of the L-type

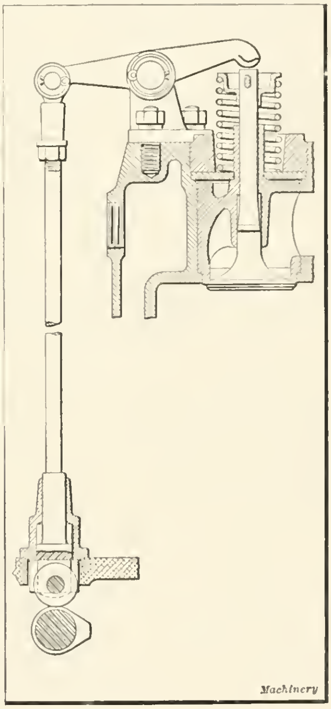

Fig. 3. Section through Valve of a Poppet Valve Engine of the Overhead Type

It is the object of the writer, in the following, to analyze the different types of cams, and to make a comparison between the designs. While the present article deals primarily with the various timing cams of automobile engines, the author believes that the study of the dynamics connected with them will be of interest to all readers of MACHINERY, whether they are directly engaged in the automobile industry or not. A short introduction on the types of engines used in self-propelled vehicles, and a survey of the present situation, will help the layman to grasp the importance of the problem and acquaint him, in a general way, with the "whys and wherefores" of the various types of valves used on the present-day motor cars.

Need of Valves

There are two general types of gas engines, known as two- and four-stroke cycle engines; but no matter what type of engine is selected for automobile use, the cycle consists of four distinct acts, namely: suction, compression, expansion, and exhaust. In the two-stroke cycle engine these four acts are accomplished in one revolution of the crankshaft or two strokes of the piston, while in the four-stroke cycle engine these four acts are extended over a period of two revolutions of the crankshaft or four strokes of the piston.

In the two-stroke cycle engine, suitable exhaust and inlet ports are provided in the cylinder walls, which the piston in its course of travel covers and uncovers, drawing in or expelling gases, and thus acting as its own valve. (See Fig. 1.) The piston of a four-stroke cycle engine, however, cannot unassisted be its own valve, as it will uncover both ports every other stroke, while the four-cycle action requires the opening of the ports only once in four strokes of the piston. Hence the need of auxiliary valves.

Types of Valves

The great majority of automobile engines operate on the four-cycle principle. These engines can be classified in various ways—horizontal or vertical, long- or short-stroke, water- or air-cooled, etc.; but, the classification which interests us most at present is that based on the type of valves employed. When studied from this point of view, any engine can be placed in one of the three following groups:

1. Poppet valve engine, shown in Figs. 2 and 3.
2. Sliding piston-valve engine, shown in Fig. 4.
3. Rotary valve engine, shown in Fig. 5.

At present the first group is by far the largest, and the poppet valve engines represent a well tried out, established and conventional form of design. The second group, up to a short time ago, was in its experimental stage, but with the recent advent of the "Silent-Knight" engine, it is considered by some to be the coming rival of the first group. The rotary valve engines are conceded to be in a purely experimental stage of development.

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[*] See MACHINERY, engineering edition, February, 1911, "Timing an Offset Automobile Engine," and other articles there referred to.

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In the last group the inlet and exhaust valves have a continuous rotary motion, accomplished either by direct gearing with the crankshaft, or by means of an endless silent chain driven by the crankshaft. Thus, on account of the continuous rotary motion of the valves, the cam problem does not exist in this group.

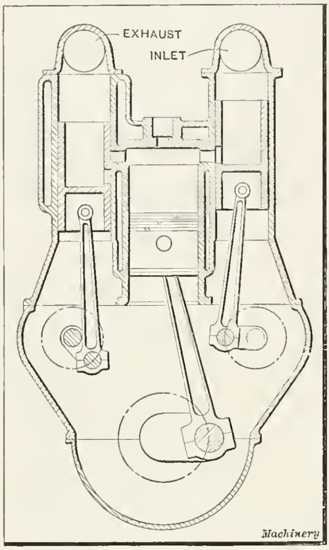

Fig. 4. Sliding Piston-valve Engine

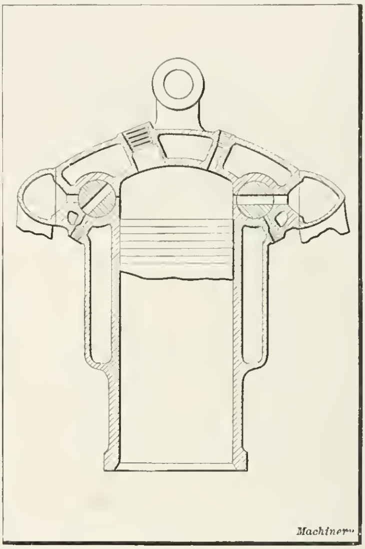

Fig. 5. Arrangement of a Rotary Valve Engine

The first two groups have the feature of reciprocating valve motion in common. The valve mechanism of the sliding sleeve engine is a miniature reproduction of the main working parts of the engine; in other words, it consists of a secondary crankshaft, connecting-rods and pistons (or sleeves as used in the "Silent-Knight" engine). The secondary crankshaft receives its motion from the main crankshaft, either by means of gears or an endless silent chain, and with the assistance of the small connecting-rods it imparts a reciprocating motion to the secondary pistons—valves or sleeve-valves, as the case may be. These valves travel in a smooth bore with no obstacles in their paths. The highest and the lowest points of their travel are determined by the throw of the secondary crankshaft. In other words, the entire linkage of the sliding piston or sleeve-valve is rigid.

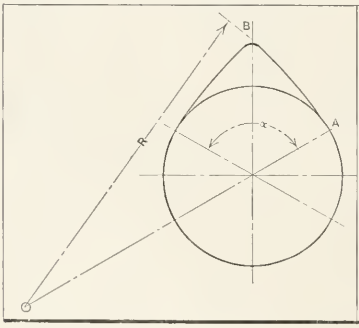

Fig. 6. Cam used on Early Automobile Engines

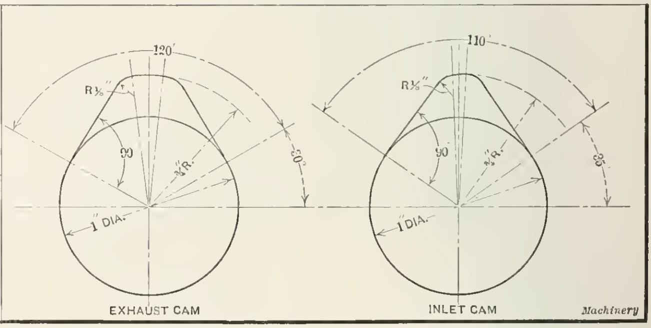

Fig. 7. Dimensions of Exhaust and Inlet Cams

As mentioned before, the poppet valves also have a reciprocating motion, but, in order to insure gas-tightness in the working cylinder, the valves must be brought tightly against their seats (flat or conical) which are formed either in the main casting or in inserted cages at right angles to the path of the valves. (See Figs. 2 and 3.) In a properly working gas engine these seats determine, then, one of the extreme points in the line of valve travel, and with this arrangement, the use of rigid linkage for poppet valve gears is out of the question. Even if it were possible by accurate machining or careful adjustment to introduce some kind of rigid linkage, the difference in contraction and expansion of the cylinder casting and the valve stems would soon result in an appreciable gap between the valves and their seats, which, in turn, would be the cause of gas leakage, poor compression, pre-ignition, back-firing and other well-known gas engine troubles; hence, the apparent necessity for a linkage with one or more "broken joints," a cam to open the valve, and a spring to close it.

It is an admitted fact that by far the greater portion of the noise caused by the modern automobile engine is due to its valves. As the noise is due directly to the pounding action of the valve gear at its broken joints and at the valve seat, no improvement along this line can be expected until designers turn their attention to the study of the various cam shapes and their respective dynamic effects.

Brief History of Development of Automobile Engine Cams

The design and construction of power plants of the early motor cars were based largely on two elements: guesswork and the then established practice in stationary and marine gas engine work. In the latter class of engines a cam of the type shown in Fig. 6 was used almost exclusively, so there is but little wonder that it was also adopted by the early automobile manufacturers. This cam is still retained in automobile engines when a so-called "mushroom" type of follower is employed; but for a roller-follower it was displaced entirely by the so-called "tangential" cam.

Some eight years ago the Buick Motor Co., then located in Detroit, Mich., and engaged in the construction of marine engines, was experimenting with its first model of self-propelled vehicles. It was not long before it was discovered that the old marine type of cam was altogether too noisy on high engine speeds. In searching for a more suitable shape of cam, it was observed that the noise seemed to decrease as the radius of the arc *AB*, Fig. 6, was increased. In the light of this discovery, the next idea that naturally suggested itself was to make the radius of the arc infinite, or, in other words, to make the arc *AB* a straight line. The results obtained were so gratifying that this new cam—now known as tangential—was immediately adopted, and the Buick Motor Co. was soon followed in this by other manufacturers. At present, the vast majority of the motor car engines are equipped with tangential cams.

Whether the Buick Motor Co. deserves the entire credit for the introduction of the tangential type of cam or not, is, of course, pretty difficult to say. There is no doubt, however, that the tangential cam is merely a product of experimental development, whereas the uniformly accelerated and retarded motion cam is a product of study based on the well-known laws of falling bodies. The fact that the simple contour of the tangential cam makes it an easy manufacturing proposition and permits of ready detection of error in the inspection room, undoubtedly hastened its general adoption in the motor car field; but the very simplicity of its shape has aroused suspicion in the minds of many as to its other advantages, and has been the cause of many proposals to have it replaced by the uniformly accelerated and retarded motion cam. Perhaps one of the earliest proposals made in this country was published in 1905 by Mr. P. M. Heldt, editor of the *Horseless Age*. This question was again referred to in that publication in 1911 (issue of June 28, page 1083), which indicates that an opposite view—if one were ever held by anybody—was never given any publicity, or, at least, not sufficiently proved.

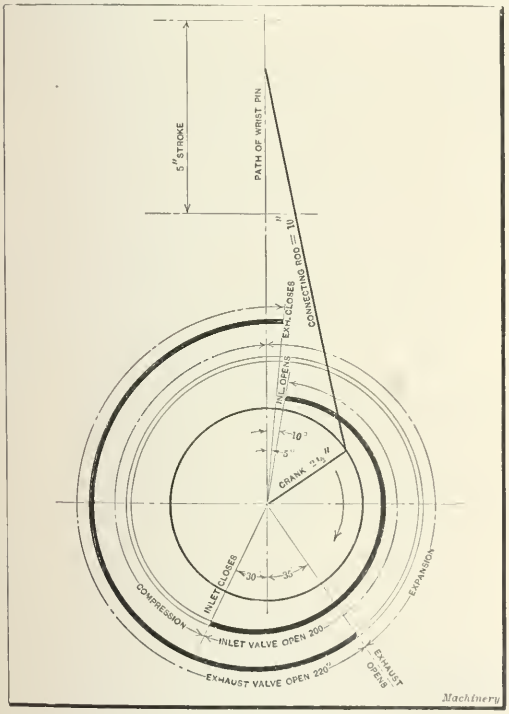

Fig. 8. Timing Diagram for Cams

The author wishes to state at the outset that until a short time ago he shared Mr. Heldt's opinion, and that he was greatly puzzled by the results of a practical experiment which turned out contrary to his expectations. When he started the present investigation it was his purpose to prove the superiority of the uniformly accelerated and retarded motion cam over its tangential rival, but his logic brought him to entirely different conclusions.

Analysis of Tangential Cam

Let us now first take an actual case from practice and analyze the working conditions. Suppose an engine of 4-inch bore and 5-inch stroke is to have the following timing and general dimensions:

Exhaust opens	35 degrees ahead of the lower dead center.
Exhaust closes	5 degrees past the upper dead center.
Inlet opens	10 degrees past the upper dead center.
Inlet closes	30 degrees past the lower dead center.

Cam to be of the tangential type.

Base circle of the cam = 1.000 inch diameter.
Cam roller circle = 1.000 inch diameter.
Lift of cams = ¼ inch.
Radius of cam fillet = ⅛ inch.
Clearance angle = 5 degrees.
Maximum speed of the engine at which quiet operation of valves is expected, to be between 1600 and 1700 R. P. M.

In regard to timing, the reader is referred to the article, "Timing an Offset Automobile Engine," in MACHINERY, engineering edition, February, 1911. The problem of clearance and clearance angle will be taken up in detail later on.

Fig. 8, known as a timing diagram, represents the path of the piston, length of connecting-rod, length of crank, and the crank circle. The opening and closing points of the valves are referred to the latter. Thus the inlet valve of the first cylinder begins to open at the instant the first crank pin is 10 degrees past the upper dead center, etc.

It is evident then from Fig. 8 that the exhaust valves are open during 220 degrees and the inlet valves during 200 degrees of the crankshaft motion. Since the camshaft revolves at one-half the speed of the crankshaft, the angles of exhaust and inlet cams will be 110 degrees and 100 degrees, respectively. To these angles we must add 10 degrees (twice the clearance angle), giving 120 degrees for the exhaust and 110 degrees for the inlet cam. This is shown in Fig. 7. The dimensions given are those found on a manufacturing drawing. Assuming that the steel cams in their finished forms correspond exactly to the dimensions given in Fig. 7, we shall proceed to analyze their action.

From Fig. 2 it is clear that the motion of the valve gear as a whole is identical with the motion of the cam roller center. The motion of either is referred to the camshaft center, which is regarded as stationary. The camshaft turns in a left-hand direction with a constant angular speed, and the roller center (as well as the rest of the valve gear) moves up and down in a straight line with a variable speed. The relative motion of the cam and roller centers will remain unchanged if we consider the cam stationary and the roller following the contour of the cam.

Exhaust Cam

In Fig. 9 is shown the exhaust cam and its roller. The face of the cam (CC_4) is a straight line, and, as the roller moves along this line, its center A describes a straight line parallel to CC_4. As the roller center assumes its successive positions at A_1, A_2, A_3, etc., its distance from the cam center increases.

If D is the distance of A from O, in inches, corresponding to any angle θ, then:

$$D = \frac{OA}{\cos\theta} = \frac{OC + CA}{\cos\theta} = \frac{\frac{1}{2} + \frac{1}{2}}{\cos\theta} = \frac{1}{\cos\theta}$$

Now, if the roller did not rise at all, its center A would have followed the circular path AB, the center of which lies at O. Consequently, the actual rise of the roller corresponding to θ_1, θ_2, etc., is measured by A_1B_1, A_2B_2, etc.

If L stands for the lift or rise of the roller center in inches, then

$$L = D - OA = \left(\frac{1}{\cos\theta} - 1\right)$$

This equation represents the law governing the motion of the valve gear as long as the roller is in contact with the face of the cam, *i. e.*, from C to C_4. As this law is expressed in terms of θ it is of importance to us to know the limiting values of θ between which it operates.

From Fig. 9 it is clear that the limiting values are zero and the angle AOA_4. The problem is to find the value AOA_4 in degrees. For the sake of clearness, we shall use the right half of the cam; the latter being symmetrical, the same construction would apply to either side. CC_4 is tangent at C to the base circle of the cam and at C_4 to the fillet circle, the center of which lies at F. Hence CC_4 is at right angles to OA at C and to FC_4 at C_4. Draw EF parallel to CC_4. Then EF is at right angles to OA. Also, since A_4C_4 is at right angles to CC_4 at C_4, line FC_4A_4 is a straight line.

By construction,

$$EC = FC_4 = FC_7 = \frac{1}{8} \text{ inch.}$$
$$OE = OC - CE = \frac{1}{2} - \frac{1}{8} = \frac{3}{8} \text{ inch.}$$
$$OF = OC_7 - FC_7 = \frac{3}{4} - \frac{1}{8} = \frac{5}{8} \text{ inch.}$$

$$EF = \sqrt{\overline{OF^2} - \overline{OE^2}} = \sqrt{\tfrac{25}{64} - \tfrac{9}{64}} = \tfrac{1}{2} \text{ inch.}$$

$$EF = CC_1 = AA_4 = \tfrac{1}{2} \text{ inch.}$$

Hence, $\tan AOA_4 = \frac{AA_4}{OA} = \frac{\frac{1}{2}}{1} = \frac{1}{2}$, and angle $AOA_4 = 26$ deg. 34 min.

The first law of motion of our valve gear, as we shall refer to it from now on, is expressed by the equation:

$$L = \frac{1}{\cos\theta} - 1$$

the limiting values of θ being 0 and 26 degrees 34 minutes. Now, let us look into the motion of the valve gear while the roller is traveling on the cam fillet. In order to make our discussion clearer, we shall carry out the geometrical construction simultaneously in Figs. 9 and 10. It is evident from Fig. 9 that, as the periphery of the roller moves along the fillet arc C_4C_7, the center of the roller describes the arc A_4A_7 concentric with C_4C_7. In other words, the roller center moves in an arc of a circle the center of which lies at F and the radius of which is FA_4.

Now, $FA_4 = FC_4 + C_4A_4 = \frac{1}{8} + \frac{1}{2} = \frac{5}{8}$ inch, and $OF = \frac{5}{8}$ inch. Then, if in Fig. 10, with F as a center, we describe a circle of radius FA_4, the circumference of the circle will pass through O. Note, however, that this is not always the case. In this instance it is due to the fact that the roller diameter is equal to the diameter of the base circle of the cam, and also to the fact that the radius of the fillet is made equal to one-half of the cam lift. The roller center, as explained before, describes the arc A_4A_7. Take any position of the roller center, as A_5; its distance from $O = OA_5 = OA_7 \cos\beta_5 = 1.25 \cos\beta_5$ inch.

With O as a center and OA as a radius, strike the arc AB (same as in Fig. 9). The actual lift of the roller center at A_5 equals:

$$B_5A_5 = OA_7 \cos\beta_5 - OB_5 = 1.25 \cos\beta_5 - 1.$$

Since A_5 is any position of the roller center on its path A_4A_7, the same equation will apply to every point on that path. Hence,

$$L = 1.25 \cos\beta - 1.$$

This equation represents what we shall term the second law of the valve gear motion.

It will be observed that this second law of motion is expressed in terms of a constantly decreasing angle. The lift increases as the angle β decreases. The limits of β are 0 degree and the value of angle A_4OA_7. It remains to determine the value of this angle.

Angle $AOA_4 = FA_4O = A_4OA_7$. But angle $AOA_4 = 26$ degrees 34 minutes. Hence angle $A_4OA_7 = 26$ degrees 34 minutes.

The valve, then, attains its full lift of $\frac{1}{4}$ inch in 53 degrees 8 minutes of the angular rotation of the cam. During the remaining portion of cam's rotation, known as dwell—equal to 6 degrees 52 minutes, considering only one-half of the cam—the valve remains stationary, and its third law of motion may be expressed as $L = \frac{1}{4}$ inch.

Inlet Cam

Thus far we have considered the exhaust cam only, but it can be easily demonstrated that the motion of the inlet valve gear is identical with that of the exhaust, except that it begins and ends 5 degrees later with respect to the horizontal center line of the camshaft. By comparing Fig. 11 with Figs. 9 and 10, the reader will have no trouble in discovering the truth of this statement for himself. The laws of motion and the limits between which they operate are the same for both the inlet and exhaust valves, and this fact can be taken advantage of in making the valve springs interchangeable, as well as the rest of the valve gear. It may be stated here, in a general way, that, while the roller moves along the face of the cam, the valve has an accelerated motion, and during the roller's contact with the cam fillet, the valve has a retarded motion. In fact, the sole object of the fillet is to serve as a cushion.

There are several camshafts made with the exhaust cam fillet of somewhat greater radius than that of the inlet cam, in the belief that the exhaust cam requires more cushioning. That there is absolutely no reason for it may be demonstrated by the study and comparison of Figs. 9, 10 and 11.

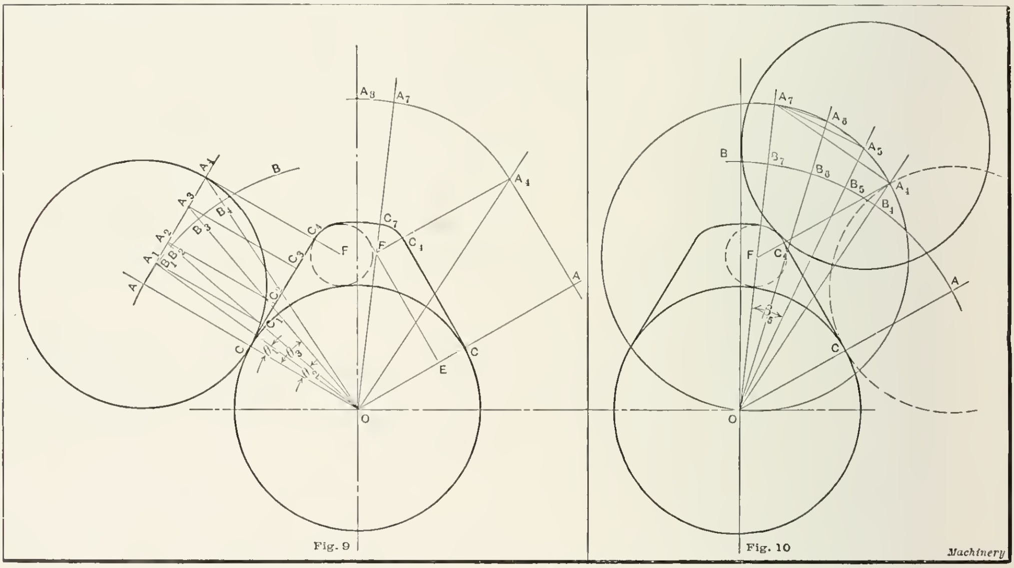

Fig. 9

Fig. 10

Figs. 9 and 10. Diagrams used for the Analysis of the Dynamics of a Tangential Exhaust Cam

Lift, Velocity and Acceleration

Let

α = the angle formed at any instant during the upward motion of the valve by the line of cam and roller centers with the line OA. The maximum value of α is 53 degrees 8 minutes, according to Figs. 9, 10 and 11. For the sake of simplicity, we will make it 53 degrees. (Tables I and II, column 1.)

θ = the angle that enters in the equation of the first law of motion. It is identical with α except that its maximum value equals 26 degrees 30 minutes (one-half of the maximum value of α). (Table I, column 2.)

β = the angle that enters in the equation of the second law of motion. Like α and θ it represents the angular position of the cam, but is measured from the line

OA_7. In other words, during the required motion of the valve gear, angle β decreases as a increases; the relation between β and a is expressed by the following equation: $\beta = 53$ degrees $- a$ (Table II, column 2).

TABLE I. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
a	θ	$\frac{1}{\cos\theta}$	L	v	V	a	A
Deg.	Deg.						
0	0	1.0000000	0	0.0001524	0.0635		
1	1	1.0001524	0.0001524	0.0004570	0.1904	0.0003046	631.6
2	2	1.0006094	0.0006094	0.0007629	0.31785	0.0003059	637.3
3	3	1.0013723	0.0013723	0.0010695	0.4456	0.0003066	638.7
4	4	1.0024418	0.0024418	0.0013780	0.5742	0.0003085	642.7
5	5	1.0038198	0.0038198	0.0016885	0.7035	0.0003105	646.9
6	6	1.0055083	0.0055083	0.0020014	0.8339	0.0003129	651.9
7	7	1.0075097	0.0075097	0.0023177	0.9657	0.0003163	659.0
8	8	1.0098274	0.0098274	0.0026378	1.0990	0.0003201	666.9
9	9	1.0124652	0.0124652	0.0029613	1.2338	0.0003235	674.0
10	10	1.0154265	0.0154265	0.0032902	1.3708	0.0003289	685.2
11	11	1.0187167	0.0187167	0.0036238	1.5098	0.0003336	695.0
12	12	1.0223405	0.0223405	0.0039638	1.6515	0.0003400	708.3
13	13	1.0263043	0.0263043	0.0043094	1.7955	0.0003456	720.0
14	14	1.0306137	0.0306137	0.0046623	1.9425	0.0003529	735.2
15	15	1.0352760	0.0352760	0.0050235	2.0930	0.0003612	752.4
16	16	1.0402995	0.0402995	0.0053923	2.2467	0.0003688	768.3
17	17	1.0456918	0.0456918	0.0057704	2.4043	0.0003781	787.6
18	18	1.0514622	0.0514622	0.0061585	2.5657	0.0003881	808.5
19	19	1.0576207	0.0576207	0.0065570	2.7320	0.0003985	830.2
20	20	1.0641777	0.0641777	0.0069674	2.9030	0.0004104	855.0
21	21	1.0711451	0.0711451	0.0073896	3.0790	0.0004222	879.6
22	22	1.0785347	0.0785347	0.0078256	3.2607	0.0004360	908.3
23	23	1.0863603	0.0863603	0.0082760	3.4482	0.0004504	938.3
24	24	1.0946363	0.0946363	0.0087417	3.6423	0.0004657	970.2
25	25	1.1033780	0.1033780	0.0092238	3.8430	0.0004821	1004.4
26	26	1.1126018	0.1126018	0.0097243	4.0515	0.0005005	1042.6
27	27	1.1223261	0.1223261	0.0102440	4.2680	0.0005197	1082.6
28	28	1.1325701	0.1325701				

L = lift of valve gear in inches corresponding to any angle a. The values of L are computed from the equations representing the first two laws of motion (Tables I and II, column 4).

v = the velocity of the valve gear in inches per degree of the angular motion of the cam. By definition, velocity is the time-rate of change of position, and since our time unit is that corresponding to an angular movement of one degree, the numerical difference between any two successive values of L will represent the average velocity during that interval of time. (Tables I and II, column 5.)

a = acceleration in inches per degree per degree of the angular motion of the cam. By definition, acceleration is the time-rate of change of velocity, and, again, since our time unit is one degree, the numerical difference between any two successive values of v is the average acceleration during that interval of time. (Tables I and II, column 7.)

V = velocity of valves in feet per second corresponding to any value of v. (Tables I and II, column 6.)

A = acceleration in feet per second per second corresponding to any value of a. (Tables I and II, column 8.)

The last two quantities, V and A, are both expressed in gravitational units and are of great importance in our investigation. V and A can be computed from v and a respectively, but in order to do so it is necessary to establish the numerical relation between the time unit measured in seconds and the time unit as expressed in degrees.

From our specifications, the maximum speed of the engine equals from 1600 to 1700 R. P. M.; assume it to equal 1680 R. P. M. Since the camshaft revolves at one-half the speed of the engine shaft, its speed is equal to 840 R. P. M., or 14 revolutions per second. Since one revolution equals 360 degrees, the camshaft turns through 360 × 14 = 5040 degrees in one second. Therefore, the time unit corresponding to one degree is 1/5040 second. For the sake of simplicity we shall assume one degree = 1/5000 second, or one second = 5000 degrees. Hence,

$$V = \frac{5000\,v}{12} \text{ (Tables I and II, column 6.)}$$

$$A = \frac{5000 \times 5000 \times a}{12} = \frac{25{,}000{,}000\,a}{12}$$

(Tables I and II, column 8.)

It may occur to some that in carrying out the values of L, column 4, Tables I and II, to seven decimal places one loses "the sense of values," and that in practice both the cam and the roller will vary enough to affect the third decimal place by one or two units. Indeed, were we to attach importance to any one value of L, it would be folly to carry it out beyond the third decimal place, but what we aim to determine is not the individual values of L, but the succession of these values. This method gives us four significant places for the values of a (column 7) which is not too much. If the cam and its follower were a few thousandths of an inch below or above their standard dimensions, the relative differences would be the same throughout columns 3 and 4 of both tables. The values of a would all be changed, but these new values would differ from one another in the same manner as those given in Tables I and II.

It must be borne in mind that the method pursued for finding v and a is an approximate one. The exact values of v and a at any instant can be obtained only by differential calculus. However, since the values of L were taken close together (one degree apart) this method gives as accurate results as are required for our purpose.

TABLE II. ANALYSIS OF GAS ENGINE EXHAUST CAM

1	2	3	4	5	6	7	8
a	β	1.25 cos β	L	v	V	a	A
Deg.	Deg.						
25	28	1.1036845	0.1036845	0.0100737	4.1970		
26	27	1.1137582	0.1137582	0.0097343	4.0557	−0.0003394	−707.1
27	26	1.1234925	0.1234925	0.0093922	3.9134	−0.0003421	−712.7
28	25	1.1328847	0.1328847	0.0090171	3.7694	−0.0003451	−719.0
29	24	1.1419318	0.1419318	0.0086992	3.6245	−0.0003479	−724.8
30	23	1.1506310	0.1506310	0.0083490	3.4788	−0.0003502	−729.6
31	22	1.1589800	0.1589800	0.0079953	3.3312	−0.0003537	−736.9
32	21	1.1669753	0.1669753	0.0076104	3.1833	−0.0003549	−739.3
33	20	1.1746157	0.1746157	0.0072827	3.0344	−0.0003577	−745.2
34	19	1.1818984	0.1818984	0.0069221	2.8842	−0.0003606	−751.2
35	18	1.1888205	0.1888205	0.0065603	2.7334	−0.0003618	−753.7
36	17	1.1953808	0.1953808	0.0061962	2.5815	−0.0003641	−758.5
37	16	1.2015770	0.2015770	0.0058302	2.4292	−0.0003660	−762.5
38	15	1.2074072	0.2074072	0.0054624	2.2758	−0.0003672	−765.0
39	14	1.2128696	0.2128696	0.0050929	2.1220	−0.0003695	−769.8
40	13	1.2179625	0.2179625	0.0047220	1.9674	−0.0003709	−772.7
41	12	1.2226845	0.2226845	0.0043494	1.8122	−0.0003726	−776.2
42	11	1.2270339	0.2270339	0.0039758	1.6565	−0.0003736	−778.3
43	10	1.2310097	0.2310097	0.0036005	1.5001	−0.0003753	−781.8
44	9	1.2346102	0.2346102	0.0032249	1.3436	−0.0003756	−782.4
45	8	1.2378351	0.2378351	0.0028475	1.1864	−0.0003774	−786.2
46	7	1.2406826	0.2406826	0.0024696	1.0289	−0.0003779	−787.2
47	6	1.2431522	0.2431522	0.0020911	0.8712	−0.0003785	−788.5
48	5	1.2452433	0.2452433	0.0017117	0.7132	−0.0003794	−790.4
49	4	1.2469550	0.2469550	0.0013318	0.5549	−0.0003799	−791.4
50	3	1.2482868	0.2482868	0.0009518	0.39657	−0.0003800	−791.6
51	2	1.2492386	0.2492386	0.0005709	0.23786	−0.0003809	−793.5
52	1	1.2198095	0.2498095	0.0001905	0.07937	−0.0003804	−792.0
53	0	1.2500000	0.2500000				

Tables I and II cover only the upward motion of the valve, but a little thought will show that the same values of v and a and of V and A taken in reverse order will apply to the downward motion as well, with a changed sign of acceleration. The tables for the inlet cam will be precisely the same. The tables as well as the acceleration curve plotted from them (see Fig. 12) show that the cam starts the valve gear on its upward journey with an ever-increasing acceleration. Readers familiar with mechanics know that even were the acceleration constant, the cam and its follower would be in contact under pressure, for a constant acceleration of the follower can be due only to a constant force acting on it, *i. e.*, a constant pressure of the cam on the follower. Since, in our case, the acceleration is of a gradually increasing nature, it is more than sufficient to keep the cam in contact with its follower, and consequently the pressure of the spring is unnecessary as long as the roller moves along the face of the cam.

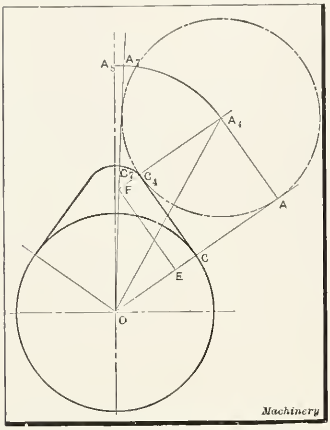

Fig. 11. Analysis of Tangential Inlet Cam

At $\alpha = 26$ degrees 30 minutes (point *B* in acceleration diagram, Fig. 12), the state of things changes. Acceleration vanishes instantly, but by this time the valve gear has acquired a definite velocity. Owing to this velocity it possesses a certain amount of energy which is consumed in compressing the valve spring through a certain distance. The spring absorbs this energy at the expense of the now decreasing velocity of the valve. A decreasing velocity can be due only to a negative acceleration; in other words, the spring does all the work of retardation (neglecting slight friction and force of gravity). It can do it in a number of different ways, but the best way is plainly the one that will insure contact (under slight pressure) of the cam with its follower, and, in order to do that, the spring must exert pressure sufficient to produce accelerations somewhat greater than those shown in Column 8, Table II, and represented in Fig. 12 by the portion *BC* of the curve.

The first part of the downward motion of the valve is due entirely to the pressure of the spring. The motion is symmetrical with that of the last part of the upward motion and a spring designed for this will be satisfactory for both motions. At *D*, Fig. 12, the acceleration changes sign and becomes negative—this time the cam doing all the work of retardation. If the spring pressure is to vanish instantly at this point, the cam will retard the valve just as effectively.

TABLE III. DATA FOR DRAWING SPRING PRESSURE CURVE

L	A	T	L	A	T
0.114	707	35.35	0.227	778	38.9
0.142	725	36.25	0.238	786	39.3
0.175	745	37.25	0.245	790	39.5
0.202	763	38.2	0.250	792	39.6
0.218	773	38.7	.....	...	....

Valve Springs

There remains now only the problem of designing a suitable valve spring. Let,

T = pressure of the spring in pounds at any point between *B* and *C*, Fig. 12.

A = acceleration (in feet per second per second) necessary at that point to keep the cam in contact with its follower.

m = mass of the reciprocating parts of the valve gear, including one-half the mass of the spring itself.

Then, $T = m \times A$.

Assuming the weight *w* of the reciprocating parts to be 1.6 pound,

$$m = \frac{w}{g} = \frac{1.6}{32} = \frac{1}{20}$$

$$T = A \times \frac{1}{20} = \frac{A}{20}$$

The valve springs most commonly used on automobile engines are of the type shown in Figs. 2 and 3. Any helical spring develops pressure in direct proportion to the amount of distortion it undergoes, provided its elastic limit is not exceeded. It will, therefore, prove useful to plot a curve *BC*, Fig. 14, using lifts for abscissas and spring pressures for ordinates. This can be easily accomplished by selecting, from Table II, eight or ten values of *L* and the corresponding values of *A*. Table III is made up of these values selected at random; the third column of this table gives the spring pressures in pounds. In Fig. 14, the curve *BC* corresponds to curve *BC* in Fig. 12.

The compression curves of the springs shown in Figs. 2 and 3 are straight inclined lines (within the elastic limit), and in accordance with our preceding discussion the compression curve of our spring must be slightly above *BC*, if the cam and its follower are to be kept in contact under pressure. There are two more conditions to which our spring must conform. The first of these is that the maximum safe load of the spring should not be exceeded when the valve reaches its full lift. The second condition is that, when the piston is drawing in a fresh charge, the spring pressure must be sufficient to keep the exhaust valve tight on its seat against the back pressure of the exhaust gases in the muffler.

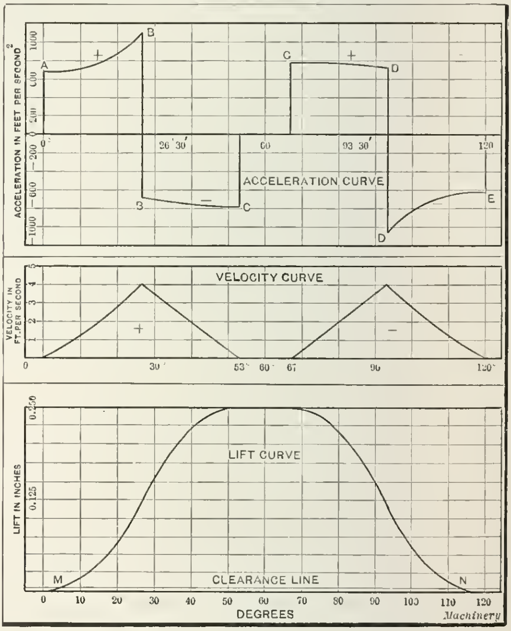

Fig. 12. Accelaration, Velocity and Lift Curves of Tangential Cam

Suppose that the valve is of the dimensions shown in Fig. 13, that the back-pressure of exhaust gases is about 8 pounds gage, or about 23 pounds absolute, and that the pressure in the cylinder on the suction stroke drops to 12 pounds absolute. Total difference in pressures on valve head is:

$$23 \times \frac{\pi}{4} \times \left[(1\tfrac{1}{2})^2 - \left(\frac{5}{16}\right)^2 \right] - 12 \times \frac{\pi}{4} \times \left(1\frac{11}{16}\right)^2 = 12$$

pounds.

When the valve is closed, *i. e.*, when $L = 0$, the spring pressure must be somewhat in excess of 12 pounds or else gas-tightness at the seat will not be secured. In practice, probably nothing short of 30 pounds would do. There are two reasons for this discrepancy between theory and practice: 1. The pressure in the exhaust header, which is located in the immediate neighborhood of the exhaust valves, must, on account of restricted passages, be somewhat higher than the back-pressure in the muffler; 2. The exhaust of burnt gases does not take place in a continuous stream, but comes in "puffs," and, thus, the pressure in the header is of a pulsating nature, with a maximum instantaneous value considerably in excess of the muffler pressure.

In designing a spiral spring, the two following formulas given by Unwin (Part I, page 39) are generally used by designers:

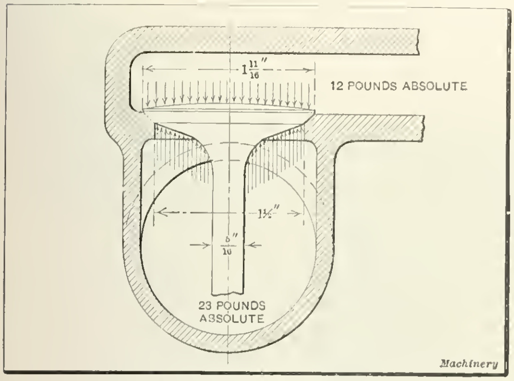

Fig. 13. Section through Exhaust Valve

$$P_1 = \frac{180{,}000\ d^4}{nr^3} \qquad (1)$$

$$P = \frac{12{,}000\ d^3}{r} \qquad (2)$$

where P = maximum safe load of the spring in pounds.

P_1 = pressure on spring in pounds per inch of deflection,

n = number of full coils,

d = diameter of wire in inches,

r = mean radius of the spring.

Cut and try methods are generally applied to Formulas (1) and (2). Practical considerations, however, greatly reduce the tedious work of calculating the springs. The amount of room available for springs limits their outside diameter; in other words, it limits r. According to Table III, the maximum pressure of the spring need not exceed 40 to 45 pounds. Making $P = 45$ pounds, and $r = \frac{1}{2}$ inch, and substituting these values in Equation (2) we get $d = 0.123$ inch.

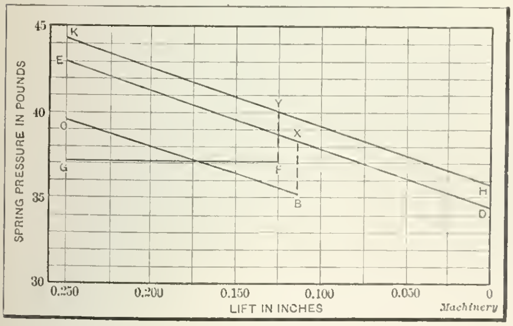

Fig. 14. Spring Pressure Diagram for Tangential and Uniformly Accelerated Motion Cams

The nearest size of wire is No. 11 B. W. G., which is equal to 0.120 inch. Therefore, making $d = 0.120$, retaining 45 for the value of P, and solving for r in Equation (2), we get $r = 0.462$ inch.

In Equation (1) d and r are now practically determined. Referring to Table III it will be seen that the spring pressure must increase by about 4 pounds with a corresponding compression of about ⅛ inch; in other words the spring pressure per inch of deflection $= \frac{4}{\frac{1}{8}} = 32$ pounds.

Making $P_1 = 35$ pounds in Equation (1) and solving for n, we get $n = 10.8$ coils.

If we make the spring with eleven free coils:

$$P_1 = \frac{180{,}000 \times 0.00020736}{11 \times 0.0986} = 34.4 \text{ pounds.}$$

Now, if the spring be made 1 inch longer in its free state than when it is in place with the valve closed, its initial pressure will amount to 34.4 pounds, and with the valve at its full lift, the final pressure of the spring will amount to 34.4 × 1.25 = 43 pounds. The pressure line of the spring is represented graphically by line DE in Fig. 14. It will be observed that the spring thus designed fulfills all requirements. The ideal spring pressure line is the one that will practically coincide with line BC.

So far as design is concerned, our problem is now completely solved. However, if we wish to look further into the advantages and disadvantages of the tangential cam, we must compare it with some other type of cam. This method of comparison is a very useful one, for it eliminates the necessity of several assumptions, and at the same time brings out definitely both the desirable and the undesirable features of cams. A comparison with the uniformly accelerated and retarded motion cam will be made in the next installment of this article.

* * *

EDUCATION IN ACCIDENT PREVENTION

At the accident prevention meeting of the Conservation Congress at Indianapolis, October 2, Mr. Melville W. Mix, president of the Dodge Mfg. Co., Mishawaka, Ind., read a paper in which the general principles of accident prevention in his plant were outlined, and from which we have made the following extract:

"With the development of the new doctrine of indemnity in the case of occupational accidents, which disregards the assumption of risk, negligence of fellow employes or contributory negligence, as defenses to the employer, it becomes necessary to consider the question from a purely educational standpoint, establishing collaterally therewith the doctrine of prevention of accidents.

"In order to bring the matter of safety directly to the employes of the Dodge Mfg. Co., the management has prepared a plan of education and competition between departments and their foremen. This is in the form of a percentage score board, such as indicates the standing of teams in the base ball leagues. The starting point is 1000. Each division is penalized according to its accidents, minor accidents of less than one day's absence not, as yet, being considered. Each day's absence bears a percentage charge in proportion to the total number of men-days per month in each division.

"The foremen of all the divisions scoring 1000, or those holding the first three places below 1000 will receive prizes for personal interest each month. The foreman scoring the largest number of first monthly prizes for one year will receive a special prize at the end of the year. All divisions holding a percentage for the year of 1000, or the highest annual percentage, will receive two days' extra pay."

The plan is in a rather crude form at present, but it will be of daily interest because of its competitive nature, and will facilitate the inculcation of preventive measures and of individual care and forethought, as well as speedy and prompt attention to reduce the severity of the accident and shorten the time of absence. The interest in the daily score board, which is 24 feet long and erected at the main works entrance, will influence all the workers.

* * *

The council of the International Association of Chemical Societies, which met in Berlin last April, unanimously approved of Prof. Ostwald's suggestion in favor of a series of uniform sizes for chemical publications. It was recommended that all the affiliated societies adopt, for their publications, the uniform size of 16 by 22.6 centimeters (about 6 5/16 by 8 7/8 inches.). It certainly would be desirable if book publishers in general could agree on certain standard sizes for all scientific and mechanical books.

MILLING SAD IRONS

This seems to be the age of the milling machine, as it is used on work hitherto thought to be entirely out of its range. Automobile manufacturers early appreciated the possibilities of this type of machine and have achieved wonderful results from its use. It is interesting to note, however, that other manufacturers have also awakened to the possibilities of milling on certain classes of work, and have in some cases increased the output greatly. An excellent example of the application of the Becker vertical type of milling machine to the manufacture of sad iron bases was obtained in the shop of the Dover Mfg. Co., Canal Dover, Ohio.

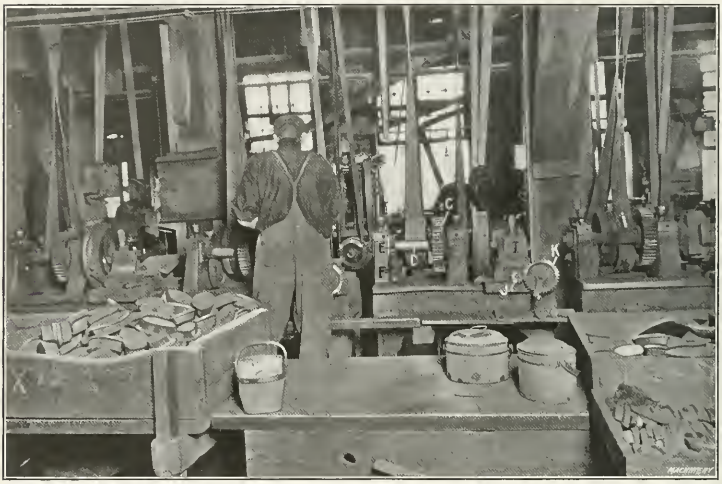

Fig. 1. "Old Lathee" formerly used for machining Sad Iron Basee

The former method of machining these sad iron bases—removing 1/8 inch of material from the base—was to hold one base at a time in a chuck, and remove the material with a single cutting tool. A row of the machines formerly used for this purpose is shown in Fig. 1, where it will be seen that they resemble somewhat in appearance an old type lathe. Fig. 3 shows a closer view of the tool-slide and chuck in which a sad iron base is retained.

The drive is from a countershaft to the pulley *A*, which is held on the back-gear shaft carrying the pinion *B*, this gear meshing with the large gear *C* on the work spindle *D*, Fig. 1. Located on the rear end of the work spindle is another pinion *E*, which through the medium of an intermediate gear *F*, drives the back shaft *G*. Shaft *G*, through bevel gears, rotates the screw *H*, which imparts the traverse movement to the slide *I*. A pinion *J*, held on the front end of the screw, provides a means for rotating the latter by hand through the gear *K* and the handle shown.

The chuck used for holding the work is a rather antique looking affair, consisting of a plate screwed to the spindle, and recessed to receive the two jaws *L* and *M*, which are milled out to suit the shape of the casting. The work is clamped by the set-screws *N* and *O*, the screw *O* extending through the jaw *L*, while the screw *N* bears on a spring plunger that pinches the casting. It is only necessary to operate the set-screw *N* to clamp the work, when the set-screw *O* has once been properly set. (Note the fancy guard for the set-screw.)

These machines were arranged in a row so that one man could attend to the "gang", removing and inserting the work, keeping the cutting tools sharp, etc. Great difficulty was experienced in producing a smooth surface at the extreme ends of the sad iron base, owing to the cutting tool *P* springing when leaving and approaching the work. This necessitated rotating the work slowly by means of the back-gear arrangement, and using a fine feed. With five of these machines (only four are shown in Fig. 1) it was possible by keeping them going continually to turn out 1000 sad irons per day—at a rate of one casting from each machine every three minutes.

Upon the installation of the two Becker vertical milling machines shown in Fig. 2, which were equipped with rotary fixtures, this production was increased by 300 per cent (to 4000 sad iron bases per day), with a corresponding increase in the quality of the work. Instead of one man attending to five machines, each machine is attended by an operator whose attention is confined to removing and inserting the work. The milling is accomplished with a high-speed steel inserted tooth milling cutter, having fourteen blades, which support each other, obviating chatter and enabling the use of a coarse feed.

A closer view of the rotary milling fixture used is shown in Fig. 5, while Fig. 4 shows the construction of the clamping arrangement. The fixture consists of a circular base *A*, which is clamped, as shown, to the rotary table and is provided with cast projections forming the base of a three-point support for the sad iron base. As shown in Fig. 4, the sad iron base rests on a hardened block *B*, and is supported and clamped on the forward end by two hardened studs *C* which are beveled to grip the casting securely, when it is forced against them by the strap *D*. This strap is provided with a heel, and is located in a machined recess in the lug *E* to which the hardened block *B* is also fastened. The clamping strap is held against the work by a winged nut *F*, screwed onto a stud that is located in the cast lug.

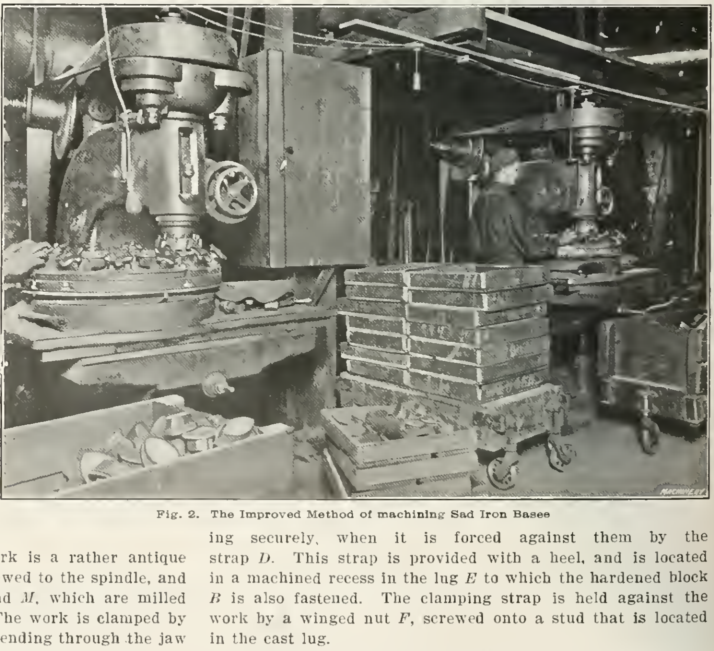

Fig. 2. The Improved Method of machining Sad Iron Basee

In operation, as the table rotates, the operator releases the clamping nut, removes the casting, brushes off the "seats," and inserts a rough casting, repeating this order as the castings are machined. It requires approximately 2½ minutes for the fixture to make one revolution, and in this time 14 sad iron bases are machined, as against one sad iron base in 3 minutes by the old method. As before, 1/8 inch of material is removed from the base of the castings.

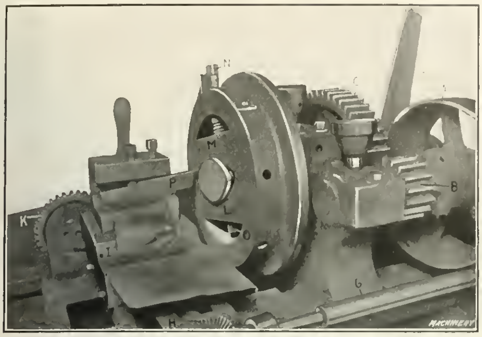

Fig. 3. View showing Construction of Old Chuck and Tool-slide

The machining of these sad iron bases is an excellent example of the application of rotary continuous milling fixtures to the manufacturing of castings in large quantities, and illustrates in a forceful manner the advance made in manufacturing methods. The fixtures used were designed and built by the Becker Milling Machine Co., Hyde Park, Mass.

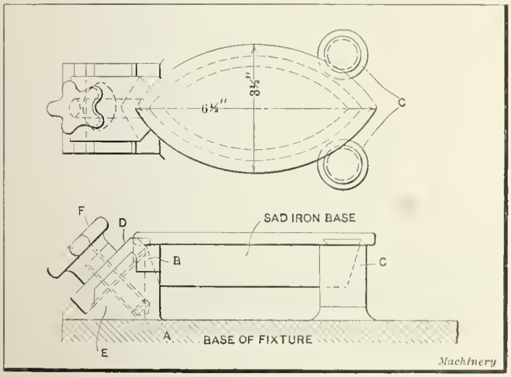

Fig. 4. Method of Clamping the Sad Iron Bases on the Continuous Rotary Milling Fixture

D. T. H.

* * *

The Minneapolis, St. Paul & Sault Ste. Marie Railway has posted a notice in its car shops to the effect that employes will not be permitted to wear neckties or torn overalls while at work. This order has been issued with a view to reducing the danger of accidents in the shops, as many injuries have been due to the men having been drawn into machinery by their neckties or by ragged garments being entangled in the mechanism.

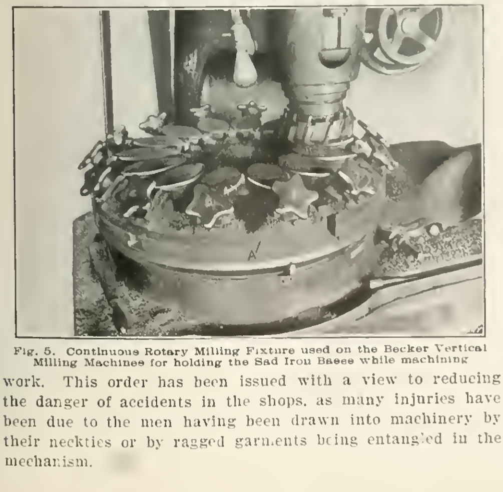

Fig. 5. Continuous Rotary Milling Fixture used on the Becker Vertical Milling Machines for holding the Sad Iron Bases while machining

FLUTING ANGULAR MILLING CUTTERS AND TAPERED REAMERS*†

BY GEORGE W. BURLEY‡

The "lands" which are formed on the teeth of all kinds of milling cutters and reamers, except those which are of the formed variety and those which are eccentrically relieved, whether cylindrical or conical, usually have a uniform width from one end of the cutter or reamer to the other. It is, of course, quite possible to arrange the cutter or reamer blank in the milling machine dividing head for the fluting or grooving operation so that the lands which are formed on the teeth will be tapered. The latter form of land is, however, never used in connection with axial and radial teeth, in good practice, and is very rarely used in connection with inclined teeth—that is, teeth on angular milling cutters and tapered reamers.

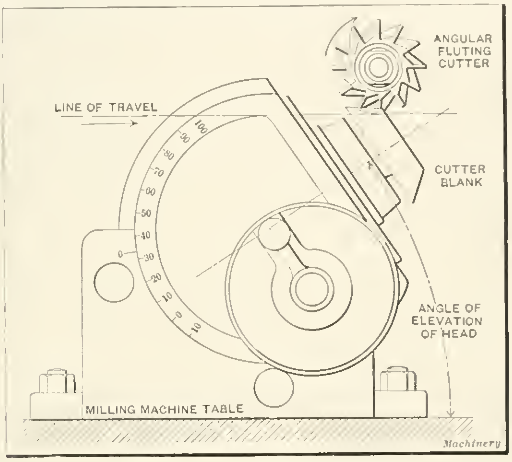

Fig. 1. Dividing Head set for Milling Teeth in Angular Cutter

For the formation of lands of uniform width on radial teeth on the sides and ends of cylindrical milling cutters and on inclined teeth on the conical surfaces of angular milling cutters and tapered reamers, it is necessary to set the axis of the cutter or reamer and, therefore, the axis of the dividing head, at a definite angle with respect to the horizontal axis of the dividing head and footstock centers. This angle depends upon several factors, which, in the case of angular milling cutters and tapered reamers, are enumerated and dealt with below. This angle is known as the "angle of elevation" of the dividing head (see Fig. 1). For cutters having radial teeth, the question of its determination and that of the depth of cut required was discussed in the November and December, 1911, numbers of MACHINERY by the present writer. The problem involving the determination of the values of this angle and the required depth of cut for angular cutters and tapered reamers is, however, more complicated, and is considered in the present article.

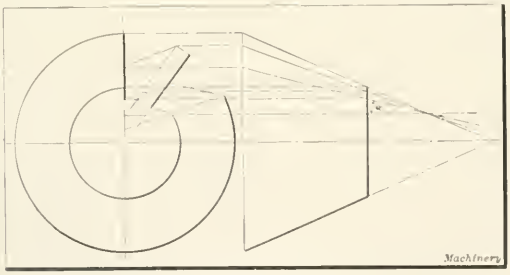

Fig. 2. Diagrammatical Representation of Principles involved in Milling Teeth in Angular Cutters

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* With Data Sheet Supplement.

† See also MACHINERY, March, 1912, "Milling Axial Teeth in Cutter and Reamer Blanks," and the articles there referred to.

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TABLES V AND VI. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 16

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	46° 20′	0.020	0.4025	0.040	0.3813	0.080	0.3389	0.120	0.2965
	50	49° 39′		0.3500		0.3314		0.2942		0.2570
	60	55° 40′		0.2491		0.2359		0.2095		0.1831
	70	60° 26′		0.1670		0.1581		0.1403		0.1225
	80	64° 36′		0.6946		0.0895		0.0794		0.0693
30	45	37° 40′	0.020	0.4145	0.040	0.3925	0.080	0.3485	0.120	0.3045
	50	40° 51′		0.3575		0.3385		0.3005		0.2625
	60	46° 20′		0.2574		0.2438		0.2166		0.1894
	70	50° 40′		0.1767		0.1673		0.1485		0.1297
	80	54° 28′		0.1052		0.0996		0.0884		0.0772
40	45	30° 10′	0.020	0.4176	0.040	0.3954	0.080	0.3510	0.120	0.3066
	50	32° 50′		0.3640		0.3446		0.3058		0.2670
	60	37° 33′		0.2662		0.2520		0.2236		0.1952
	70	41° 20′		0.1860		0.1760		0.1560		0.1360
	80	44° 40′		0.1144		0.1084		0.0964		0.0844
45	45	26° 24′	0.020	0.4270	0.040	0.4042	0.080	0.3586	0.120	0.3130
	50	28° 58′		0.3698		0.3500		0.3104		0.2708
	60	33° 25′		0.2686		0.2542		0.2254		0.1966
	70	36° 51′		0.1897		0.1787		0.1567		0.1347
	80	39° 55′		0.1185		0.1121		0.0993		0.0865
50	45	23° 35′	0.020	0.4200	0.040	0.3970	0.080	0.3510	0.120	0.3050
	50	25° 30′		0.3678		0.3482		0.3090		0.2698
	60	29° 21′		0.2621		0.2495		0.2243		0.1991
	70	32° 30′		0.1925		0.1821		0.1613		0.1405
	80	35° 14′		0.1220		0.1155		0.1025		0.0895
60	45	17° 25′	0.020	0.4114	0.040	0.3896	0.080	0.3460	0.120	0.3024
	50	18° 40′		0.3705		0.3510		0.3120		0.2730
	60	21° 38′		0.2750		0.2603		0.2309		0.2015
	70	24° 0′		0.1979		0.1871		0.1655		0.1439
	80	26° 7′		0.1278		0.1210		0.1074		0.0938
70	45	11° 0′	0.020	0.4330	0.040	0.4098	0.080	0.3634	0.120	0.3170
	50	12° 14′		0.3727		0.3527		0.3127		0.2727
	60	14° 14′		0.2770		0.2622		0.2326		0.2030
	70	15° 50′		0.2008		0.1900		0.1684		0.1468
	80	17° 15′		0.1328		0.1267		0.1115		0.0973
80	45	5° 30′	0.020	0.4269	0.040	0.4040	0.080	0.3582	0.120	0.3124
	50	6° 3′		0.3745		0.3545		0.3145		0.2745
	60	7° 3′		0.2799		0.2649		0.2349		0.2049
	70	7° 51′		0.2038		0.1929		0.1711		0.1493
	80	8° 35′		0.1343		0.1271		0.1127		0.0983

Number of Teeth in Cutter to be Fluted = 18

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	49° 26′	0.020	0.3513	0.040	0.3297	0.080	0.2865	0.120	0.2433
	50	52° 18′		0.3040		0.2852		0.2476		0.2100
	60	57° 31′		0.2162		0.2029		0.1763		0.1497
	70	61° 45′		0.1435		0.1347		0.1171		0.0995
	80	65° 24′		0.0802		0.0752		0.0652		0.0552
30	45	40° 31′	0.020	0.3570	0.040	0.3350	0.080	0.2910	0.120	0.2470
	50	43° 20′		0.3109		0.2919		0.2539		0.2159
	60	48° 7′		0.2238		0.2100		0.1824		0.1548
	70	51° 58′		0.1516		0.1422		0.1234		0.1046
	80	55° 19′		0.0885		0.0831		0.0723		0.0615
40	45	33° 2′	0.020	0.3615	0.040	0.3395	0.080	0.2955	0.120	0.2515
	50	35° 5′		0.3153		0.2959		0.2571		0.2183
	60	39° 14′		0.2290		0.2149		0.1867		0.1585
	70	42° 33′		0.1591		0.1493		0.1297		0.1101
	80	45° 30′		0.0963		0.0904		0.0786		0.0668
45	45	28° 48′	0.020	0.3650	0.040	0.3430	0.080	0.2990	0.120	0.2550
	50	31° 0′		0.3211		0.3011		0.2611		0.2211
	60	34° 57′		0.2340		0.2196		0.1908		0.1620
	70	38° 0′		0.1622		0.1522		0.1322		0.1122
	80	40° 43′		0.0993		0.0932		0.0810		0.0688
50	45	25° 25′	0.020	0.3660	0.040	0.3440	0.080	0.3000	0.120	0.2560
	50	27° 20′		0.3225		0.3025		0.2625		0.2225
	60	30° 45′		0.2356		0.2211		0.1921		0.1631
	70	33° 33′		0.1648		0.1546		0.1342		0.1138
	80	35° 59′		0.1020		0.0958		0.0834		0.0710
60	45	18° 48′	0.020	0.3665	0.040	0.3445	0.080	0.3005	0.120	0.2565
	50	20° 6′		0.3238		0.3038		0.2638		0.2238
	60	22° 45′		0.2371		0.2225		0.1933		0.1641
	70	24° 53′		0.1677		0.1573		0.1365		0.1157
	80	26° 45′		0.1060		0.0995		0.0865		0.0735
70	45	12° 20′	0.020	0.3670	0.040	0.3450	0.080	0.3010	0.120	0.2570
	50	13° 13′		0.3250		0.3050		0.2650		0.2250
	60	15° 0′		0.2395		0.2251		0.1963		0.1675
	70	16° 27′		0.1701		0.1596		0.1386		0.1176
	80	17° 43′		0.1095		0.1027		0.0891		0.0735
80	45	6° 2′	0.020	0.3700	0.010	0.3476	0.080	0.3028	0.120	0.2580
	50	6° 33′		0.3260		0.3058		0.2654		0.2250
	60	7° 26′		0.2401		0.2257		0.1969		0.1681
	70	8° 10′		0.1730		0.1622		0.1406		0.1190
	80	8° 48′		0.1129		0.1059		0.0919		0.0779

The lands on the teeth of any milling cutter or reamer are invariably finally formed in the grinding operation, but they can be—and usually are—initially formed in the operation of milling the flutes or grooves between the teeth. This reduces the duration and cost of both the milling and the grinding operations. This case is illustrated in Fig. 2, where angle α represents the angle of elevation of the indexing or dividing head. It could be conceived, however, that the fluting or grooving cutter and the cutter or reamer blank were so arranged with respect to each other that the cutter penetrated the blank to such a depth that each tooth was formed in the fluting operation with a sharp edge which possessed none of the characteristics of a land. This case is illustrated in Fig. 3, where the angle of elevation of the indexing or dividing head is represented by α. A comparison of Figs. 2 and 3 will show a marked difference between the two cases. In the first case, the bottom of the flute or groove does not pass through the apex of the cone of which the cutter or reamer blank is a frustum; in the second case, it does. It does not follow as a corollary, however, that, for similar conditions and dimensions (with the exception of the width of the land), the angles of elevation for the two cases are different, since it can be very readily demonstrated that the width of the land in any case has no influence upon the angle of elevation of the dividing head. This being the case, it is of no material importance which of the cases is considered for determining this angle; we shall, however, take the latter case (that is, the one involving no land-width), as it is the simpler of the two to treat.

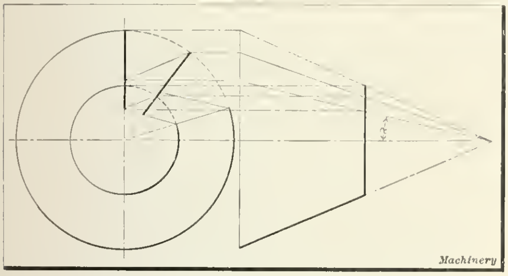

Fig. 3. Conditions obtaining if Tooth were milled to a Sharp Point

There are two ways in which the angle of elevation can be determined. The first is the direct method, by means of which the value of α is calculated without any intermediate steps or operations. It is, however, an exceedingly complicated and cumbersome method, and not nearly as simple as the second one in its application. The second method involves three separate steps or operations: 1. The determination of the value of the angle $(\alpha + \delta)$, Fig. 4; 2. The calculation of the angle δ in the same figure; 3. The obtaining of the difference between these two angles.

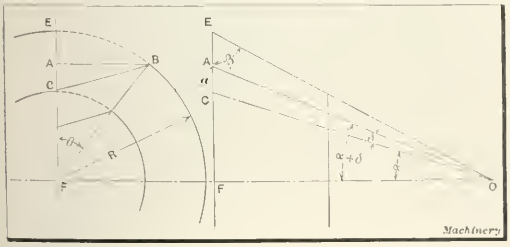

Fig. 4. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

The conditions of the problem are indicated in Fig. 4, in which O represents the vertex of the cone of which the blank is a part or frustum; FE and FB represent the radius of the large end of the blank and are, therefore, equal to each other; CO represents the bottom of the flute produced to the vertex O; and ECB represents the flute at the large end of the blank.

Let R = the radius of large end of blank,

θ = tooth-angle of the blank (this angle is equal to 360 ÷ number of teeth to be milled in blank, the teeth being supposed to be spaced uniformly around the periphery of the blank),

β = angle of blank (this angle is measured as indicated in Fig. 4),

γ = angle of fluting cutter (this being assumed to be a single-angle cutter),

α = angle of elevation of dividing head.

Then $FA = FB \cos\theta = R\cos\theta$, and

$$\tan(\alpha+\delta) = \frac{FA}{FO} = \frac{R\cos\theta}{FO}.$$

Now, $\frac{FO}{FE} = \tan\beta = \frac{FO}{R}$; therefore $FO = R\tan\beta$. Hence

$$\tan(\alpha+\delta) = \frac{R\cos\theta}{R\tan\beta} = \frac{\cos\theta}{\tan\beta} \qquad (1)$$

Since θ and β are known for any particular case, the values of $\cos\theta$ and $\tan\beta$ can be obtained from a table of trigonometrical ratios, and the value of $\tan(\alpha+\delta)$ calculated, and the value of the angle $(\alpha+\delta)$ obtained.

The second part of the process of finding the value of the angle of elevation of the head involves the determination of angle δ. In Fig. 4 $\sin\delta = \frac{a}{AO}$. Now, from an examination of Fig. 5, which is a section normal to the bottom of the flute or groove and passing through line AB, and by comparing it with Fig. 4, we see that $a = AB\cot\gamma$. Further,

$$AO = \frac{AF}{\sin(\alpha+\delta)} = \frac{AB}{\sin(\alpha+\delta)\tan\theta}. \text{ Therefore}$$

$$\sin\delta = \frac{AB\cot\gamma}{\dfrac{AB\cot\theta}{\sin(\alpha+\delta)}} = \cot\gamma\tan\theta\sin(\alpha+\delta) \qquad (2)$$

This expression will give the value of $\sin\delta$, since at this stage all the other quantities involved are obtainable from the given data, and from $\sin\delta$ the value of angle δ is obtained.

It will now be observed that the values of the angles $(\alpha+\delta)$ and δ can be calculated from the furnished data, and that their difference is the angle α required (the angle of elevation of the dividing head).

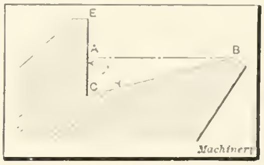

Fig. 5. Section Normal to Bottom of Tooth

As the expressions above, however, are obviously altogether too cumbersome to admit of their use in ordinary machine shop practice, the accompanying Data Sheet Supplement has been prepared, giving the values of the angles of elevation of the dividing head for a large number of combinations of number of teeth to be milled in blank, angle of blank, and angle of fluting cutter. For any combination not provided for, the "simple proportion" method of determining the values of angle α from the values given in the tables will usually give a result sufficiently close for practical purposes. To illustrate this point, let us take the case of a cutter blank in which 15 teeth have to be milled, the angle of the blank (β) being 65 degrees, and the angle of the fluting cutter (γ) being 55 degrees. Consulting the tables and applying the "simple proportion" method in steps, we find that α = 15 degrees 58 minutes for this case, while if calculated by means of Equations (1) and (2), the value of the angle equals 16 degrees 3 minutes, the difference of 5 minutes being negligible, as it is not possible to set the dividing head spindle to within 10 minutes, in the majority of cases.

In addition to the angle of elevation of the dividing head, it is necessary to know the depth of cut required to form the width of land selected. This is also given in the accompanying Data Sheet Supplement. The mathematical deductions required to obtain the values given in the tables will be dealt with in the following.

TABLES VII AND VIII. ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS

Number of Teeth in Cutter to be Fluted = 20

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	51° 43′	0.020	0.3119	0.040	0.2904	0.080	0.2474	0.120	0.2044
	50	54° 18′		0.2688		0.2504		0.2136		0.1768
	60	58° 59′		0.1897		0.1767		0.1507		0.1247
	70	62° 44′		0.1258		0.1172		0.1000		0.0828
	80	66° 0′		0.0692		0.0644		0.0548		0.0452
30	45	43° 0′	0.020	0.3142	0.040	0.2927	0.080	0.2497	0.120	0.2067
	50	45° 15′		0.2744		0.2556		0.2180		0.1804
	60	49° 30′		0.1960		0.1826		0.1558		0.1290
	70	52° 56′		0.1325		0.1234		0.1052		0.0870
	80	55° 55′		0.0766		0.0713		0.0607		0.0501
40	45	34° 39′	0.020	0.3220	0.040	0.2999	0.080	0.2557	0.120	0.2115
	50	36° 47′		0.2779		0.2589		0.2209		0.1829
	60	40° 30′		0.2008		0.1870		0.1594		0.1318
	70	43° 30′		0.1375		0.1281		0.1093		0.0905
	80	46° 7′		0.0823		0.0767		0.0655		0.0543
45	45	30° 29′	0.020	0.3300	0.040	0.3076	0.080	0.2628	0.120	0.2180
	50	32° 37′		0.2829		0.2595		0.2227		0.1859
	60	36° 9′		0.2028		0.1896		0.1607		0.1330
	70	38° 53′		0.1407		0.1311		0.1119		0.0927
	80	41° 19′		0.0846		0.0788		0.0672		0.0556
50	45	27° 3′	0.020	0.3250	0.040	0.3026	0.080	0.2578	0.120	0.2130
	50	28° 47′		0.2820		0.2627		0.2241		0.1855
	60	31° 51′		0.2051		0.1906		0.1616		0.1326
	70	34° 20′		0.1432		0.1334		0.1138		0.0942
	80	36° 31′		0.0879		0.0819		0.0699		0.0579
60	45	20° 0′	0.020	0.3232	0.040	0.3010	0.080	0.2566	0.120	0.2122
	50	21° 15′		0.2831		0.2637		0.2249		0.1861
	60	23° 36′		0.2079		0.1933		0.1649		0.1365
	70	25° 30′		0.1460		0.1360		0.1160		0.0960
	80	27° 10′		0.0920		0.0857		0.0731		0.0605
70	45	13° 0′	0.020	0.3321	0.040	0.3093	0.080	0.2637	0.120	0.2181
	50	14° 0′		0.2860		0.2663		0.2269		0.1875
	60	15° 36′		0.2122		0.1972		0.1672		0.1372
	70	16° 54′		0.1479		0.1377		0.1173		0.0969
	80	18° 0′		0.0952		0.0887		0.0757		0.0627
80	45	6° 30′	0.020	0.3250	0.040	0.3030	0.080	0.2590	0.120	0.2150
	50	6° 56′		0.2871		0.2675		0.2283		0.1891
	60	7° 45′		0.2106		0.1962		0.1674		0.1386
	70	8° 25′		0.1480		0.1379		0.1177		0.0975
	80	8° 59′		0.0953		0.0888		0.0758		0.0628

Number of Teeth in Cutter to be Fluted = 24

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	55° 0′	0.020	0.2531	0.040	0.2321	0.080	0.1901	0.120	0.1481
	50	57° 12′		0.2169		0.1989		0.1629		0.1269
	60	61° 2′		0.1522		0.1396		0.1144		0.0892
	70	64° 7		0.1000		0.0918		0.0754		0.0590
	80	66° 50′		0.0540		0.0495		0.0405		0.0315
30	45	46° 5′	0.020	0.2549	0.040	0.2339	0.080	0.1919	0.120	0.1499
	50	48° 0′		0.2202		0.2020		0.1656		0.1292
	60	51° 30′		0.1563		0.1434		0.1176		0.0918
	70	54° 20′		0.1045		0.0959		0.0787		0.0615
	80	56° 48′		0.0590		0.0541		0.0443		0.0345
40	45	37° 39	0.020	0.2559	0.040	0.2348	0.080	0.1926	0.120	0.1504
	50	39° 15′		0.2230		0.2046		0.1678		0.1310
	60	42° 20′		0.1598		0.1466		0.1202		0.0938
	70	44° 48′		0.1083		0.0994		0.0816		0.0638
	80	46° 59′		0.0629		0.0577		0.0473		0.0369
45	45	33° 45′	0.020	0.2569	0.040	0.2357	0.080	0.1933	0.120	0.1509
	50	36° 15′		0.2251		0.2065		0.1693		0.1321
	60	37° 50′		0.1620		0.1486		0.1218		0.0950
	70	40° 7′		0.1102		0.1011		0.0829		0.0647
	80	42° 7′		0.0653		0.0599		0.0491		0.0383
50	45	29° 40′	0.020	0.2578	0.040	0.2366	0.080	0.1942	0.120	0.1518
	50	30° 52		0.2270		0.2082		0.1706		0.1330
	60	33° 25′		0.1639		0.1503		0.1231		0.0959
	70	35° 30′		0.1120		0.1027		0.0841		0.0655
	80	37° 20′		0.0664		0.0610		0.0502		0.0394
60	45	21° 50′	0.020	0.2602	0.040	0.2386	0.080	0.1954	0.120	0.1522
	50	22° 52′		0.2276		0.2090		0.1714		0.1340
	60	24° 50′		0.1650		0.1514		0.1242		0.0970
	70	26° 27′		0.1136		0.1042		0.0854		0.0666
	80	27° 50′		0.0690		0.0633		0.0519		0.0405
70	45	14° 25′	0.020	0.2610	0.040	0.2394	0.080	0.1962	0.120	0.1530
	50	15° 5′		0.2290		0.2102		0.1726		0.1350
	60	16° 25′		0.1676		0.1537		0.1259		0.0981
	70	17° 33′		0.1147		0.1053		0.0865		0.0677
	80	18° 30′		0.0700		0.0643		0.0529		0.0415
80	45	7° 5′	0.020	0.2682	0.040	0.2460	0.080	0.2016	0.120	0.1572
	50	7° 30′		0.2300		0.2111		0.1733		0.1355
	60	8° 10′		0.1684		0.1545		0.1267		0.0989
	70	8° 43′		0.1177		0.1079		0.0883		0.0687
	80	9° 13′		0.0715		0.0657		0.0541		0.0425

In the foregoing the formulas required for calculating the angle to which to set the dividing head when milling angular cutters or taper reamers are given. The question of determining the depth of the cut required for any given width of land will now be dealt with. As will be shown in the following, the depth of cut required depends, among other factors, upon the selected width of land, and, therefore, a change in the depth of cut will cause a land of another width to be formed.

The conditions of this part of the problem are represented in Fig. 6. In this figure, W represents the width of the land. Now, as has already been explained in previous articles by the present writer in MACHINERY, the width of the land formed in the grinding operation is a straight-line quantity, but W in the figure is a circular width (that is, it is measured on the circumference of the blank circle). In the majority of cases, however, the difference between the two quantities is of infinitesimal dimensions and may, therefore, be neglected. Hence, in our treatment of the case, we shall assume that the two are equal. This circular land-width W (measured, in this instance, on the circumference of the circle representing the large end of the blank) subtends an angle ϕ at the center of the circle, the value of ϕ, in degrees, being $\frac{W}{R} \times 57.3$. The chord cR is the chord which subtends the angle $(\theta - \phi)$ at the center of the circle, the coefficient c being the length of this chord when $R = 1$. The line AB has already been referred to in connection with Figs. 4 and 5; d is the depth of cut required, and is measured in a direction normal to the bottom of the flute and from the edge of the blank.

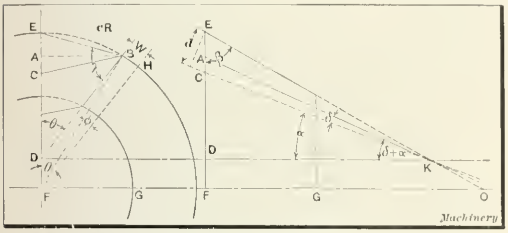

Fig. 6. Diagram for Deduction of Formula for finding Setting Angle for Dividing Head

An examination of Fig. 6 will show that:

$$d = EK \sin \{90 - (\alpha + \beta)\} = EK \cos (\alpha + \beta) \qquad (3)$$

Now, $EK = \frac{ED}{\cos \beta}$, and $ED = \frac{cR \sin \lambda}{\sin \theta}$. But $\lambda = \left(90 - \frac{\theta + \phi}{2}\right)$; hence, $\sin \lambda = \sin \left(90 - \frac{\theta + \phi}{2}\right) = \cos \frac{\theta + \phi}{2}$. Therefore:

$$EK = \frac{cR \cos \frac{\theta + \phi}{2}}{\cos \beta \sin \theta}, \text{ and}$$

$$d = \frac{cR \cos \frac{\theta + \phi}{2} \cos (\alpha + \beta)}{\cos \beta \sin \theta} = KR \qquad (4)$$

in which

$$K = \frac{c \cos \frac{\theta + \phi}{2} \cos (\alpha + \beta)}{\cos \beta \sin \theta}$$

and is the depth of cut required for a blank having unit radius.

To make this expression of practical utility, the values of K corresponding to the combinations of number of teeth N, and angles β and γ selected in the case of the angle of elevation of the dividing head, and several values of $\frac{W}{R}$ are given in Tables V, VI, VII and VIII, along with the angles of elevation of the head. Intermediate values (that is, values not covered by the combinations adopted in these tables, are obtainable within very close limits by means of the "simple proportion" method, as in the case of the angle of elevation of the head.

To illustrate the application of this method, let us take the case of a cutter blank in which 20 teeth have to be milled, the angle of the blank (β) being 45 degrees, and the angle of the fluting cutter (γ) being 60 degrees. Let the selected value of $\frac{W}{R}$ be 0.030. Then the depth for unit radius, when $\frac{W}{R} = 0.020$, equals 0.203 inch; and when $\frac{W}{R} = 0.040$, the depth equals 0.190 inch. Hence, when $\frac{W}{R} = 0.030$, the depth for unit radius equals

$$\frac{0.203 + 0.190}{2} = 0.1965 \text{ inch.}$$

The radius of the blank is invariably made a trifle larger than the radius of the finished cutter or reamer in order to allow for grinding after hardening, in which case, theoretically, it is necessary to make an allowance for the difference between the two radii in the expression giving the depth of cut. The modified expression is:

$$d = KR + (R_1 - R) \cos \alpha$$

in which R_1 = the radius of the large end of the blank, and R = the radius of the large end of the finished cutter or reamer.

* * *

METHOD OF PRODUCING SOUND INGOTS

The trouble experienced by railroads with broken rails, especially in countries where low temperatures prevail in winter, has demonstrated the necessity of producing sound rails. To produce sound rails means that the ingots from which the rails are made must also be quite sound and free from piping, segregation and blow-holes. Unless the ingots fulfill these requisites, trouble is bound to be experienced with the rails rolled from them.

The defects mentioned are caused by the conditions that existed in the ingot during the cooling process. Trouble from piping is caused by unequal contraction of the metal during cooling. This is due to the fact that the outer sections solidify first. Solidification continues little by little, the center being the last to reach the solid form. This means that an unequal degree of contraction takes place in the ingot, and as the space made void by this contraction is filled by liquid metal flowing down from the top, a cavity or "pipe" is formed in the upper section.

It is an established fact that defective ingots cannot be rolled into sound rails. The method of doing away with defects from piping employed by Sir Robert Hadfield and described in a paper read before the September 1912 meeting of the Iron and Steel Institute, consists of placing charcoal or other combustible material on top of the ingot mold after it has been filled. A layer of cupola slag is placed between the charcoal and the molten steel in order to protect the latter from the oxidizing effect of a blast of air which is directed on top of the ingot to facilitate the combustion of the charcoal. The ingot mold is fitted with a sand top, holding a supply of metal which is kept in a molten condition by the heat generated by the charcoal. This molten metal descends in the mold as contraction takes place and eliminates any tendency toward piping which would otherwise result from the contraction that takes place during cooling. The addition of small quantities of metallic aluminum tend to "quiet the metal", that is to say the aluminum combines with oxygen which is present and carries it away in the form of slag. This reduces the tendency toward the formation of blow-holes. Fortunately it has been found that a remedy which overcomes the tendency toward piping also tends to check the formation of blow-holes or segregated sections. Consequently ingots produced according to this process are particularly free from defects, and the additional expense is more than offset by the reduction in the quantity of material which must be discarded during subsequent processes.

RELATION OF PRICE OF TOOL STEEL TO MANUFACTURING COSTS

BY D. G. CLARK[*]

A short time ago we received an order from an up-to-date concern, bearing this notation: "This steel, which costs twice as much, must give at least double the production of our present steel in the operation in which it is to be used, otherwise it will be returned." The buyer in this concern was one of the men who believe that if one tool steel costs fifty per cent more per pound than another, it must do fifty per cent more work to justify the price. As a matter of fact, if one steel does five per cent more work than another it is well worth fifty per cent more per pound on all usual operations. There are many ways of proving this. One is to take any machine in the shop and learn the relation of tool cost to total costs. For illustration, we have selected a lathe using tools made from 1½ by ¾ inch steel. How much high-speed steel is used a day? Our observations, estimates and averages show that the daily consumption is one-twelfth pound of high-speed steel on the average lathe, doing fairly hard work at a good speed. This is based on work requiring the tool to be ground five or six times a day. If the tools cut all day on one grinding it indicates that they are cutting considerably below capacity, although this is sometimes necessary owing to local conditions. The one-twelfth pound daily consumption of steel is arrived at in the following way:

High-speed Steel used Daily on 20-inch Lathe

Size of tool: 1½ by ¾ inches. Average number of grindings: six per day.

Steel ground away each grinding	1/32 inch
Steel ground away each day (six grindings)	3/16 inch
Steel ground away each week (six days)	1 inch (approx.)

Then the tool needs redressing. In redressing and retempering, a small piece of steel is cut off. Making liberal allowance, this waste is about one-half inch of steel.

The waste of steel in redressing is	½ inch
The amount of steel ground away is (see above)	1 inch
The weekly consumption of steel	1½ inches

One-and-one-half lineal inches of 1½ by ¾ inch high-speed steel weighs one-half pound. The daily consumption, therefore, is one-sixth of one-half pound, or one-twelfth pound.

The Daily Cost of Tool Steel

On the basis of one-twelfth pound steel consumption per day, if equal quantities were used:

High grade high-speed steel at 71 cents per pound costs, per day	$0.06
Cheap high-speed steel at 48 cents per pound costs, per day	.04
Increased first cost of higher priced steel, per day	$0.02

The Cost of Operating

On a lathe such as we are using for illustration,

The machinist's hourly rate, about	$0.36
The overhead (including power)	.24
The total hourly rate	$0.60
The day rate (eight hours)	$4.80

The Value of the Product

If the man operating the lathe which we are using for illustration turns out 100 units of work daily, each piece costs the manufacturer 1/100 of $4.80 or 4.8 cents, and just that much value is produced. If the higher priced steel enables the machinist to turn out one piece more daily, thus increasing the output only one per cent, we have the following results:

Value of one extra piece produced	$0.048
Increased first cost of the steel	.020
Net daily profit on one per cent increase	$0.028

In this case a one per cent increase would warrant buying a good grade of steel costing fifty per cent more than cheap steel.

With a steel like "Blue Chip," for example, increases in production as high as fifty per cent or one hundred per cent are often secured, but the object of this article is to show that a five per cent increase in production justifies paying much more than a fifty per cent increase in first cost.

Taking the same illustration from another point of view: With the higher priced steel at 71 cents per pound,

The man's time per day	$2.88
The "overhead" per day	1.92
Steel per day	0.06
Daily total	$4.86

With cheap steel at 48 cents per pound,

The man's time per day	2.88
The "overhead" per day	1.92
Steel per day	0.04
Daily total	$4.84

The total daily cost has been increased less than one-half of one per cent; one-half of one per cent of $4.84=2.4 cents. Therefore if the higher priced steel does one-half of one per cent more work, it is the cheapest, although the price per pound may be fifty per cent higher than the steel formerly used.

Saving in Grinding

There is another point of view from which the price of tool steel should be considered, and that is the saving in grinding. Some tool steel users think that if the steel costs twice as much, it must require grinding only one-half as many times, but in the foregoing illustration, if one grinding is saved in two days, it justifies paying fifty per cent more for the steel. We arrive at this conclusion through the following: We have found that sixty cents an hour is a conservative estimate of the cost of a man's time and the overhead expense. On this basis every grinding which requires about five minutes means a loss of time and production worth five cents. The excess first cost of steel at seventy-one cents, as compared with a forty-eight-cent steel on the machine we are using for illustration, amounts to two cents a day. Therefore, if tools made from the higher priced steel save one grinding in two days, they warrant an increase of fifty per cent in the price per pound.

In addition to the profit and saving resulting from increased production and fewer grindings, there are also secondary savings to be considered. For instance, tools made from the higher priced steel will require redressing and rehardening less frequently, and the cost department knows what this means in the way of economy. Another saving results through a reduction in the amount of steel used. This has not been brought into our figures, but it should be considered in discussing tool steel costs. Less of the high-priced steel will be required than is the case where cheap steels are used.

Another important saving that is often forgotten, and which cannot be computed, is the time saved on break-down or emergency jobs. There are times in many shops when the management would gladly pay as much as the monthly tool steel bill to save an hour on a repair part, the lack of which holds up a large shipment, or stops work throughout the shop.

A number of minor savings have not been mentioned, but they are not needed to prove the wisdom of paying fifty per cent more for a steel which does five per cent more work. In conclusion, it may be stated that this method of considering tool steel costs may be applied on any machine, regardless of the kind of steel used. In nearly every case the higher priced steel, whether in ordinary tool steel grades or in high-speed steel grades, will be found cheapest if it brings about even a slight increase in the efficiency of cutting tools.

[The indirect relation of the cost of the tools of production to the cost of production so clearly set forth by Mr. Clark in the foregoing, applies all along the line. The first cost of a machine is of little importance in comparison with its productive capacity during its lifetime. A lathe costing $1000 may in the course of ten years, earn $10,000 for the shop in which it is used, while another of the same nominal capacity but of superior design and workmanship, costing say $1100, might earn $12,500 in the same period, or sufficiently more than the other to wipe out the original cost and the interest on the investment.—EDITOR.]

* * *

Many a carefully guarded trade secret is a huge joke. Ostriches can hide from each other, you know, by all thrusting their heads into the sand.—*Webster Method.*

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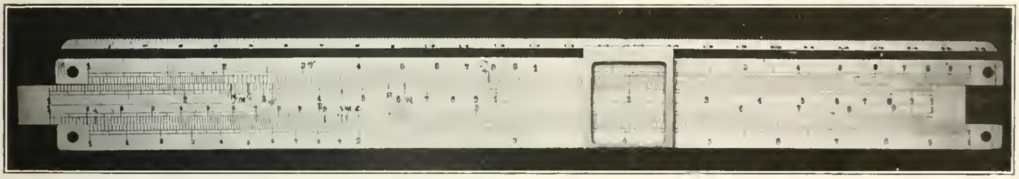
SLIDE-RULE CONSTANTS

BY A. LAURENS

The illustration which appears in connection with this description shows the writer's slide-rule on which several useful constants have been laid out. These constants refer to quantities which are frequently used by designers and estimators, and their use enables the weight of disks or rings of various metals to be rapidly determined. The metals in question are indicated on the rule by the following letters laid out on scale 3 of the slide-rule: *S*, for steel; *WI*, for wrought iron; *CI*, for cast iron; and *B* for brass. On the same scale there is marked a constant *V* that is used to determine the volume of disks or rings. In using the rule, on which these constants are marked, to obtain the weight of a disk or ring of the metal in question, it is only necessary to bring the symbol for the particular metal over the figure for diameter on scale 4 of the rule. The required weight or volume is then read on scale 1 of the rule above the thickness of the disk on scale 2. These results will be found accurate enough for almost any class of work and this method of calculation is far more rapid than the customary arithmetical process.

To illustrate the use of these constants, the reader is referred to the setting of the rule shown herewith. Here it will be seen that the constant for cast iron is set for a disk 20 inches in diameter. To get the weight of such a disk 3 inches thick, the reading of 245 pounds is obtained on scale 1 directly above the figure 3 on scale 2. To obtain the volume of a disk 20 inches in diameter and 3 inches thick, the constant *V* on scale 3 would be brought up to the figure 20 on scale 4. The volume of 944 cubic inches is then read on scale 1 over the figure 3 on scale 2. For the sake of checking the accuracy of this method, the same problem is carried through in the ordinary way. The weight of this disk will be $\frac{\pi D^2}{4} \times$ thickness × weight per cubic inch of cast iron. The weight of a cubic inch of cast iron is 0.26 pounds and substituting the other known values, a figure of 245.3 pounds is obtained for the weight of the disk. The volume of the disk is $\frac{\pi D^2}{4} \times$ thickness $=$ 943 cubic inches. These figures correspond closely enough for all practical purposes with the one obtained by using the constants. Even allowing that the arithmetical method can be worked out on a slide-rule, it will be granted that such a method takes longer than the one where the constants are used. With the constants, only one setting of the rule is required, and after this setting has been made any number of weights or volumes can be read off at once. In obtaining the weight or volume of a ring of metal, the process has to be repeated, and one reading subtracted from the other, the method being that of finding the difference in weight or volume between two disks of metal of the outer and inner diameters of the ring.



Slide-rule laid out with Some Useful Constants

It will be seen that several other constants have been laid out on scale 2 of the rule. These are *M M* = 25.4 which represents the number of millimeters in an inch. *G* = 277, which is the number of cubic inches in a gallon. This is the number of cubic inches in the British Imperial gallon and for the use of American engineers it would be better to give this figure a value of 231, which represents the number of cubic inches in the standard U. S. gallon. *R* = 57.3, which is the number of degrees in a radian. *W* = 62.3, which is the number of pounds per cubic foot of water. These are constants which engineers frequently need to use, and having them marked directly on the face of the rule saves a lot of time.

HOW A LITTLE SHOP GREW

BY A. P. PRESS

One evening we were out on the back door-step, and Billy, our next-door neighbor, came to the fence and called us over. Now, we had known Billy a long while. He was a pretty good fellow. He didn't drink or use any red paint, had a wife and two kids who, although they used to stone our cat once in a while, were pretty good boys after all. Billy had learned his trade with us some six years ago, and then he got out and went with the B. & H. Co., and had been with them ever since, and while we knew that he had been tinkering down cellar we were kind of surprised at what he wanted.

"Say, Mr. Press, haven't you got an attic over in your shop there that isn't working very hard?"

"Yes, Billy, I guess so."

"Well, I've been doing a little manufacturing on the side the last year. In the summer time I did it down cellar, and last winter I moved it up in the bed-room. Now it's getting kind of thick, and I thought perhaps you could let me have that back attic, and put all the junk up there."

"That's all right, Billy," we said. "Go ahead and put it in. You probably won't need any power, but if you do we'll cut a hole through the floor and run a belt up. What do you want to run?"

"Oh, nothing much; just a power press and a drill press, and possibly a lathe."

"Well, Billy, go ahead. The attic is not very big, but if you can stand it we can."

So Billy went ahead. He moved in one Saturday afternoon, and from then on there was more or less noise from the back attic that indicated that Billy was working. We didn't butt in on him, but when he had been there about six months we took a notion one evening to go in and see him, and we were surprised. He had a nice little lathe, drill press, power press and foot press, all in that 10 by 14 attic, and he was turning out some of the neatest little tool attachments we had ever seen.

"Well, Billy, where did you get those ideas?"

"Oh, I kind of picked them up, and put them through the patent office, and I suppose they are mine now."

We went away and let Billy alone. Six months more passed by, and Billy came around one night and said:

"Well, Mr. Press, I guess I'll have to move out next month."

"Why, how's that?"

"Well, you see, it's kind of crowded, and so I'm going to build a little shop in the back-yard."

So Billy built his "little shop" (it was about 20 by 40 feet) and moved his tools in. There was a smart looking boy working steady every day, but Billy was only there evenings, for he still held his position with the B. & H., where he had risen to be master mechanic, and was drawing a good salary.

For a whole year we watched Billy nights and Saturday afternoons (the place was shut tighter than a drum Sundays) and one Monday we noticed Billy hanging around the place all day. The next morning we happened to see him over the fence, and sang out to him.

"How's that, aren't you working this week?"

"No," said Billy, "not this week. You see it was like this. The orders were piling in on me for those little tool attachments, and I got so many ahead that I was kind of worried So I told them down to the factory that I wanted two weeks off, and while they put up an awful howl, I said it was either that or fire me. They didn't want to fire me, so they gave me the two weeks. I guess I will catch up in that time."

Two weeks passed, and we saw Billy again.

"Say, Mr. Press, you don't know where I could get a good man to take my job down to the B. & H., do you?"

"Why, what's the matter?"

"I thought I could catch up with my orders here in two weeks, but instead of that I'm farther behind than I was when I came out. So I went down and told them, and they put it up to me good and plenty that I either had to go back or else get them a man to take my job, so I'm looking for the other man."

Well, to make a long story short, Billy found the "other man." He has been out in the little shop nearly a year now, and it has been running 313 days. Sundays and Christmas are the only days that Billy doesn't work, and from the ink stains that I saw on Mrs. Billy's fingers the other day, I should say that she runs the bookkeeping end of the job.

We were in to see him not long ago (our power was shut down and we wanted to grind a chisel) and he had the nicest little shop that we have seen for a long time. It was crowded, and Billy says:

"I can't seem to get caught up on the work, and the only thing that I can see is to add on some floor space somewhere. I haven't much money, but I went and told all my customers just how it is, that I've got to turn my money over pretty often to make both ends meet, so as to take care of Mrs. Billy and the kids, and they have all done fine."

It doesn't take much of a vision to look into the future (not very far, either) and see Billy holding down an arm chair with a roll top desk, and with the business increasing to support the same.

Now, if any of you boys are planning to follow in Billy's footsteps, and want the secret of his success, it is very easy to get. It is work, work hard, and then work some more. We will try and keep tabs on Billy for at least a year or so more and tell you about him again. If you are a young man it will do you good. If you are an old fellow it wont hurt you any.

* * *

CROSS-SLIDE REAMING ATTACHMENT FOR THE CLEVELAND PLAIN AUTOMATIC

It is generally recognized that the plain type of automatic screw machine built by the Cleveland Automatic Machine Co., Cleveland, O., lends itself admirably to the rapid production of parts requiring the use of only one turret tool; hence in some shops this type of machine is confined to work requiring the use of one turret tool exclusively. The chief advantage gained in using the plain type of machine is that most of the idle movements common to the turret type are eliminated, thus cutting down the production time considerably.

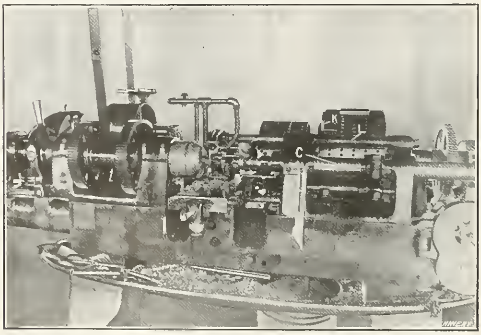


Fig. 1. Method of Gaging Work to Length

The piece shown in Fig. 2 is a good example of work, which with a little thought on the part of the designer can be produced economically on the plain type of machine. As can be seen, this piece, if made on the turret machine, would require three turret tools: stop, drill and reamer.

The method of "tooling" the plain machine for producing this piece is shown in Figs. 1 and 3. Here a drill *A* is held in a split holder *B*, the latter being retained in the tailstock spindle *C*. Enveloping the tailstock spindle is a collar *D*, which is provided with a notched lug fitting the bent end of the push-rod *E*.

The reamer *F* is held in a spindle *G*, which is a sliding fit in the bracket *H* clamped to the front cross-slide. Fastened to the front end of the spindle *G*. is an arm *I*, which extends down and is provided with a hole through which the push-rod *E* passes. This push-rod is threaded on the end passing through the arm, and is provided with adjusting nuts located on either side of the arm. These nuts are used for adjusting the push-rod, so that its bent end will always enter the slot in the collar *D*, the coil spring *S* always returning this rod to the same position, ready to be engaged again when the cross-slide is advanced to bring the reamer into position.

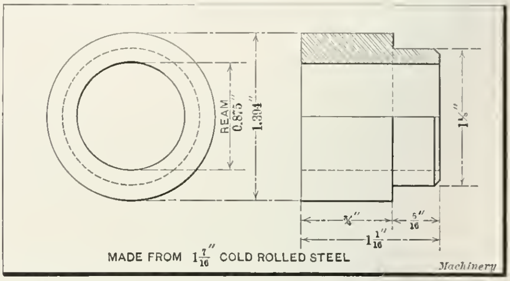


Fig. 2. Type of Work profitably made on Cleveland Plain Automatic

In operation, the stock is fed out, and is gaged to length by the swinging stop *J*, which is operated by a cam block *K* in Fig. 1. This stop is returned to the "up position" by a twisted spring *L*. After the stock is gaged to length, the cross-slide is advanced and the work turned to the required shape and diameter by a flat forming tool *M*. The cross-slide then retreats, and the tailstock spindle carrying the 0.865-inch drill *A* is advanced, producing the hole.

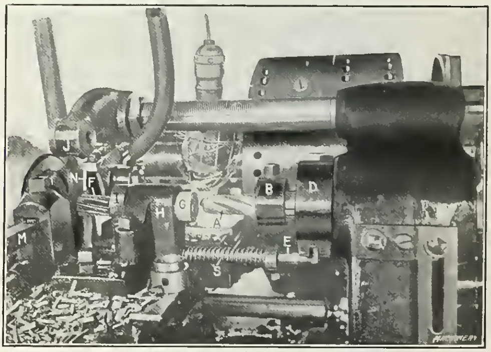


Fig. 3. The Method of "Tooling" the Machine

The tailstock spindle now retreats into the position shown in Fig. 3; then the cross-slide advances and the bent end of the push-rod engages with the slot in the collar. The tailstock spindle then advances and as it is connected with the reamer holder by the push-rod, it follows that the 0.875-inch reamer is forced into the work.

Before the reamer has finished cutting, the rear cross-slide is advanced, carrying the cut-off blade *N*, which severs the completed piece from the bar. While the work is being severed, the tailstock spindle recedes, and as it reaches the "back position", the push-rod is disconnected from the collar by the cross-slide dropping back, thus clearing the machine ready for this cycle of operations to be repeated.

The cams are timed on all of the various drums, so that each tool just clears, thus cutting down the idle time to a minimum. The work is rotated, in a forward direction, at 334 R. P. M., and it requires 84 seconds to complete one piece. The feeds given the various tools are:

Drill	0.008 inch per revolution.
Reamer	0.012 inch per revolution.
Form	0.003 inch per revolution.
Cut-off	0.003 inch per revolution.

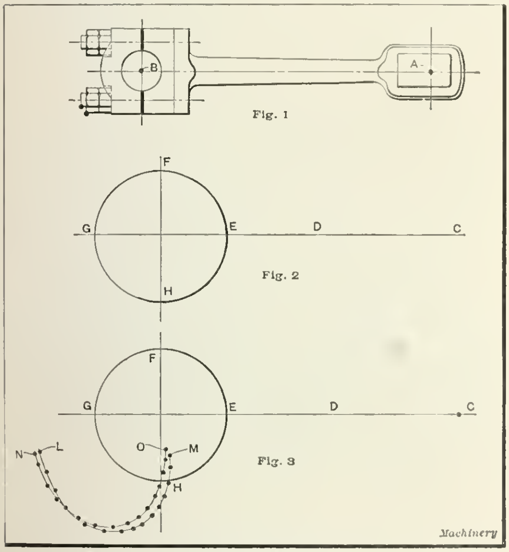
D. T. H.

SOME PROBLEMS SOLVED BY THE USE OF TRACING CLOTH

BY JOHN S. MYERS[*]

The designer sometimes wastes considerable time trying to determine whether he has allowed proper clearance for a moving part. The method of laying out the part in several different positions in an attempt to determine whether there is any interference is the longest way around. Some draftsmen draw a circle or a straight line which is termed the "clearance line" and to which they work. However, if properly developed, the actual clearance boundary is often a peculiar curve which differs considerably from a circle or a straight line. Methods of this kind often compel the erector to get the required clearance by chipping off ribs which are actually needed for strength. The cost is increased, the designer loses prestige, and there is annoyance all around.

The best and simplest way for investigating the clearance requirements is to roughly trace the moving part on transparent paper or tracing cloth and move it over the layout with a motion similar to that of the moving part. In this way accurate clearance boundaries may be quickly established, and while this method is quite generally known, the writer believes that its value is not sufficiently appreciated, and that advantage is not taken of this method as often as would be advisable. The following will illustrate its use.



Figs. 1 to 3. Methods used in Investigating the Clearance Requirements by Means of Tracing Cloth

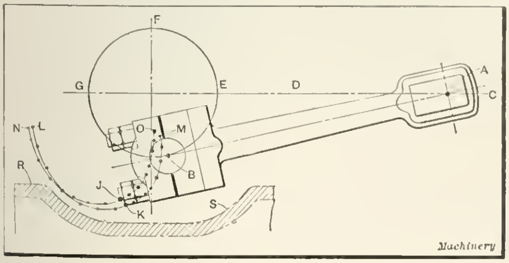


Fig. 4. The Clearance Determined

In Fig. 1 is shown a connecting-rod, the clearance for the crank-end of which is to be determined. First draw the lines indicated in Fig. 2 on the drawing paper. Here the line *CD* represents the path of point *A*, Fig. 1, while circle *EFGH* represents the path of point *B*. The connecting-rod in Fig. 1 is drawn on tracing cloth, and this may now be laid on top of the lines drawn on the drawing paper in Fig. 2, as indicated by Fig. 4. The connecting-rod on the tracing cloth is then moved about, point *A* being kept on the line *CD* and point *B* on the circle *EFG*. The points *J* and *K* then describe the clearance curves required at the further end. These can be pricked with a pin, and the curves *LM* and *NO* drawn through the points thus determined.

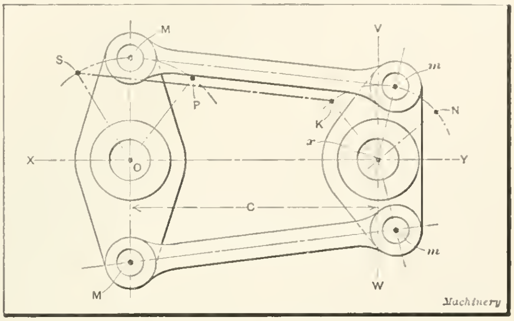
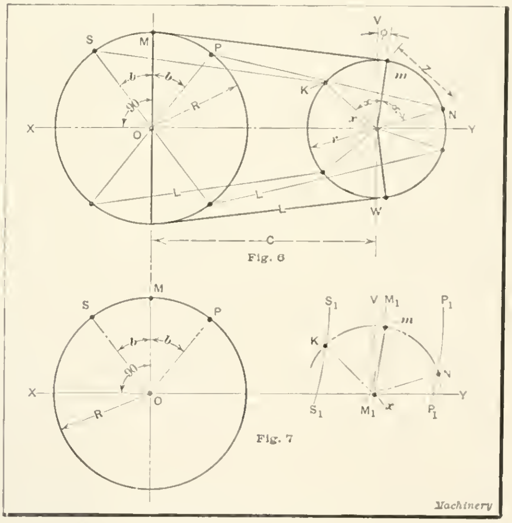


Fig. 5. A Mechanism involving a Complex Geometrical Problem

Another kink which can be made use of in connection with tracing cloth may be of interest. In making the blueprint from which Fig. 4 is reproduced, the writer did not wish to redraw the complete connecting-rod, yet it had to be shown to make the illustration complete. The method pursued was as follows: Fig. 1 was laid on top of Fig. 2 and the points of curves *LM* and *NO* pricked through and the curves drawn, which resulted in a drawing as shown in Fig. 3. The tracing in Fig. 1 was now placed on top of the tracing of Fig. 3, in correct position, and secured to it by adhesive tape; then a blueprint was made with sufficient extra exposure to allow for the double thickness of tracing cloth. The result then was a blueprint as indicated by the illustration shown in Fig. 4, to which, of course, was later added the dash-dotted lines showing the bed of the engine. The white spots left on the blueprint by the adhesive tape can be trimmed off and all evidence of the use of two tracings disappears. The contour of the bed casting *RS*, Fig. 4, is shown merely to indicate the reason for determining the clearance lines. The case chosen for illustration is a simple one, but the methods used are applicable to a wide range of work.



Figs. 6 and 7. Method of Solving the Geometrical Problem involved in the Linkage in Fig. 5

The draftsman also sometimes meets with geometrical problems which would prove difficult to a professor of mathematics; yet he must find some quick and practical solution.

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[*] Address: 2456 Almond St., Philadelphia, Pa.

By the use of a piece of tracing cloth the designer may often solve problems which mathematically are so involved as to seem almost hopeless. Such a case is given in the following.

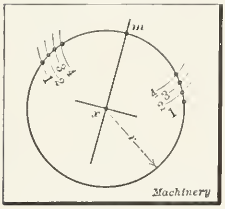

Fig. 8. The Lay-out made on Tracing Cloth

In the linkage shown in Fig. 5, point M oscillates between points S and P, being actuated by point m moving along curve KmN. The object of the construction is to obtain a toggle joint action as point m approaches points K and N. A skeleton diagram is shown in Fig. 6. Point O is a fixed center, while, due to the angularity of the links Mm, point x moves on line XY, making center distance C a variable quantity. It was found that by putting point m at some angular position ϕ away from line VW, the movement of point x along line XY could be very materially reduced. The problem then was to determine a value for ϕ such that the movement of point x would be a minimum. The mathematical solution by the aid of calculus seemed very difficult, and after some experimenting it was decided that if center distance C was the same for the central position of the links Mm as for the extreme positions SK and PN, the movement of point x would be reduced to practically a minimum. The problem then reduced itself to this: R, r and L being known, find values of C, α, and ϕ such that C will be constant for positions OS, OM and OP of the linkage. The solution is as follows:

With radius R draw the circle in Fig. 7 and lay out the maximum angular movement b, thus locating points S, M and P. Draw XY through O perpendicular to OM. With radius L draw arcs S_1S_1, M_1M_1, and P_1P_1, S, M and P being their respective centers. On a transparent sheet draw a circle of radius r, x being its center, see Fig. 8. Choose some point on this circle, as m, and draw (with any convenient radius known to exceed Z in Fig. 6) the arcs 1, 1; then with slightly smaller radii draw arcs 2, 2; 3, 3; 4, 4; etc. Number these arcs 1, 2, 3, 4, etc.

Lay Fig. 8 on top of Fig. 7 and shift it around until, with point m lying on arc M_1M_1 and x lying on line XY, a position is found in which two similarly numbered points such as 1, 1, 2, 2, or 3, 3 lie upon arcs S_1S_1 and P_1P_1. When this position is found, prick through these numbered points, and also through points x and m; they will then represent the points similarly marked in Fig. 6. Mark these points found on Fig. 7, and draw lines xK, xm, xN, and xV, the latter being perpendicular to XY. Now $Ox = C$, angle $mxK = \alpha$, and angle $mxV = \phi$, the three unknown quantities which were to be found.

With a value of ϕ determined by the above method, the center distance C will be exactly the same in value for the links in position Mm, SK, or PN, but for any intermediate position, C will be slightly increased, or if angle b be exceeded, C will decrease.

There are a great number of difficult problems which may be solved in a somewhat similar manner by the employment of a little ingenuity. The writer's object in presenting the foregoing examples has simply been to call attention to the methods available and the value of a piece of tracing cloth.

* * *

DIMENSIONS OF LEAD PIPE

BY S. E. FERRY*

Some time ago I had occasion to use some lead pipe, and as it was necessary to know the inside as well as the outside diameters of the pipe (the space being limited) and the safe working pressures, I sought for the information in various books, but was surprised to find that the data was not available in the references at hand. After considerable hunting through the lead manufacturers' and plumbers' supply books, I was able to compile the accompanying table, which gives the outside diameter, inside diameter, thickness, weight per foot, approximate bursting pressure and safe working pressure of lead pipe from ⅜ inch to 2 inches inside diameter, in double extra strong, strong, medium and light weights.

DIMENSIONS OF LEAD PIPE

Inside Diameter	Outside Diameter	Thickness	Weight per Foot		Approximate Bursting Pressure in Pounds per Square Inch	Safe Working Pressure in Pounds per Square Inch	Commercial Designations	
							Lead Pipe Manufacturers	Plumbing Supplies Catalogues*
Inch	Inch	Inch	Lbs.	Oz.				
⅜	0.74	0.183	1	12	2150	430	AAA	D. E. S.
⅜	0.72	0.173	1	8	2000	400	AA	E. S.
⅜	0.66	0.143	1	4	1650	330	A	Strong
⅜	0.63	0.128	1	0	1500	300	B	Medium
⅜	0.58	0.103	0	12	1250	250	C	Light
⅜	0.55	0.088	0	10	1050	210	D	E. L.
⅜	0.51	0.068	0	7	800	160	E	Aqueduct
7/16	0.66	0.111	1	0	1165	230	B	Medium
7/16	0.63	0.096	0	13	1000	200	C	Light
½	1.01	0.255	3	0	2000	400	AAA	D. E. S.
½	0.87	0.185	2	0	1600	320	AA	E. S.
½	0.84	0.170	1	12	1500	300	A	Strong
½	0.76	0.130	1	4	1150	230	B	Medium
½	0.71	0.105	1	0	900	180	C	Light
½	0.67	0.085	0	12	700	140	D	E L.
½	0.63	0.065	0	9	550	110	E	Aqueduct
⅝	1.13	0.253	3	8	1700	340	AAA	D. E. S.
⅝	1.05	0.213	2	12	1500	300	AA	E. S.
⅝	1.02	0.198	2	8	1300	260	A	Strong
⅝	0.96	0.167	2	0	1150	230	B	Medium
⅝	0.88	0.128	1	8	900	180	C	Light
⅝	0.80	0.088	1	0	600	120	D	E. L.
⅝	0.77	0.073	0	12	500	100	E	Aqueduct
¾	1.31	0.280	4	12	1900	380	AAA	D. E. S.
¾	1.21	0.230	3	8	1400	280	AA	E. S.
¾	1.16	0.205	3	0	1150	230	A	Strong
¾	1.07	0.160	2	4	950	190	B	Medium
¾	1.01	0.130	1	12	750	150	C	Light
¾	0.94	0.095	1	4	550	110	D	E. L.
¾	0.91	0.080	1	0	450	90	E	Aqueduct
1	1.59	0.295	6	0	1300	260	AAA	D. E. S.
1	1.51	0.255	4	12	1100	220	AA	E. S.
Inches	Inches	Inch	Lbs.	Oz.				
1	1.42	0.210	4	0	900	180	A	Strong
1	1.36	0.180	3	4	775	155	B	Medium
1	1.28	0.140	2	8	600	120	C	Light
1	1.23	0.115	2	0	500	100	D	E. L.
1	1.17	0.085	1	8	400	80	E	Aqueduct
1¼	1.82	0.285	6	12	1000	200	AAA	D. E. S.
1¼	1.75	0.250	5	12	900	180	AA	E. S.
1¼	1.67	0.210	4	12	750	150	A	Strong
1¼	1.59	0.170	3	12	600	120	B	Medium
1¼	1.52	0.135	3	0	475	95	C	Light
1¼	1.50	0.125	2	8	450	90	D	E. L.
1¼	1.45	0.100	2	0	350	70	E	Aqueduct
1½	2.11	0.305	8	8	900	180	AAA	D. E. S.
1½	2.04	0.270	7	8	800	160	AA	E. S.
1½	1.96	0.230	6	8	700	140	A	Strong
1½	1.88	0.190	5	0	550	110	B	Medium
1½	1.82	0.160	4	4	475	95	C	Light
1½	1.78	0.140	3	8	400	80	D	E. L.
1½	1.75	0.125	3	0	350	70	E	Aqueduct
1¾	2.42	0.335	10	0	850	170	AAA	D. E. S.
1¾	2.26	0.255	8	8	650	130	AA	E. S.
1¾	2.21	0.230	7	0	600	120	A	Strong
1¾	2.15	0.200	6	0	500	100	B	Medium
1¾	2.09	0.170	5	0	450	90	C	Light
1¾	2.03	0.140	4	0	375	75	D	E. L.
2	2.59	0.295	11	12	650	130	AAA	D. E. S.
2	2.51	0.255	9	0	550	110	AA	E. S.
2	2.45	0.225	8	0	500	100	A	Strong
2	2.41	0.205	7	0	450	90	B	Medium
2	2.37	0.185	6	0	375	75	C	Light
2	2.26	0.130	4	12	275	55	D	E. L.

The above table is based on 2240 pounds per square inch as the tensile strength of lead with 5 as a safety factor.

* D. E. S. = double extra strong; E. S. = extra strong; E. L. = extra light.

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* Address: Care of Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

MULTIPLE-SHOULDER SHAFT TURNING ON THE CLEVELAND AUTOMATIC

An excellent example of multiple shoulder shaft turning in a Cleveland plain type automatic screw machine, is shown in Fig. 2. As can be seen, this shaft has six different diameters —three on each end. All of these various diameters are turned and the shaft completed in one operation. The end of the shaft next to the chuck is turned by a cross-slide tool arrangement carrying three turning tools, and operated transversely by the tailstock spindle, as shown in Figs. 1 and 3.

By referring to Fig. 1 it will be seen that a long connecting-rod *A* is held free to slide in an arm *B*, which is clamped to the tailstock spindle *C*. The rear end of this connecting-rod is threaded and furnished with check-nuts, the function of which will be explained later.

The cross-slide arrangement consists of a block *D*, fastened to the T-slot of the regular cross-slide and provided with a dovetailed top face to which an auxiliary top-slide *E* is fitted. This slide is furnished with a gib to compensate for wear, and is machined to retain the three tool-holders *F*, which can be adjusted so as to bring the shoulders on the work the required distance apart.

The end of the shaft facing the tailstock spindle is turned by a box-tool carrying three cutters and provided with roller supports to steady the work, as in Fig. 3. This box-tool *G* has a shank which is held in the regular manner in the tailstock spindle. The turning tools are retained in holders *I*, which can be adjusted along the body of the box-tool to the required positions.

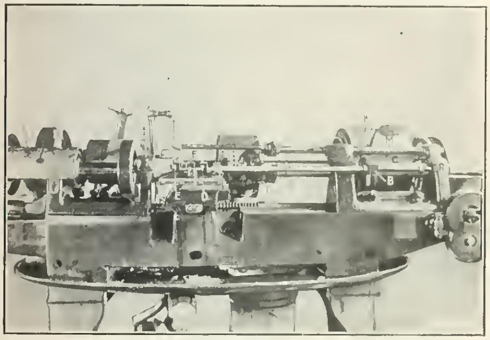

Fig. 1. Turning a Multiple Shoulder Shaft on the Cleveland Plain Automatic

In operation, the stock is fed out by a special cam on the stock-feed drum, and at the same time, the swinging stop *J* is brought down to gage the stock to length by a cam on drum *K*, see Fig. 1. When the chuck closes, the stop *J* is returned to the "up position" by the twisted spring *M*. The box-tool is now advanced, bringing the first tool *N*, Fig. 2, into operation, and at the same instant the regular cross-slide is advanced, feeding the tools *O*, *P*, and *Q* in to the proper depth. The cross-slide then retreats, and remains stationary with the tools clear of the work until the arm *B* approaches the check-nuts on the connecting-rod *A*. Just as this takes place, the regular cross-slide is again advanced, bringing the turning tools in to the correct depth.

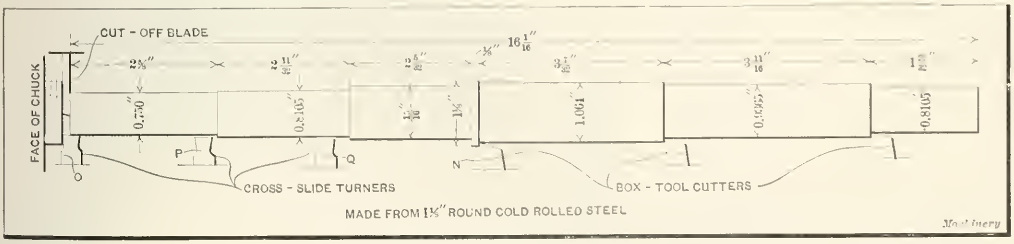

Fig. 2. Tools used in finishing the Shaft in One Operation

The cross-slide turning tools which are now ready to turn the work to the required diameter, are advanced longitudinally on the work when the advancing arm *B* contacts with the check-nuts. The connecting-rod *A*, which acts as a link joining the tailstock spindle and auxiliary slide *E*, is pivotally connected to the latter. When the roll reaches the end of the lobe of the tailstock spindle operating cam, the spindle is returned by a spring, but does not carry the top-slide *E* with it until the arm *B* reaches the check-nuts *R*. By this time the regular cross-slide has withdrawn the tools from the work, thus clearing the machine for the finished piece to be severed from the bar by the cut-off blade *S*, held on the rear cross-slide.

The material from which this shaft is made is cold-rolled steel 1⅛ inch in diameter. The turning tools are operated at a surface speed of approximately 85 feet per minute, and finish the bar to the required diameter in one cut. The box-tool cutters when working alone, are advanced at a rate of 0.008 inch per revolution. The cross-slide tools when being fed in to the desired depth, receive a feed of 0.002 inch per revolution, and when the box-tool and cross-slide tools are working together, the rate of advance is 0.006 inch per revolution. The work is cut off with a feed of 0.004 inch per revolution. This shaft, which is 16 1/16 inches long, is completed in 5½ minutes. D. T. H.

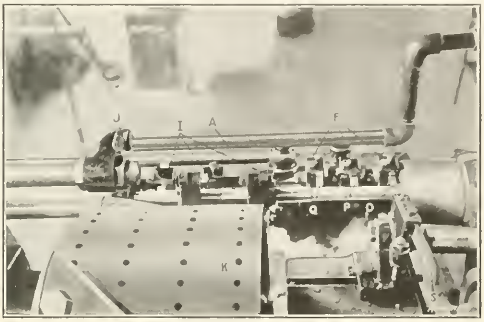

Fig. 3 Arrangement of Tools and of Adjustable Stop

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LARGEST TESTING MACHINE IN THE WORLD

The issue of the *Engineering Record* for September 28 contains an interesting description of what is believed to be the largest testing machine in the world. It was designed by Mr. Tinius Olsen of Philadelphia, and has a capacity of 10,000,000 pounds. The machine was built for the structural materials testing laboratory of the United States Geological Survey, which is now part of the laboratory of the Bureau of Standards, located in Pittsburg, Pa., and was placed in operation on September 12. At this time, a number of members of the International Association for Testing Materials were present to witness its operation, and among their performances, a square brick column twelve feet high and four feet on each side, was broken; a load of 6,580,000 pounds was required to complete this test. The machine is designed with a capacity for testing pieces up to 60 feet in length and the distance between tension screws, is 6 feet. These dimensions fit the machine for testing exceedingly large columns as well as slabs, and by placing an extension table on the lower platen, the largest beams may be broken.

A SEMI-AUTOMATIC SLOTTING FIXTURE

BY J. H. HARRIS

The fixture to be described in this article is used by the Remington Typewriter Co. for the rapid and economical slotting of the part shown in Fig. 5. The fixture is semi-automatic in its action. It is carried on a shaft driven by the back-gears of a milling machine and all the operator has to do is to place the work between the jaws as they come around. As the fixture revolves, the work is fed against the cutter where it is slotted; it is then carried on to the discharge point and dropped into a pan provided for the purpose.

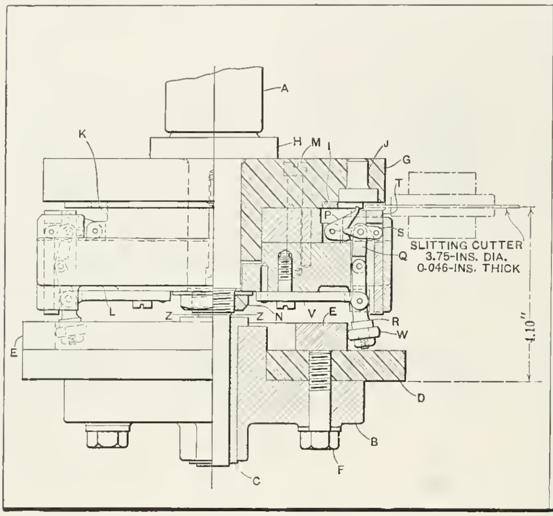

Fig. 1. Plan View of Slotting Attachment

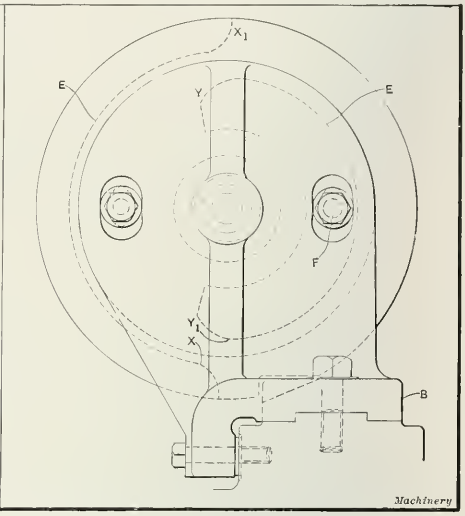

Fig. 2. End View, showing Arrangement of Cams and Bracket

In starting to give a detailed description of this fixture, reference is first made to Fig. 1 where a plan view is shown. Here it will be seen that the fixture is carried on the horizontal driving shaft *A*. This shaft is supported at its outer end by the bracket *B*, which is clamped to the table by means of three cap-screws, and equipped with a bronze-bushed bearing *C* that carries the shaft.

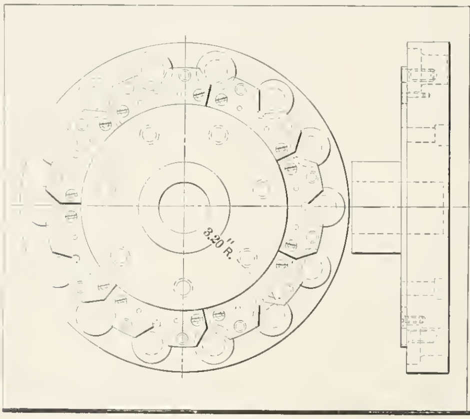

Fig. 3. Casting G, showing Method of Locating Work

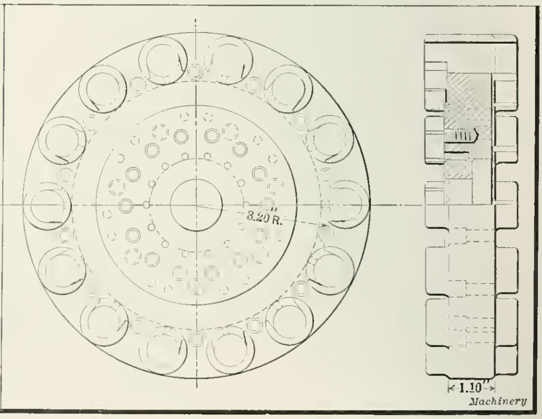

Fig. 4. Casting L, showing Holes for Clamps T

A machine steel plate *D* is secured to the inner face of the bracket and two cams *E* are carried by this plate. Two elongated holes are cut in the bracket through which the cap-screws *F* are passed to secure the plate *D* to the bracket. These elongated holes give sufficient play to the screws so that the cams may be adjusted to exactly the required position. The arrangement of the bracket plate and cams is clearly shown in Fig. 2. The work is located in V-blocks *I*, against hardened steel buttons *J* that are carried by the casting *G* shown in detail in Fig. 3. This casting bears against the shoulder *H* on the driving shaft.

The clamping mechanism is carried by two castings *K* and *L*, which are doweled together and screwed to the casting *G*, as shown in Fig. 1. These three castings are secured to the driving shaft by means of the nut and washer *N* which force them against the shoulder *H*. The casting *K* is shown in detail in Fig. 6, where it will be seen that there are fourteen lugs in which the clamping members *P* are pivoted.

Each clamp is operated by means of a pair of toggle jointed levers *R* and *Q* and a link *S*. As the link *S* is moved toward the back of the fixture it forces the sharp edge of the clamp *P* against the work. The opposite end of the link *S* engages with the clamp member *T* which slides in a hole in the casting *L*, as shown in Fig. 4. Each pair of clamping members *P* and *T* is thus forced simultaneously against the work by the action of the toggle levers, transmitted through the link *S*.

To explain the operation of the toggle levers, reference is made to Fig. 1, where one of the fourteen plates *V* that are screwed and doweled to the casting *L* is shown. These plates have a bearing at their outer ends in which the members *R* are pivoted. It will be apparent that any move- of the end of *R* will open or close the clamping members *P* and *T* on the work through the pivoted connections between these members and *S*, *Q* and *R*. The required movement of the end of the levers *R* is secured through the action of the rollers *W* on the cams *E*. Referring to Fig. 2, it will be seen that the rollers at the ends of *R* bear against the inner sides of the cam plate at the left of the fixture from *X* to X_1. This holds the clamps open until the point *Y* is reached; from this point to Y_1, the roller bears against the outside edge of the cam on the right and between these two points the clamps are closed.

It will be seen from this description that the work is placed in the fixture on the left hand side, where the clamps are open. It is then carried around to the right, where the clamps close before the work is fed to the cutter. The work is still held in the fixture until it has reached the point *X*. Here each successive clamp opens and drops its work into a pan conveniently placed for the purpose. As the operation of the fixture is continuous, it enables the work to be rapidly handled at a consequently low cost.

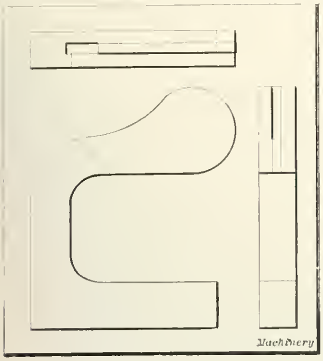

Fig. 5. Typewriter Part slotted as shown

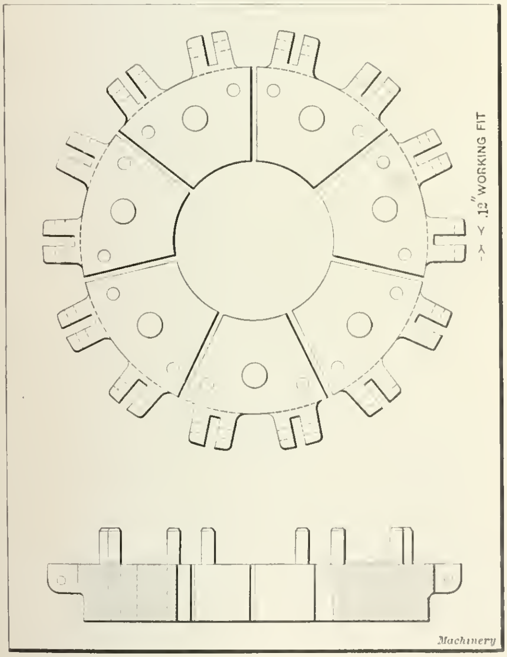

Fig. 6. Casting K, showing Method of pivoting Clamp P

* * *

Some interesting data is given in *Teknisk Tidskrift*, from a German source, of the large hydro-electric development at present being planned at Lyons, France. A dam is to be built across the Rhone which will produce a head of about 225 feet. The average amount of power that can be developed throughout the year is 350,000 horsepower. Present calculations indicate that it will be possible to deliver power from this development at the price of slightly less than one cent per kilowatt hour. It is planned to distribute the power over an area having a radius of between two and three hundred miles.

A PATENT OFFICE PARADOX

BY ROBERT MILLER

Much has been published recently about proposed changes in the patent laws of this country. Numerous statesmen have drafted bills to remedy the evils that have been apparent for years. All this proposed legislation deals, however, only with the scope of the patent, and not one single sentence attempts to correct the one crying abuse of the entire system—interference.

When an inventor has his first dealings with the patent law he imagines that, except for whatever may be revealed by a search, and patent office citations against his application, he is fairly secure in his possession of protection for that which his brain has conceived. Yet, should an interference be declared, he awakes with a rude shock. It may be proper to first explain the term "interference." An interference is a proceeding instituted for the purpose of determining the question of priority of inventions, between two or more parties claiming substantially the same patentable invention. This sounds simple, but in its amplified form it can readily be made the means of the rankest injustice. For instance, A has a patent which has been issued for some time; if B files an application for the identical invention, an interference may be declared, provided B's application is filed within two years of the date of issue of A's patent. If the subject of the patent is a very valuable one and B happens to represent a powerful corporation, A, being a private individual, may be unable to fight for his rights.

The proceedings in an interference may be very costly, and are as follows: A notice of interference is sent to each party by the examiner of interferences; each party is then required to set forth, under oath, all of the details and circumstances, with dates, regarding the invention. These affidavits must be filed with the examiner before a certain date, and are termed preliminary statements. The examiner then appoints a time when testimony may be taken by each party to establish his position. During these proceedings an applicant or his attorney may cross-examine witnesses.

All this, of course, takes time, and, being legal procedure, also considerable money. Any patent attorney, therefore, would much rather handle a nice, complicated interference, than half a dozen ordinary applications. It might be possible, under the two-year clause, for a powerful interest to have an application filed after the issue of a patent, copying it, line for line and word for word, and by means of false witnesses prove priority, and thus have the original patent nullified and a new patent issued to itself. Further, the patent office itself, by its complicated rules, does not help to simplify the matter.

The writer will now describe an actual case, using some of the phraseology of the patent office. In this case A applied for a patent on a device in March, 1910; except for a few trivial references cited against the application, it was a clear case, and the claims were allowed in May of the same year. Being in no hurry to have his patent issued, he allowed almost the legal six months to elapse before making his final payment of twenty dollars. The patent was issued in December, 1910. The patent received considerable attention in the trade press, as the device was of a type just then of considerable interest to the industry.

In August of the following year A received notice of an interference with B. The usual preliminary statements were filed, and it was learned that B had filed his application in July, 1909, almost a year before A had. The drawings and specifications showed that both were identical in so far as the idea of the device was concerned. The claims were different, yet any novice could see that here were two applications lying together in the same class and sub-class, for a patent of the same device. Yet, the patent office did not declare an interference at this time, but waited until after the issue of the patent to A.

An industry might have been organized on the strength of A's patent, which would have prospered for a short time, and which would then either have been forced out of business, or been obliged to pay B large royalties—all this after having obeyed the letter and spirit of the law, acceding to every requirement of the patent office and paying the just dues.

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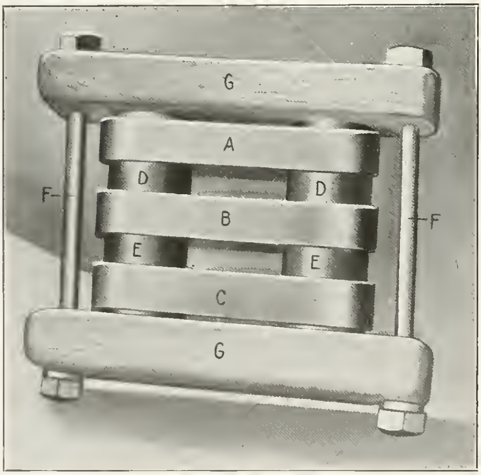
A direct appeal was made to the commissioner to explain this peculiar occurrence, asking why the interference had not been declared before the issue of the patent. The reply was that as the claims were different, "it was not proper to suggest A's claims to B." A case was then cited to the commissioner in which the office had suggested claims to both parties for the purpose of causing an interference. The reply to this communication quoted some obscure rule that was supposed to fit the case. The patent was, of course, granted to B as it should have been in the first place. For this same patent, therefore, two complete fees were paid, and to the man in the street it would seem as if there ought to be a refund. To a lawyer this would seem to be a square deal—with about ten thousand interferences a year the profession should prosper; to the man trying to improve things, it is discouraging.

* * *

A BUILT-UP LIMIT GAGE

At the shops of the New Departure Mfg. Co., Bristol, Conn., a type of limit gage is used by the inspectors that has the advantage of being easily kept in good condition. The illustration represents the general appearance of the gage.

The openings in the gage are the spaces between plates *A* and *B* and *B* and *C*. The space between *A* and *B* is regulated by size blocks *DD;* in this particular instance the size blocks are 0.4999 inch. The opening between *B* and *C* in this gage is regulated by size blocks *EE* which are 0.5001 inch in thickness. The strips *A*, *B*, and *C* may be of any convenient thickness and, of course, they are hardened and the gaging surfaces are ground and lapped. The important parts of the gage, parts which regulate its accuracy, are the size blocks *EE* and *DD*, which, of course, must first be very carefully ground and lapped to size. After the size blocks have been placed between the gaging strips, small disks are applied to the outside of the strips *A* and *C* and the entire built-up gage is clamped together by bolts *FF* which pass through wooden strips *GG*. The object of the wooden strips is to provide a means for handling, without affecting the accuracy of the gage by the heat of the hand.



A Built-up Limit Gage

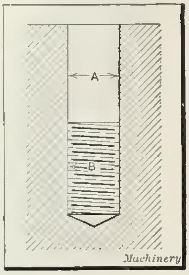
To maintain the accuracy of such gages it is only necessary from time to time to release the tension upon bolts *FF*, remove strips *A*, *B* and *C*, and regrind and relap the four gaging surfaces. It is not necessary to touch the size blocks as no wear comes upon their surfaces. C. L. L.

* * *

When cold-rolled stock is used, an allowance must be made in the bore, as this stock comes exactly to size or a trifle over size. When turned shafts are used, the bore should always be made standard, and the allowance made in the journal.

THE SCREW THREAD STANDARDS

Since a few years ago when the tap makers agreed to start a campaign against the sharp V-thread, the use of this form of thread has steadily diminished. Some of the tap makers, however, state that they still make as much as forty per cent of their taps with V-threads, while others make only from thirty down to ten per cent of their total production with this kind of thread, the remainder being the United States standard. An interesting reason given for the continued use of the V-thread by one of the largest machine tool building firms in the country, is that a V-thread tap permits the tapping of the bottom of a counterbored hole with the same diameter thread as the diameter of the counterbore. In the accompanying illustration the diameter of the counterbore *A* and of the thread *B* is nominally the same. When a sharp V-thread tap is used, of correct angle diameter, it will not be over the standard size on the outside diameter, on account of the small flat necessarily provided on the top of the threads. It can, therefore, enter the counterbored hole and tap the thread without scratching or marking the sides of the counterbored hole, which, in many cases, is required to be a good fit for the stud entering into it. If a U. S. standard thread tap were used, instead, the outside diameter of this tap would ordinarily have to be a certain amount over size, and hence, it would scratch or mar the counterbored portion of the hole when entering. To avoid this, most designers have been in the habit of making the counterbore larger in diameter than that of the threaded portion, but this, of course, necessitates a shoulder on the stud and a larger diameter of stock. It would seem, however, that the condition mentioned would be met with in machine design so seldom, comparatively speaking, that it should not be necessary to maintain two standard screw threads on this account. The committee appointed by the American Society of Mechanical Engineers to investigate into allowances and working limits for the U. S. standard thread, will probably take up this question and suggest some means of overcoming the difficulty even when a U. S. standard thread is used. It is not desirable to have the two thread forms continued side by side, especially since—as has been repeatedly pointed out in these columns—there is no accepted standard dimensions for the sharp V-thread, the different manufacturers making taps with this thread to different standards or gages.



A Condition where the Sharp V-thread has shown Advantages over the U. S. Standard Thread

There may be cases where the U. S. standard thread is not the best one for the purpose, but they are comparatively few. One is staybolt taps which are being more and more generally made with a Whitworth thread on account of the decreased tendency of the staybolts to break when this thread is used. On account of the unequal expansion of the side sheets, the staybolt is bent back and forth, and if there is a sharp corner at the bottom of the thread, as in the case of the U. S. standard or the V-thread, a crack is more liable to develop than when the bottom is rounded, as in the case of the Whitworth thread.

The A. S. M. E. standard for machine screws seems to gain ground rapidly. Some tap makers state that they make nearly all their machine screw taps according to this standard, while others still make from thirty to fifty per cent of the old V-thread standard. There is a tendency among the larger concerns to adopt the A. S. M. E. standard exclusively, while the smaller concerns, to whom the expense for new gages is more serious, still retain the old standards. It would be a great advantage to the tap and screw makers, as well as to the mechanical trade in general, if the old standards could be entirely eliminated. It would seem possible for the tap makers to agree to make the old standard thread only to order, and to charge a higher price for taps with this kind of thread so as to discourage the use of the V-thread on both the machine screw sizes and on larger dimensions of screws and taps.

DESIGNING A HOB FOR HOBBING SPUR GEARS*

DETERMINING THE THREAD SHAPE, NUMBER OF FLUTES, AND GENERAL DIMENSIONS

BY JOHN EDGAR†

A reader of MACHINERY has requested information regarding the design of a hob to cut spur gears. The gears to be cut are cast-iron, and have 120 teeth, 16 diametral pitch and ⅝ inch width of face. The pitch diameter, hence, is 7½ inches. The hole in the hob for the spindle is to be 1¼ inch in diameter with a ¼-square inch keyway, the hob to be run at high speed.

The first thing to be settled is the form and dimensions of the tooth or thread section of the hob. If the form is to be the standard shape for the involute system with a 14½-degree pressure angle, the dimensions of the hob tooth would be as shown in Fig. 1. A modification of this shape may in some cases be advisable, and will be referred to later in this article. The standard rack-tooth shape with straight sides, as shown in Fig. 1, however, is the easiest to produce, and unless gears with a very small number of teeth are to be cut, it is entirely satisfactory.

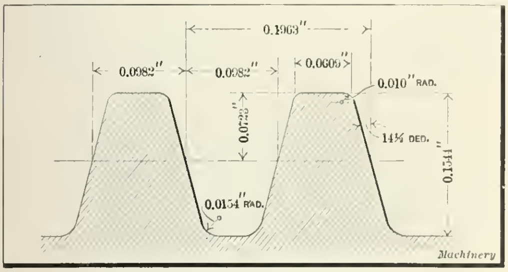


Fig. 1. Standard Hob Tooth Dimensions

The circular pitch corresponding to 16 diametral pitch is 0.1963 inch which is obtained by dividing 3.1416 by 16. The thickness of the tooth on the pitch line is one-half of the circular pitch, or 0.0982. The height of the tooth above the pitch line is equal to the reciprocal of the diametral pitch plus the clearance, which latter is equal to 0.1 of the thickness at the pitch line. Hence, the height of the tooth above the pitch line equals 0.0625 + 0.0098 = 0.0723 inch. This distance equals the space in the gear below the pitch line.

The depth of the tooth of the hob below the pitch line is usually made greater than the distance from the pitch line to the top of the tooth. The extra depth should be equal to from one-half to one times the clearance. On small pitches, one times the clearance is not too great an allowance, and, therefore, the depth below the pitch line is made equal to 0.0723 + 0.0098 = 0.0821, making the whole depth of tooth equal to 0.1544. The extra depth at the root of the thread is to allow for a larger radius at the root, so as to prevent cracking in hardening. The radius may then be made equal to two times the clearance, if desired. In the illustration, however, the radius is made equal to 0.1 of the whole depth of the tooth. The top corner of the tooth is rounded off with a corner tool to a radius about equal to the clearance, or say 0.010 inch. This corner is rounded to avoid unsightly steps in the gear tooth flank near the root. Having obtained the hob tooth dimensions, the principal dimensions of the hob may be worked out with relation to the relief, the diameter of the hole and the size of the keyway.

The proper relief for the tooth is a matter generally decided by experience. We may say that, in general, it should be great enough to give plenty of clearance on the side of the tooth, and on hobs of 14½-degree pressure angle the peripheral relief is, roughly speaking, about four times that on the side. For cutting cast iron with a hob of the pitch in question, a peripheral relief of 0.120 inch will give satisfactory results; for steel, this clearance should be somewhat increased. The amount of relief depends, necessarily, also upon the diameter of the hob.

With a peripheral relief of 0.120 inch, the greatest depth of the tooth space in the hob must be 0.1544 + 0.120 = 0.2744. The gash will be made with a cutter or tool with a 20-degree included angle, 3/32 inch thick at the point, and so formed as to produce a gash with a half-circular section at the bottom. The depth of the gash should be 1/16 inch deeper than the greatest depth of the tooth space, or about 11/32 inch.

The radius of the hob blank should be equal to 5/8 + 1/8 + 11/32 + the thickness of the stock between the keyway and the bottom of the flute. If we use a 3-inch bar we can turn a hob blank 2¾ inches in diameter from this, which would allow sufficient stock to be turned from the outer portion of the bar to remove the decarbonized surface. If we make the blank 2¾ inches in diameter we have 9/32 inch of stock over the keyway, which is sufficient.

The number of gashes or flutes depends on many factors, some of which have been previously discussed in MACHINERY. (See the article "How Many Gashes Should a Hob Have?" in the January, 1909, number.) In Fig. 2 is shown an end view of a hob with twelve gashes. This number gives plenty of cutting teeth to form a smooth tooth surface on the gear without showing prominent tooth marks. A larger number of gashes will not, in practice, give a better tooth form, but simply increases the liability to inaccuracies due to the forming process and to distortion in hardening. This number of gashes also leaves plenty of stock in the teeth, thus insuring a long life to the hob.

The question whether the gashes should be parallel with the axis or normal to the thread helix is one that is not easily answered. It must be admitted that when the angle of the thread is great, the cutting action at both sides of the tooth is not equal in a hob with a straight gash; but in cases of hobs for fine pitch gears, where the hobs are of comparatively large diameter, thus producing a small thread-angle, the parallel gash is more practical because it is much easier to sharpen the hobs, and the long lead necessary for spiral gashes, in such cases, is not easily obtained with the regular milling machine equipment. However, when it is desired to obtain the very best results from hobbing, especially in cutting steel, the gash should be spiral in all cases when the thread angle is over 2½ or 3 degrees. In our case the thread angle figured at the pitch diameter of the blank is equal to 1 degree 22 minutes; hence, straight flutes are not objectionable.

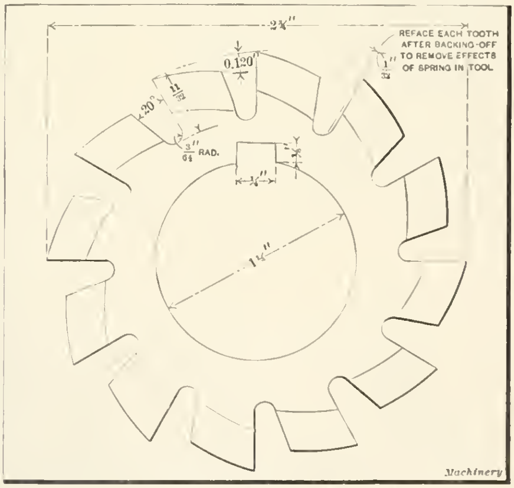

2¾"
REFACE EACH TOOTH AFTER BACKING-OFF TO REMOVE EFFECTS OF SPRING IN TOOL
1/32"
0.120"
20°
11/32
3/64" RAD.
¼"
1¼"
Machinery

Fig. 2. Hob with Twelve Gashes or Flutes

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* See also MACHINERY, July, 1912, "Hobs for Spur and Spiral Gears," and the articles there referred to.

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The linear pitch of the hob and the circular pitch of the gear, when considered in action, are to each other as 1 is to the cosine of the thread angle. In the present case they do not differ appreciably and may be considered as equal. In cases where the difference is over 0.0005, the true linear pitch should be used.

The change-gears for the lathe may be figured by the formula:

$$\frac{\text{Gear on lead-screw}}{\text{Gear on stud}} = \frac{\text{lead of lead-screw}}{\text{linear pitch of hob}}$$

On a lathe with a lead-screw of six threads per inch, or a lead of 1/6 or 0.1667 inch, the gears that would give accurate enough results for the present hob would be 28 teeth on the lead-screw, and 33 teeth on the stud.

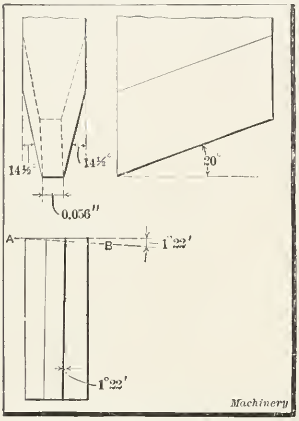


Fig. 3. Threading Tool for Hob

In Fig. 3 is shown the hob thread relieving tool. The front of the tool is relieved with a 20-degree rake for clearance. The sides are ground straight at a 14½-degree angle to form the sides of the thread, and are at an angle of 1 degree 22 minutes with the vertical to clear the sides of the thread. A tool made like this can be sharpened by grinding across the top without losing its size or form. If the gashes were made on the spiral, the top of the tool should be ground to the angle of the thread, as shown by the dotted line *AB*. In cases where the angle of the thread is considerable, the angle of the sides of the tool must be corrected to give the proper shape to the hob tooth. (See MACHINERY, May, 1905, or MACHINERY'S Reference Book No. 32, "Formula for Planing Thread Tools.") The point of the tool should be stoned to give the proper radius to the fillet in the bottom of the hob tooth space.

The best practice in making the hob is to anneal it after it has been bored, turned, gashed and threaded, the annealing taking place before relieving the teeth. Before hardening, the hob ought to be re-gashed or milled in the groove, removing about 1/32 inch of stock from the front side of the tooth to eliminate chatter marks and the effect due to the spring in the tool, which always leaves the front edge of the teeth without relief. In hardening, do not attempt to get the hob too hard, as the required high heat and quick cooling would distort the teeth badly.

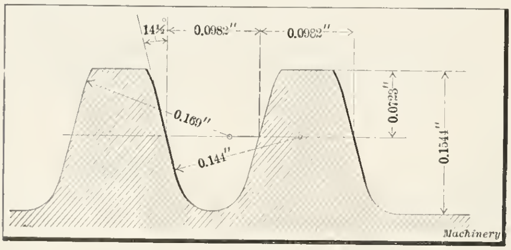


Fig. 4. Special Hob Tooth Dimensions

In case the 120-tooth gear is to run with a pinion of a small number of teeth and is the driver, as in small hand grinders where gears of this size are often used, it would be advisable to make the tooth shape as shown in Fig. 4. This shape will obviate undercutting in the pinion and relieve the points of the teeth in the gear so as to obtain a free-running combination. This shape is more difficult to produce and requires more care in forming. If the hob is made of high-speed steel, it should run at about 115 revolutions per minute for cutting an ordinary grade of cast iron with a feed of 1/16 inch per revolution of the blank. The feed may be increased considerably if the gear blank is well supported at the rim. The best combination of speeds and feeds in each case can be found only after considerable experimenting.

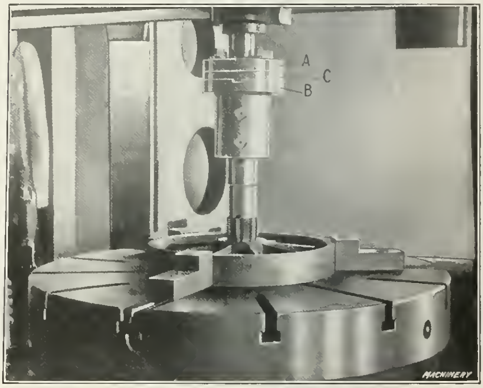
* * *

METHOD OF TAPPING FACEPLATES ACCURATELY IN A BORING MILL

At the New Haven Mfg. Co., New Haven, Conn., an interesting application of the familiar "Oldham" coupling is made use of in tapping the spindle holes of faceplates. Formerly considerable trouble was experienced when tapping faceplates, because if the work was not located exactly true with the boring machine spindle the tap would invariably cut large. By using the coupling shown in the illustration, trouble from this source has been overcome.

The upper half *A* of the coupling is held in the boring machine spindle and the lower half *B* supports the tap. Both these parts have on their inner faces shallow rectangular slots approximately ¼ inch deep by 1½ inch wide. The central part *C* of the coupling has on its upper face a tongue to fit the slot in the upper half and on its lower face a tongue is provided at right angles with the one on the upper face fitting in the slot in the lower half of the coupling. Four large cap-screws are provided which are threaded into the lower half of the coupling but pass through enlarged holes in the central and upper halves of the coupling. These screws serve merely to hold the parts together and do not prevent the parts of the coupling from adjusting themselves while the tapping operation is being performed. With this fixture the tap quickly finds a central location in the faceplate and the result is that the holes are quickly and accurately tapped.

C. L. L.



Tapping Faceplates in a Boring Mill

* * *

A Bureau of Mines paper states that all commercial explosives owe their power of doing work to the expansive force of the great volume of gas evolved from them at the moment of explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases: 40 per cent dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given above.

MOLDING DIES FOR FIBER INSULATION

BY EVERETT CHIPMAN*

The black fiber insulations shown in Fig. 1 are formed in molding dies which it is the purpose of this article to describe. The stock consists of fiber tubes which are made by rolling material of the thickness of paper on iron bars. During the rolling process, heat is applied in such a way that the material, which consists of pulp from wood fiber, is joined together to form a solid tube. The tubes are received in lengths of about 3 feet, and of varying diameters; they are sawed up into blanks of the right size for the different insulations and are then transferred to the forming presses.

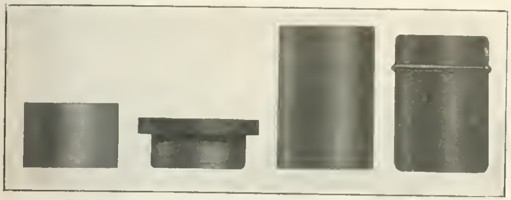
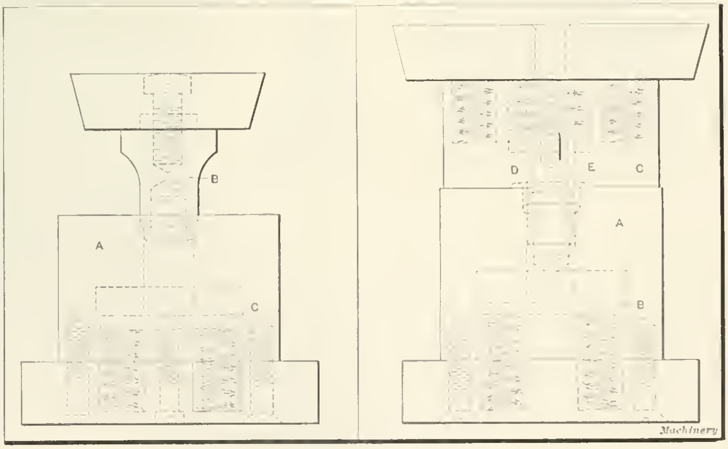


Fig. 1. Blanks and Fiber Insulations formed from them

Fig. 2 shows the punch and die used for molding the insulation shown at the left-hand side in Fig. 1. In this operation the shoulder is formed at the top and the lower edge is rounded at the same time. During this forming process the pressure applied causes a certain amount of shortening to take place; consequently it is necessary to allow enough extra on the length of the blanks to make up for this compression. The blanks are fed into the die by hand.

Reference to Fig. 2 will make the design of the punch and die used for this operation readily understood. *A* is the mold or form in which the outside of the blank is shaped. *B* is the plunger which is fastened to the head block of the press. *C* is the stripper for the form *A*; *C* also acts as a locating plug and forms the radius on the lower end of the blank. The plunger *B* has a recess into which the central stud of *C* enters as the press descends. The work is then formed in the space left between the mold *A*, the punch *B* and the locating plug *C* on the stripper, after the stripper has been pressed down to its lowest position. When the forming operation is completed, the finished blank is ejected by the action of the springs under the stripper. The finished insulation is held on the central plug of the stripper when the plunger has reached the top of its stroke, and can be readily removed with a fork-shaped piece of metal which lifts it off by means of the shoulder. This mold is used in a press having a ½-inch stroke and the work is produced with a variance of only two or three thousandths of an inch.

Fig. 3 shows a rather more complicated punch and die which is used for forming the insulation shown at the right-hand side in Fig. 1. This die represents the result of about three months experimental work during which time a number of methods were tried out and discarded.



Figs. 2 and 3. Punches and Dies used for Forming Insulations shown in Fig. 1

In forming this insulation both the upper and lower edges are rounded and a shoulder is formed on the side as shown. It was the method of forming this shoulder which constituted the difficult point in designing the punch and die. The following notation has been adopted in Fig. 3 for refering to the different parts of the punch and die. *A* is the mold; *B*, the stripper for the mold; *C*, the punch; *D*, the stripper for the punch; and *E*, the central or locating plug. It will be noted that in this case the locating plug is carried by the punch stripper instead of by the mold stripper as in the preceding case.

The blanks formed in this mold fit into the recess in the die and rest on top of the stripper. The die is bored out to the outside size of the shoulder for a depth of about ¾ of an inch, and there is an annular ring on the punch which comes down and fills the space between the outer wall of the blank and the outer diameter of the recess in the die. The lower edge of this ring is rounded and with the base of the counterbore in the die forms a semi-circular cavity in which the shoulder is formed. As the punch descends the central pin locates the blank and then enters the recess in the mold stripper which has been provided to receive it. The blank holds the two strippers apart against the tension of the springs until each stripper has reached its stop. The pressure is then increased, and since the only relief is in the ring at the point where the shoulder is formed, the fiber gives at this point and conforms to the desired shape. The punch and die stripper are of such a form that they round the corners at the top and bottom of the insulation as shown. During the return stroke of the press the strippers force the bushing to leave both the punch and die, and the finished work is left on the lower end of the locating pin, from which it can be readily removed.

During both of these forming operations there seems to be a slight movement between the layers of material in the blanks. The finished work, however, is perfectly compact, and if such a movement does take place it is probable that the heavy pressure of the forming operation generates sufficient heat to reunite the layers before the operation is completed. In each case the use of these dies has meant a great saving over the former method, which was the use of a molded paste composition for the smaller and screw machine work for the larger piece. The press method also produces more accurate work with less breakage.

* * *

WHAT IS SPACE?

In a paper on the fourth dimension, published in the *Polytechnic Engineer* for 1912, William J. Berry states that a serious difficulty presented in discussing mathematical subjects is the variety of meanings attached to words. A word may have one meaning to the physicist, another to the mathematician, and still another to the man in the street. "The average layman thinks of space, if indeed he thinks of it at all, as a huge box or hollow sphere in which all things lie—a sort of frame for the material universe. This idea is crude and vague. . . . . . Space is an idea caused by the perception of simultaneous groups of phenomena. Space is not a phenomenon or a group of phenomena, though without phenomena there can be no idea of space." The idea of space is subjective, and is distinguished in three forms, *i. e.*, visual space, tactual or feeling space and motor or traveled space.

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ACTION OF PEENING STRAINS IN A CAST-IRON BENCH PLATE

BY DOUGLAS T. HAMILTON*

A cast-iron bench plate was recently brought to the Cleveland Machine Tool Co., Cleveland, Ohio, for machining, which was sprung out of shape, being 3/16 inch high in the center lengthwise and 1/8 inch high crosswise. This bench plate, which is shown in Figs. 1 and 2, is 7 feet long by 3 feet wide, the plate portion being 1½ inch thick before machining.

To straighten this plate, it was carefully clamped to the planer table, and a 3/16-inch cut taken over its entire surface. After taking this cut, a straightedge was placed on the plate which to the astonishment of the operator was found to be 3/16 inch low in the center. The supports under the center portion of the plate were held so tightly that they could not be moved, while the supports under the ends were loose. Another 3/16-inch cut was then taken and when the straightedge was applied, the plate was found to be 1/32 inch high in the center. A 1/32 inch cut was then taken, the straps released a slight amount and a final cut about 1/64 inch removed, which brought the surface of the plate back to a true plane.

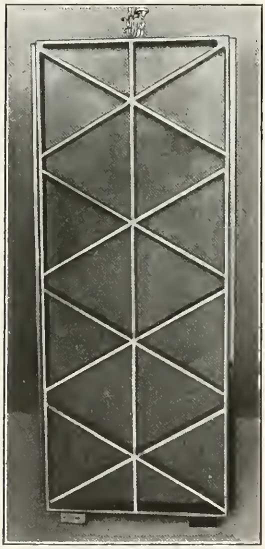

Fig 1. View of Bench-plate showing Triangular Ribbing

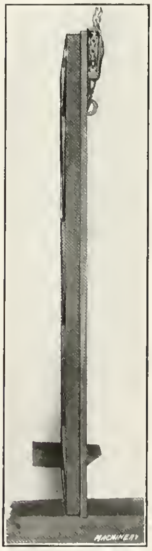

Fig. 2. Condition of the Plate after Machining

In clamping, particular care had been taken not to spring the plate, so that the action just mentioned cannot be due to that cause, and as is evident in the illustration Fig. 1, the plate was well ribbed and supported. The only conclusion which can be drawn from this peculiar action of springing, is that the plate had been used more in the center than at the ends, and that the surface had become stretched and hardened due to the continued peening action caused by hammering and placing work on it. Then when this hard scale was removed, the plate returned to its normal state—the fibers straightening out—this action being similar to that which takes place in a rod of cold-rolled steel, when only a portion of it is machined.

It is reasonable to assume that this same condition exists to a slight extent in a planer table which has been subjected to considerable use and abuse. The action of this plate also shows that extreme care is necessary in handling work on a planer table; it should not be used either as an anvil or a straightening plate, but simply as a means for holding the work while machining. Another point brought out by the action of this plate is that one cut cannot be relied upon to straighten a surface when it has become sprung. Some mechanics, when they get a job to do on the planer which must be accurate, put a broad tool in the holder and take a skin cut from the platen, thinking that by so doing they are producing a true plane. The fact of the matter is that in nine cases out of ten they have only partially relieved the strain and inaccuracy, especially if the planer has been in use for some time and has received rough usage. After taking a cut, the truth of the table should be proved with a dial test indicator held in the tool-holder, and it is generally advisable to take two cuts instead of one, that is, if the table is not sprung much, the dial test indicator being used to ascertain when the table has been brought back to a true plane.

* * *

THE INSPECTOR

BY JOHN F. WINCHESTER*

Writers in mechanical magazines often dwell on the importance of inspection systems and their relation to modern shop practice, but they seldom mention the qualifications necessary for a man to suitably fill the position of inspector, or the training that a man receives by occupying one of them. When it is considered that the keystone of success in many of our large manufacturing establishments is the inspection system, it can be seen that the human element should receive no small amount of consideration.

The requirements necessary for a man to fill satisfactorily the position of inspector vary with the concern for which he works and with the work to be done. In some factories there are inspectors who do nothing but measure duplicate parts; this particular branch of inspection can be filled by specialists with little training. In these same factories, however, there are inspectors who pass upon the final product. These men are held strictly responsible for the satisfactory operation of the product, and fill highly responsible positions.

Since the advent of the automobile, there has been a demand for another class of inspectors who are to pass upon all material that is to be used in the process of manufacture. These men test the material from the steel and iron mills and foundries, to ascertain if it meets with the required specifications. They are chemists or metallurgists, and generally have a college education or special training in that particular branch. This field is not closed to the shop-trained man, however, for with the correspondence schools, and with special courses in the engineering schools that now abound, it is within reach of him.

A man who had been promoted to an inspector was asked how he liked his new duties. He answered, "At its best, it is a thankless faultfinding position." This man did not possess the tact or proper ability to successfully fill his position and was mistaken in his estimate of it. It is not faultfinding when an inspector endeavors to detect the possible mistakes of others and report them to his superior, in order to prevent inferior goods from being produced.

The concern which employs the grades of inspector before mentioned usually has a chief inspector whose duty it is to oversee the inspection system and decide all important matters relating to it. This man must possess good mechanical training, have a decided, but not too aggressive, manner of passing on questions, and have an absolute knowledge of the details of the work being inspected.

The advantages of holding a position of inspector are numerous. He has a chance to learn by the mistakes of others, and meets with many perplexing problems, the solving of which gives him good training. He also enjoys the association of those higher up; associations count in any line of work, and the inspector, through being in contact with the executive heads of the establishment, is always in line for future promotion. Have we not here one of the ideal positions in a machine shop? I say "one of," for with the difference of opinion that always exists as to an ideal, I dare not put it stronger. It is one to which the apprentice with his boyish ambition may attain, and one which the elderly man who has held positions of greater responsibility, but with whom fortune has not dealt kindly, can accept and yet retain the dignity that he has acquired through his years of service.

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EXPORT TRADE*

SOME OF THE CONDITIONS AFFECTING THE FOREIGN MACHINE TOOL BUSINESS

In no line of exports has the American spirit of ingenuity and invention proved itself greater than in the machine tool line. It is a field in which our conditions of labor made it especially necessary to invent machines to take the place of hand workmen. Following the Civil War there was a particular growth in machine design, and in 1876 the Centennial Exhibition at Philadelphia showed something of this new line of work. Up to this time a few of the manufacturers had been exporting in a quiet kind of way, had done a good deal of business, and had earned for American tools a reputation that was a desirable one. Greater developments in design came about, until seventeen years later at Chicago we had a magnificent showing of machinery that was instructive to ourselves as well as to the foreigners who came in great numbers. The best of the engineering ability not only visited the exhibition, but visited our shops and were received with open arms. Progress had been made in foreign countries, but not to the extent that was shown in America, and after the exhibition we had a very voluminous trade. Be it said to the honor of the machine tool builders that most of the material that went abroad was material that stood upon its merits and added to the reputation that our tools had already attained abroad. There were, unfortunately, some cases where unprincipled advantage was taken of the opportunity, but the great majority of the manufacturers seemed to appreciate the real value of the opportunity.

Since that time our foreign friends have no more stood still than have we, and in the reports obtained from those who visit the foreign market to study conditions we get confirmation of what we see with our own eyes when visiting these countries—that designs are constantly improving, and that the workmanship is approaching that which we furnish from this side. That we are copied to a greater or less extent may be sincere flattery, and while we can accept as a fact that a copy can be but second best, it is dangerous from a commercial standpoint for the reason that many are persuaded that it is as good; and the lower price that can be quoted by reason of the elimination of designing and experimental costs, to say nothing of difference in wages, adds to the difficulties in competition.

Neither our own nor any other country can or should have all of the business in machine tools. As our lines develop, there is no question but that one foreign country may excel another and ourselves in a given line of development, and when such a fact is realized, we should be as open-minded and as ready to purchase as we are to desire others to consider and purchase from us.

As a people we sometimes pride ourselves on our business spirit. So much have we talked about it that some of our foreign competitors have become so imbued with the fact that they call us not only aggressive, but egotistical, tricky and even brutal in competition. We admit we try to be aggressive, denying the remaining allegations as being too strong, but when we study the methods of some of our foreign competitors in working for export trade, we wonder if we are aggressive even, and our wonder increases as we compare foreign exports with our own. Are we inspired with the possibilities before us, and willing to add perspiration to inspiration?

Export business is no different from any other business in its principles. In our domestic trade there is no lathe nor milling machine tool builder who does not take such steps to sell his goods as will cause them to be purchased rather than the goods of a competing lathe or milling machine manufacturer. In such a case the manufacturer studies the market, and does what he considers is necessary to interest the prospective customer. In export business, instead of dealing with a neighbor who lives within a comparatively short distance of us, speaking the same language and living in the same general atmosphere of business and social conditions, we are dealing with customers who, except in the case of the English, speak another language, and all of whom live under conditions of life and are inheritors of business principles and methods that differ from ours.

What do we do to get domestic business? We try to get designs that are satisfactory and for which there is or can be secured a demand. We try to offer workmanship that is of a high order, and if we have competitors who have equally good designs and present equally good workmanship, we sometimes feel that by manufacturing more cheaply we can sell more cheaply, and thus obtain a market.

To sell goods abroad there are different courses open. The sales can be effected through agents who will act as representatives, through direct travelers, or through general agents who are but little more than commission merchants. There are representatives and representatives. If you sell through a representative that is thoroughly in sympathy with you, who will work for your interests, and who will represent you alone in your line, you are in a position to reciprocate and work for him. Such a representative must be taken into your confidence; you must listen to his requirements, and while it is by no means possible to grant all of the requests that he might make, it is possible to obtain from him suggestions that will help you in obtaining a share of the business that you are seeking. When selling through such a representative you are dealing with a concern that knows the people with whom it deals, knows their peculiarities, and can more readily make a trade than could a direct representative.

To think of sending a direct representative who cannot speak the language is so far from anything that any of us would do that it is hardly necessary to discuss this feature of the question; but given one who understands the language, he has to meet, as a direct representative, conditions that it is not easy for the home people to understand, so that it almost precludes this form of representation. When, however, you second the efforts of your representing agents with the services of a direct representative, results are oftentimes obtained that show that such services are an imperative necessity. This element is one that cannot call forth positive rules. If your machine is a type of special machinery, the need is far greater than when it is a type of standard machinery, and where to draw the line is a matter of opinion.

When goods are sold abroad through representatives, it is imperative that the house selling should have first-hand knowledge of conditions existing in their foreign trade. Your agents will write until they are black in the face, and get no response from you, when—did you but know a little of what they are contending with—one letter would have sufficed to place matters in order.

We all have something of an idea of what it means to have our literature in the language of the people that are to use the goods. Yet while we spend large amounts of money on our domestic business—on circulars and all kinds of printed material—we are apt to hesitate at printing in a foreign language when we are looking for the export business. This also brings up the matter of correspondence. Are we as apt to be as prompt in answering our foreign correspondents as we are our domestic friends, especially if the latter are not more than a hundred or two hundred miles away? Are we not a little apt to think, "Well, he has been waiting for ten days, a day or two more will make no difference," rather than to think, "He has been waiting for ten days, and how tedious it must be to have to wait another ten days; therefore this letter will be answered ahead of our New York letter." As a general rule do we watch the sailings of the mail ships as closely as the foreigner and attempt to make certain that given letters and documents reach New York in time to make the best connections?

Have not some of us felt the export business was a splendid thing in bad times, but a nuisance in good times? Have we not been rather apt to give, not a *just* delivery to our foreign friend, but to give him the delivery that was left over after our domestic friends were taken care of? When we are called upon to put up some special form of packing to meet certain conditions, do we not feel that our representative is perhaps a little over particular, if not cranky, and make him feel that what is good enough for us is good enough for him, rather than to attempt to judiciously follow his wishes? Do we visit our representatives or have them visit us so often that we can talk over the things that are going on and become more closely allied? If we do, we are backing up our representative as thoroughly as we are backing our own salesman on our own ground, but if we do not we are merely playing with our foreign business.

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* Abstract of paper read by Mr. W. A. Viall of the Brown & Sharpe Mfg. Co., Providence, R. I., before the National Machine Tool Builders' Association Convention in New York City, October 16, 1912.

The United States is not the only country that has customs' regulations. We find that foreigners take the utmost pains to conform to our American customs' requirements when exporting goods to this country; but when we export to their country, are we not rather apt to consider it more or less of a nuisance to carry out in detail the requirements of those countries, and work half-heartedly, with the result that the receiver of our goods abroad is put to such trouble that he will prefer to buy from the foreigner who meets him, rather than from the American who holds off?

In the case of the foreigner we find that he goes into neutral territory, and we are informed that he will give precedent to the foreign over the domestic business. While this may be hard on his domestic customer, yet there is a national feeling at times that makes him think that he can handle his home trade rather differently from his foreign trade, to the advantage of his home trade, on the theory that he is building up his nation. Our country has not been noted, in the machine tool business at least, as being willing to use foreign countries as dumping grounds of our manufactures in the way of prices, charging all of the overhead expense to the domestic trade, and figuring the prices of the export at flat labor cost without overhead charge, but this is a thing that we are meeting in competition with foreign countries.

Wages are an important element in cost, but they are not standing still abroad. There are those who want to see lower tariffs, which will mean lower cost of living and lower wages, and then perhaps there will be a competition that will be carried forward on a basis we have not yet been able to attain, and many of us hope we shall not attain.

We have one difficulty in getting into European markets that our European competitors do not have, in that we have a great distance to travel, and this oftentimes prevents our sending men, and lessens the number of visitors—conditions which do not prevail among European manufacturers. When the South American and the Far Eastern markets are considered, however, the Europeans have as far to go as we have.

Many of us are of English descent and have inherited some of the English traits. The matter of language is one of them. How often we hear the American saying that the English language is good enough for him and let the other fellow learn English. When we go abroad, however, we find everywhere people that are speaking English. Most of us are acquainted with the young men who come to America for the main purpose of learning English (and, incidentally, to learn some of our methods), and then in turn become the men who are doing business. A knowledge of foreign languages is not an absolute necessity for the export business, but it is certainly one of the advantages that those who possess it have. We would do well to consider whether it would not pay to send more of our young men over, if for nothing more than to acquire one or two of the languages of countries where we want to do business.

If we follow closely the publications of other countries, we find in some of them indications of a spirit of cooperation not always evident in our own country. One of the purposes of our association is to draw together manufacturers so that we can act as a whole, so that we can go forth as a body of American manufacturers rather than as individuals—and results have already appeared in this direction.

In the year 1911 the United States exported to Italy, in metal- and wood-working machinery, 1,000,000 kilograms, and to Germany 6,000,000 kilograms; in 1910 America exported machinery into Switzerland to the value of 500,000 francs and into Germany to the value of 4,000,000 francs; and in 1909 America exported into France machinery to the value of 45,000,000 francs and into Germany to the value of 110,000,000. Considering these figures, is it not time that we carried into effect as individuals, and, when necessary, as an association, that attention to the requirements and desires of the foreign customer that we are giving to our domestic customer every day? In view of the figures quoted, it goes without saying that we must constantly maintain the highest standard of design and workmanship. But beyond this, what is the matter with our American export trade? Are our goods not fitted to the foreign market, or are they not properly presented to the buyer, or are the prices too high?

* * *

MAKING HINDLEY WORM-GEARING AT THE BROOKLYN NAVY YARD

When a battleship is in action it is sometimes necessary to revolve the gun turrets very quickly in order to train the guns or locate them in the proper radial position. Owing to the weight of the guns and their inertia, the mechanism for revolving the turret must be very strong and powerful to withstand the sudden shocks incident to the rapid movements which are occasionally required. The turret rotating mechanism that is applied to battleships now being built in this country consists of two motors connected to a differential gearing from which power is transmitted to the turret through Hindley worm-gearing and a pinion engaging an annular rack attached to the turret base. When both motors are operating at what might be called the normal speed, the differential gearing and turret remain stationary, but by varying the speed of either motor the turret is caused to revolve, the direction of rotation being controlled by running one motor or the other faster than the normal speed. The Hindley worm-gearing is an important part of the turret controlling mechanism, at least from the shop man's viewpoint, because gearing of this type is rather difficult to make accurately, especially in the large sizes required for the purpose mentioned.

The accompanying illustrations, Figs. 1 and 2, show a simple method of producing these large gears, which is employed at the Brooklyn Navy Yard. An ordinary lathe equipped with a special attachment is used for machining both the worm and worm-wheel. Fig. 1 shows how the worm is threaded, and Fig. 2 illustrates the method of hobbing the worm-wheel teeth. The worm is made of steel and has a pitch diameter of 10 inches, whereas the wheel is made of phosphor-bronze, has a pitch diameter of nearly 36 inches, and a circular pitch of 3⅛ inches.

The worm blank, which is integral with its shaft, is first turned to the proper curvature in another lathe, as will be described later. When the worm is being threaded, the right-hand end of its shaft is supported by the tailstock center, and the left-hand end enters a special driving plate *G* (Fig. 1), which is bolted to the regular faceplate of the lathe. A shaft is keyed to this driver and carries a bevel gear *A*. This bevel gear meshes with a corresponding gear *B* attached to a shaft at right angles, which, through the spur gears *C* and *D* and worm-gearing contained in the special base *E*, transmits motion to the spindle *F*. In this way, the worm is caused to rotate in unison with spindle *F* and the toolholding fixture *H* mounted on it.

The worm thread is formed by two separate operations and two sets of tools are used. The first set are roughing or stocking cutters, which simply form rough grooves, and these are followed by a set of finishing tools which give the threads the required shape. Fig. 1 shows the finishing cutters in the tool-holder and the roughing cutters are on the lathe bed at *J*. The cutting ends of the roughing tools vary in shape, some being square, whereas others are beveled more or less; in addition, there are right- and left-hand side tools on each side of the fixture. By having tools of different shape, some cut in one part of the groove and some in another, which facilitates the roughing operation. There are eighteen cutters in all, the number being equal to one-half the number of teeth in the worm-wheel. The circular tool-holder is mounted on a cross-slide which is fed inward by handwheel *K*, the latter being connected with the cross-feed screw through worm-gearing, as shown.

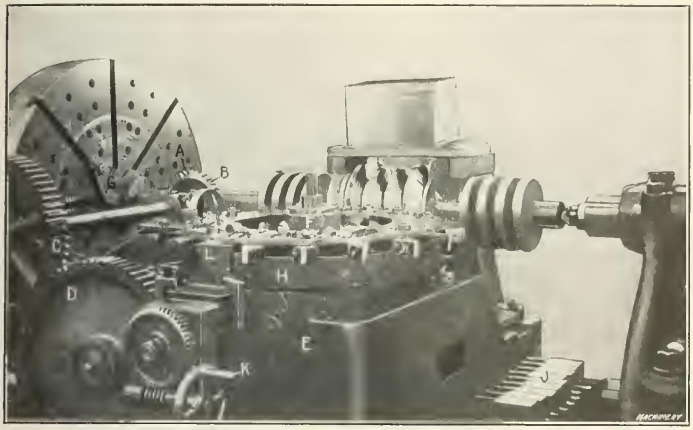


Fig. 1. Generating Thread of a Large Hindley Worm for the Battleship New York

After the thread grooves have been roughed out, the roughing cutters are replaced by eighteen finishing cutters. The tool-holder is so constructed that these tools can be accurately located each time they are placed in position. This holder consists of a circular casting *H*, having a raised inner ring fitted with set-screws against which the ends of the tools abut, and a circular ring for clamping the tools. The latter are located circumferentially by slots cut in the tool-holder, and radially by measuring the distance between the cutting ends and angle-plate *L*. In case radial adjustment is necessary, this is effected by the set-screws referred to. The tools are all numbered and there are corresponding numbers on the holder, so that each tool can always be located in the same position. The tops of the tools are, of course, in the same horizontal plane as the axis of the worm. When finishing, the tool-slide must be fed in very slowly, as each tool machines a large surface, thus making it necessary to take light cuts. The gears *C* and *D* are so proportioned that each tool, at the pitch circle, moves a distance equal to the circular pitch of the gearing, while the worm makes one revolution. Lubricant for the cutters is supplied by the tank seen above the worm. The collars on each side of the worm are integral with the shaft and engage thrust bearings when the worm-gearing is assembled.

When the worm-wheel is being hobbed (see Fig. 2), it is mounted on the same vertical spindle that drives the tool-holder, the latter being removed. The hob used for this operation has a long shaft which engages driving plate *G*, to which it is locked by a special key. The hob shaft also carries a bevel gear *A* for transmitting motion to spindle *F* through the shafting and gearing referred to. When hobbing the wheel it is necessary to run slowly and take light cuts, the same as when generating the worm thread, in order to secure smooth accurately finished teeth. The time required for hobbing one of these wheels is about five days, whereas the worm is threaded in about six days.

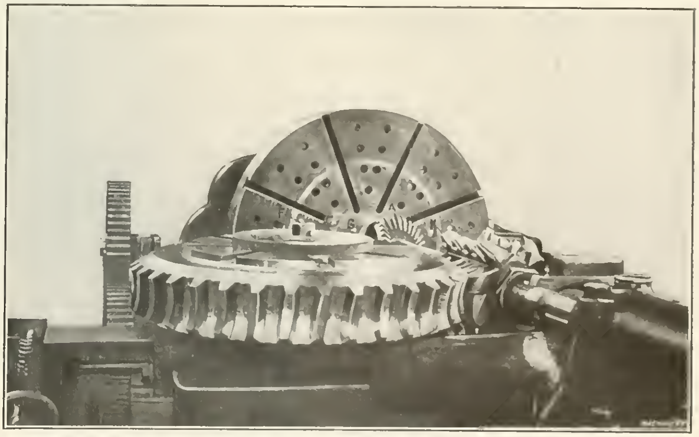


Fig. 2. Hobbing a Hindley Worm-wheel having a Pitch Diameter of approximately 36 Inches

The hob used for the work, owing to its large size, was made with a machine-steel body, and the teeth are faced with tool-steel cutters *K*. These cutters are one-half inch thick and are held in position by cap-screws and dowel-pins. The inner end of each cutter is also fitted into a slot at the bottom of the gash, which gives additional support. When making the hob, the body was first turned and threaded just like a Hindley worm of corresponding size. Seven gashes were then sawed out to form the teeth, and the cutter-retaining grooves were milled. The annealed cutters or faces for the teeth were then bolted to the hob body, after being roughed to approximately the required form. The hob was then placed in the lathe and the tool-steel faces finished to the correct shape by hobbing with the worm-thread finishing tools, the operation being similar to that followed for making a worm. After hobbing, the sides of the cutters were filed to the proper degree of clearance. The clearance angle is about three degrees, although it varies somewhat owing to the change in the angle of the teeth due to the hob curvature. The final operation was that of hardening the cutters and attaching them to the hob body. By making the hob with a machine-steel body, the danger of distorting or cracking it by hardening was eliminated. There is also an advantage in having detachable cutters, in that they can easily be replaced if necessary.

The final operation on the worm-gearing is that of grinding the teeth to remove any uneven spots or ridges that may have been left by the machining operation. This grinding is done by running the worm and gear together and applying brick-dust and water, which abrades the threads of the worm and teeth of the wheel and produces smoother and better bearing surfaces.

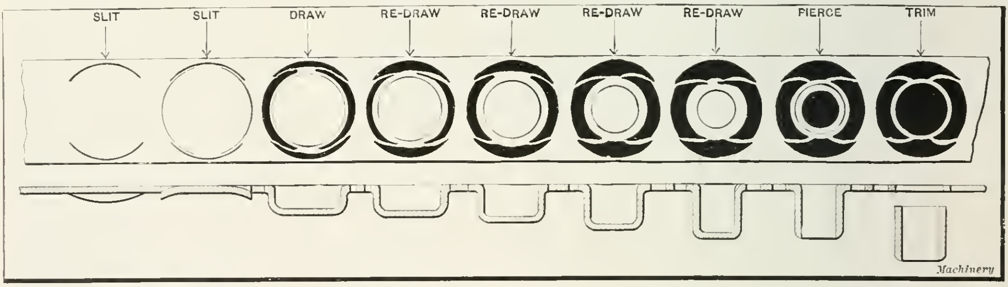
The blank for the worm is turned in a lathe equipped with a special attachment which gives the required curvature. This attachment operates on the same principle as a regular taper turning attachment. It consists of a guiding templet having a curved slot, the radius of which corresponds to that of the worm. Engaging this slot there is a steel roller attached to a bar connecting with the lathe cross-slide, so that as the carriage feeds longitudinally, the turning tool follows an arc corresponding to that of the templet. This tool is centered with the blank longitudinally and is set in the same horizontal plane as the axis of the work. The phosphor-bronze blank for the wheel is turned to the proper curvature by means of a special attachment which consists of a tool mounted in a holder in such a way that it can be turned about a vertical axis, when finishing the curved periphery of the blank.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

PRODUCING DRAWN STEEL ROLLERS IN A GANG DIE

The illustration presented herewith shows the writer's idea of a layout for the progressive and automatic production of small chain rollers in quantities ranging from 18,000 to 22,000 parts per day per unit equipment. By using stock considerably thinner than the walls of the finished roller are to be, and working upon it progressively by means of gang or follow-up dies, as shown in the illustration, the roller can be completely finished in the power press. The plan view shows the entire evolution that the shell goes through to produce the result shown at the right-hand end of the sectional view. The stock used is dead soft, cold-rolled steel, which can be fed to the die by means of an automatic roll feed. At the first stroke of the press, the metal to form the shell blank is slit radially on two sides, as shown at the extreme left of the plan view. At the next stroke of the press, the metal is fed over one die space and is again slit. The next stroke performs the first drawing operation. The fourth operation is a redraw which is also the case in the fifth and sixth operations. The seventh operation is a finish-sizing process. In the eighth operation, the bottom of the drawn shell is punched out. The ninth and final operation consists of trimming the free end from the stock, as shown at the extreme right of the sectional view.



Evolution of a Drawn Steel Roller in a Gang Follow Die

At this point, the shells are annealed and then placed in a hopper. They are then fed to compression dies which apply end pressure to the tubes, and expand the shell walls to the required thickness. This operation will size and finish the rollers in exact duplication and to accurate dimensions. It will be seen from the layout that the work is carried along in the stock until the last operation, which cuts it free in the manner previously described. The writer estimates that the approximate cost of each unit die equipment, exclusive of a single acting power press, equipped with automatic feed, would be $300. A No. 19 single acting Bliss power press equipped with a No. 2 standard double roll Bliss automatic feed, is recommended as machine equipment. Stock ranging from ¾ to 1½ inch in width, and from 1/32 to 3/32 inch in thickness is best suited for producing such work.

New York City. J. V. WOODWORTH

THE TASK IDEA

The reader of technical literature today is likely to get the impression that the "task" system is a modern institution. This, however, is not so, for there exist today in England many concerns who have used this system for probably a hundred years or more. It is not quite the same system, however, for although the fixed task is there, no bonus is paid if it is performed in a briefer space of time than that set.

Fifty years ago, the writer's father worked under this system which was in vogue then and is still used in a large iron foundry employing about one thousand men. Pipes of all kinds are produced. Long experience has allowed the average time on a job to be accurately gaged, so that the output which constitutes a fair day's work is well known to everyone concerned. Disputes seldom arise and strikes are unknown. What is termed "80 inches" of standard socket pipe for gas or water is considered a day's work for a gang of men, but the number of men to a gang varies according to the size of the pipes. The unit "80 inches" means ten 8-inch pipes, eight 10-inch pipes, two 40-inch pipes, and so on. The gangs begin work at six o'clock in the morning and continue until the task per gang is finished and cast. Any bad castings have to be made good the following day.

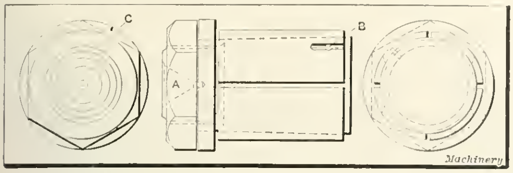
The advantages of this system are manifold to the workmen, particularly in the smaller gangs where differences of opinion less frequently arise than in the larger gangs. When the whole gang is composed of fairly intelligent men, they can by steady work finish the day's task early, and enjoy long evenings for recreation and self-development. If a man wants an hour or two off, he only needs the consent of the other men in the gang. This has been agreed to by the management; all that is required is that the day's task is completed—there is no interference with the way it is done. By hard work a gang can finish at two o'clock in the afternoon, the furnaces and cupolas being kept going practically the whole day. Three or four o'clock in the afternoon are common hours for leaving. The wages earned are from 15 to 20 per cent greater than those of the ordinary day-workers who work until five o'clock.

The writer is not at all certain that present methods are an improvement on the old-fashioned way. Is it not a fact that the hours of labor at present are too long to permit of really efficient work during the whole of the day? Mind and body become weary, resulting in general inefficiency. But little time and, at any rate, but little inclination remains to devote the evenings to the study necessary to increase efficiency. Ten hours a day is too much for any man working at a monotonous occupation; eight is ample, and, in the opinion of the writer, would produce better results, if not in the immediate future, certainly eventually. TIME LIMIT

EXPANDING CENTER FOR TURNING HOLLOW SHAFTING

A useful type of expanding center for use in turning hollow shafting, castings, or similar work, is shown in the illustration. It consists of a taper plug upon which a split shell is accurately fitted. In using this device, the lathe center fits into the hole *A*. The center is placed in the work and the split shell is then expanded through the action of the nut at the end of the plug. The pin *B* prevents relative rotation between the plug and shell, while the shell itself is held by a spanner fitting into the slot *C*. It will thus be evident that when the nut on the block is tightened, the shell is forced in on the taper and expands sufficiently to fit the work. When it is desired to disengage the block, the nut is slacked off. A sharp blow is struck on the end of the plug with a lead hammer. The center can then be as easily withdrawn as it was put into place.

These expanding centers have been found very useful on many classes of work where the hole is too large to admit of the use of the regular lathe centers. They have been used in turning crankshaft parts, thrust, intermediate and tail-shafts for the steamship *Minnesotan*, the first of eight steamships now being built at the Maryland Steel Co.'s plant at Sparrows Point, for the American-Hawaiian Line. The work turned on this type of center is found to be as accurate and free from chatter as if the work were carried on the regular centers. **Lewis Sykes**

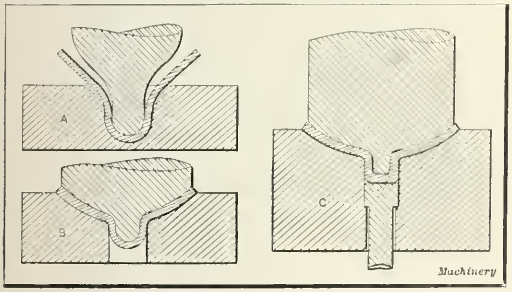


Expending Center for Turning Hollow Shafting

Baltimore, Md.

DRAWING A SMALL SHELL FROM THICK BRASS

The shell shown in section in the dies at *C* in the illustration, is an unusually difficult job to draw from thick brass, the principal difficulty being due to the fact that the metal will not draw over anything approximating a sharp corner. The usual method of producing a shell of this kind—reducing it from larger cups by successive drawing operations—was tried without success. Finally the method shown in the illustration was hit upon, and it was found that satisfactory results could thus be obtained. This makes the operation akin to squeezing rather than drawing, the point being to protrude enough metal in the first and second operations to allow pressure from below to be applied in a third operation, shaping the stock and setting it to the required dimensions.



The Three Dies used to produce the Shell

In the dies shown at *A* the object is to start the thick metal in a downward direction by means of the comparatively loose fitting punch and die shown. The edge of this die is very gradually rounded so that the metal will slide over easily. The second operation, which is performed in the dies at *B*, consists of shaping the shell around the depression already made, and the finished shape is the result of the operation performed in the dies at *C*.

The shell is started from a round blank, and two annealings are required to bring the metal to the finished shape. Subsequent piercing and cutting operations are afterward performed on the piece, but these do not differ from the general run of such operations.

Columbus, Ohio. **Otto R. Winter**

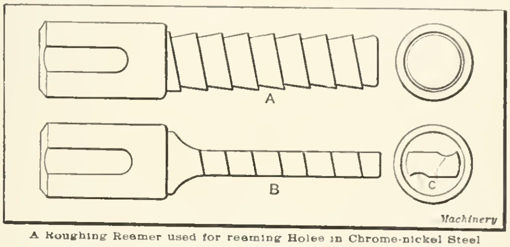
CHROME-VANADIUM STEEL FOR SCREW-DRIVERS

Screw-drivers made from properly heat-treated chrome-vanadium steel will be found superior to those made from other materials. Properly heat-treated chrome-vanadium steel possesses the hardness necessary to prevent the point from twisting off, and at the same time has enough toughness to prevent nicking or cracking; its torsional strength is exceptionally high. Actual tests have proved that when used for screw-drivers no material is superior to this steel. The heat-treatment should be as follows: Heat to from 1600 to 1650 degrees F., and quench in oil; then draw to from 700 to 800 degrees F.

Sandover, Md. **W. A. Sherwin**

ROUGHING REAMER FOR CHROME-NICKEL STEEL GEAR BLANKS

Considerable trouble was met with in reaming tapered holes in certain chrome-nickel steel gear blanks. Several types of reamers were furnished by tool experts, but the results obtained were unsatisfactory. Finally, the type of roughing reamer shown in the accompanying illustration was devised. The blank for this roughing reamer was turned to the proper taper, but 0.005 inch smaller than the finishing reamer. A buttress thread of ½ inch lead was then cut on the reamer part, as shown at *A*, after which the blank was placed between the centers in the milling machine and milled as shown at *B*; the cutting edges were then given the proper rake by milling two parallel grooves, as indicated at *C*. When removed from the milling machine, the reamer was finished by giving it the necessary relief on the cutting edges with a file.



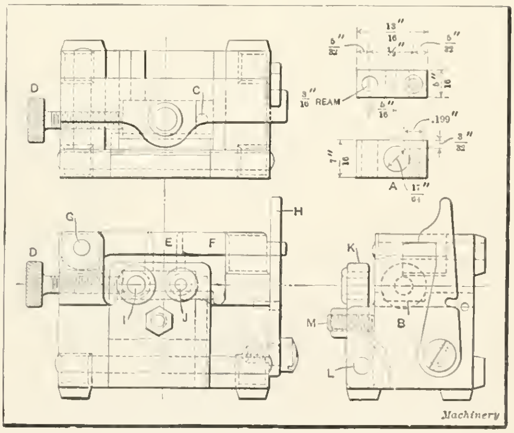
A Roughing Reamer used for reaming Holes in Chrome-nickel Steel

This reamer was fed at a rate of 0.020 inch per revolution of the spindle, and after having reamed the hole with it, a finishing reamer of standard shape was used at slow speed, with a feed of 0.010 inch per revolution of the spindle. This reamer left a nicely finished hole.

Lafayette, Ind. **W. H. Addis**

DRILLING, REAMING, COUNTERBORING AND TAPPING JIG

A simple but very efficient jig for drilling, reaming, counterboring and tapping a part for a typewriter is illustrated herewith. The work shown at *A* in this illustration is a small machine-steel block. This block is laid in a groove *B* in the body of the jig and is held against the locating pin *C* by means of the set-screw *D*. The work is held down by the head of the bushing *E* which is carried by the leaf *F*. This leaf swings

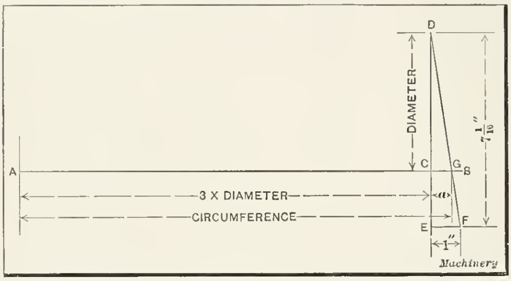


Jig for drilling, reaming, counterboring and tapping Piece A on a pin *G* and is clamped shut by the latch *H*. The largest hole is drilled through the bushing *E*, while the other two holes are drilled through the bushings *I* and *J*, which are carried in the second leaf *K* at the side of the jig. This second leaf swings on a pin *L*, but is not clamped shut. When closed, the adjusting screw *M* keeps the leaf in the correct position. After the three holes are drilled, the side leaf is lifted and one hole is reamed and the other counterbored and tapped. No guide bushing is used for the latter operation.

A. M. ROCHESTER

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE

The accompanying illustration shows a method by means of which the circumference of a circle can be laid out along a straight line, simply by using a scale. The method gives very accurate results. Lay out on line *AB* the distance *AC* equal to three times the diameter of the circle. At *C* erect a perpendicular *CD* equal to the diameter of the circle; extend *DC* to *E* (if necessary), so that *DE* equals 7 1/16 inches. Draw *EF* perpendicular to *DE*, making it 1 inch long; draw *DF*, intersecting *AB* at *G*. (Should point *F* be located on the upper side of the line *AB*, extend *DF* until it intersects *AB* at *G*.) Line *AG* then represents the circumference of the circle.



Method of Laying Out the Circumference of a Circle along a Straight Line

Since the triangles *CDG* and *DEF* are similar, we have:

$$1 : 7\,1/16 = a : \text{diameter}.$$

Hence $a = (1 \div 7\,1/16) \times \text{diameter} = 0.1415929$, and $AG = 3.1415929 \times \text{diameter}$. Since the circumference of a circle is equal to 3.1415926 × diameter, this method is, theoretically, almost exact, the error being too small to be taken into account for any practical purposes.

W. L. TRYON

Schenectady, N. Y.

THE VALUE OF AN EFFICIENT TRUCKING SYSTEM

It is surprising to note how little attention is paid to the method of handling work in some factories. These are generally the establishments which complain most of the heavy item which overhead expense makes in their cost of production. The argument is advanced that trucking is non-productive labor, and consequently does not need so much attention. This statement, however, is far from accurate.

In a certain large factory engaged in the manufacture of sheet metal products, the method of transferring work from shop to shop was seriously neglected. It was the practice to allow the machine operators to move their own work from department to department. Sheets of metal were loaded on trucks to carry them from one machine to the other, the trucks being unloaded before each operation was started. It will be evident that this method was responsible for a serious loss of time, and when this fact was recognized the mistake was corrected by adding fifty new trucks to the shop's equipment. These trucks were placed at the disposal of the men and orders were issued that all material should be kept on the trucks. This meant that each machine had two trucks; one to take away finished work and the other loaded with raw material. It may seem that the presence of so many large trucks would take up too much floor space, but the results do not show that this was the case, as the room occupied by the trucks was formerly taken up by piles of material and finished product.

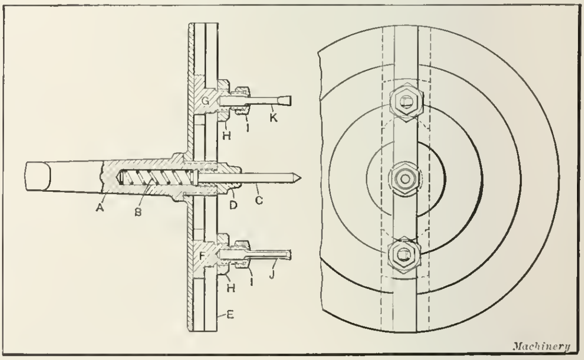
An important point in the development of the new trucking system was the maintenance of an aisle in each room, wide enough for two trucks to pass. The machines were arranged in progressive order on each side of the aisle, the men being required to keep the aisle-space clear. Instead of having the machine operators do their own trucking, a corps of truckers was employed under the direction of a floor manager, whose duty it was to keep the materials constantly moving from machine to machine as the various operations were completed. This floor manager ordered his raw materials from the yards and moved the work along through the departments as rapidly as possible. This kept each machine running continually and reduced the overhead cost to a great extent, owing to reduction in the amount of time which the equipment was idle.

New Britain, Conn. J. M. HENRY

TOOL FOR CUTTING OUT RINGS OR DISKS FROM FIBER SHEETS

The tool shown in the accompanying illustration was designed for cutting out fiber rings or disks from the sheet, forming both the hole and the outside diameter in one operation; when desired, it can be used for cutting out the blanks only. The shank *A* of the tool is supplied with a Morse taper to suit a drilling machine spindle, and a hole is drilled in its lower end to receive the spiral spring *B* and plunger *C*, the lower end of the latter being cone-pointed. The top end of the plunger is provided with a head which acts as a stop for the plunger, coming against the threaded bush *D* screwed into the lower end of the shank *A*; this bush also acts as a guide for the plunger.

A disk *E* (which in this case is 5 inches in diameter) is screwed onto the lower end of the shank, and has a T-slot milled across its face to retain the tool-holders. The tool-holders *F* and *G* are made from a square bar, bored to receive a piece of round tool steel. The outsides of the tool-holders are turned, threaded and fitted with nuts *H*, which hold them in position in the disk *E*, when set to the required radius. The lower ends of the tool-holders are turned, threaded, tapered and split, and are fitted with nuts *I* forming a split chuck for holding the cutting tools *J* and *K*. These tools *J* and *K* may be made in various lengths to suit the thickness of fiber to be cut.



An Adjustable Tool for Cutting out Rings or Disks from Fiber Sheets

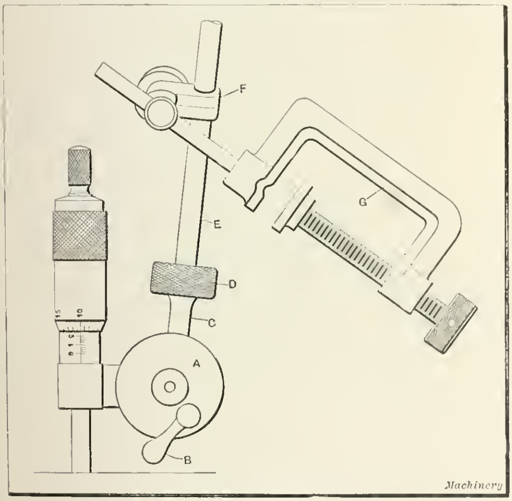
The lower face of the disk *E* is provided with circles of various diameters and is marked so that the tool-holders may be readily set to cut any given diameter. The plunger *C* is so arranged that when pressed out by the spiral spring *B* to its extreme length, the point of the center projects about 1/8 inch in advance of the cutting edges of the tools. In using this tool, the fiber is marked with a center punch, the punch mark being located far enough from the edges of the sheet so that the cutters will not break out. The tool is placed in the spindle of a drilling machine and rotated at a good speed (say 1000 R. P. M.), the fiber being placed on the table of the machine with a thin board beneath it to protect the cutters when they pass the sheet. As the cutters are brought down toward the fiber, the center *C* which projects a little in advance of the cutters, comes into contact with the work first; this enables the fiber to be moved into the correct position, before the tools commence to cut, without stopping the machine.

When rings are required to be cut out, the inside cutter, or the one which is cutting out the hole is adjusted to cut the blank out of the ring before the other cutter separates the ring from the sheet; this insures the clean cutting out of the bore, and prevents the ring from being carried around by the cutter which is cutting the bore. The spiral spring behind the center, being stiff, holds the portion which is cut out first quite firmly in position, while the ring is being separated from the sheet. When cutting out blanks one of the cutters is removed. LAWRENCE W. WILLIAMS

Handsworth, Birmingham, England.

UNIVERSAL MICROMETER DEVICE

The writer has long felt the need of a micrometer device which would make it possible to remove surfaced work from the shaper, planer or milling machine and to replace it accurately. For this purpose, the tool illustrated in the accompanying engraving was devised. A standard 1-inch micrometer is used with the anvil part of the frame removed. The friction disk bearing *A* is mounted onto what remains of the frame, at right angles with the micrometer spindle. This bearing can be locked by handle *B*. Stud *C* is inserted in the disk bearing *A*; this stud is threaded to fit nut *D*. The support *E* is provided with a collar at one end that fits into nut *D*, this arrangement making it possible to use different types of supports. The purpose of nut *F* and clamp *G* is apparent from the illustration. The device can be clamped to any stationary part of the machine, and as it is universal in its adjustment and the micrometer spindle has a range of one inch, it is a very valuable tool for the machinist and toolmaker. WM. H. ADDIS

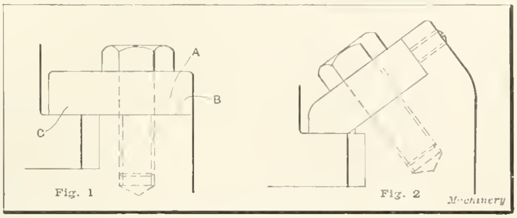


Universal Micrometer Head

La Fayette, Ind.

DESIGN OF SQUARE GUIDE FOR SLIDES

Undoubtedly the square slide is to be preferred to the V-guide when friction and wearing qualities are considered, but the objection to its wider adoption is the difficulty of adjustment of the strip *A* in Fig. 1. On some slides where the wear is small this defect is not of much consequence, but on slides such as used for shaper rams, where the wear is great, the design presents a great drawback. In addition, the cost of fitting and adjusting the slide on a new machine, if a good fit is required, is objectionable. The only way of adjusting the strip is by carefully removing metal from the surface *B* until the required fit is reached. This lack of adjustability is also a bad feature when the machine has become worn through use. Because of the trouble involved in adjusting the strip, the machine is frequently allowed to run until it is in very bad shape.

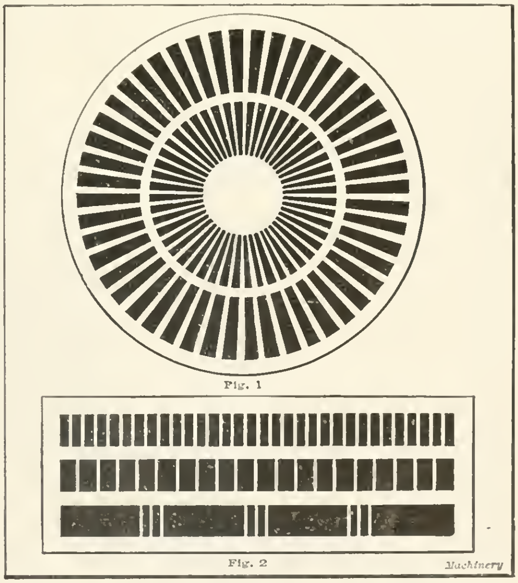


Figs. 1 and 2. Conventional and Improved Designs of Square Guide for Slides

The arrangement shown in Fig. 2 was intended to overcome the weak points of the design shown in Fig. 1, while still retaining all the good points. The construction can be quite massive, and as the bolt heads are practically over the heads of the thrust, there is little chance for looseness of the fit. The adjustment is very simple, and the ease of fitting is apparent. A. H.

DEVICE FOR DRAWING DOTTED LINES

The accompanying illustration shows the principles of a device for drawing dotted lines. It is well known that it requires considerably more time to trace dotted lines than to draw full lines and circles. The devices illustrated are made from thin sheets of amber or celluloid. The parts shown in black are cut out so that the pen will touch the paper at these points. The length of the dots and dashes can be regulated by the spacing of these sections. When drawing a dotted line, the T-square or triangle is simply placed over the "dotter" (Fig. 2) and the line is drawn as if it were a full line, without lifting the pen. When drawing dotted circles by means of the device in Fig. 1, the "dotter" must lie perfectly flat on the drawing. Care must be taken in lifting the "dotter" from the drawing so that the ink will not blot.



Devices for Drawing Dotted Lines and Circles

McKees Rocks. Pa. AUGUST H. ANGER

[It would seem difficult with a device of this kind to prevent the ink from flowing along the edges of the celluloid and also that it would be almost impossible to lift the disk from the paper without causing ink blots. The idea was tried in this office, however, and found to work fairly well.—Editor].

FILING MACHINE BRACKET

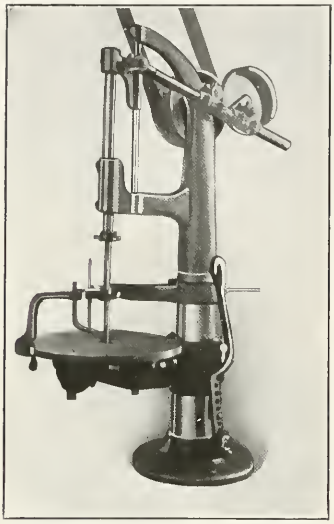


Fig. 1. Bracket applied to Filing Machine

The accompanying halftone shows the application of a special holding-down bracket used on a filing machine made by the Simplex Mfg. Co., in order to increase the range of work that can be handled on the machine. The arm is shown in detail in the line engraving Fig. 2. It is supported from the column of the machine and held in position by a clamp hub, and is as universal in its adjustment as the holding-down clamps furnished with the machine. Two offset fingers are used for clamping purposes. The use of this bracket makes it possible to keep the table clear for any class of work. After the fingers are set to accommodate the thickness of the work at hand, no further adjustment is required. One of the two ordinary clamps is also shown on the table in Fig. 1, merely to illustrate its appearance and application.

The advantages of the bracket are particularly in evidence in cases where it is required, for example, to file a set of cams for a Brown & Sharpe automatic screw machine. The whole table of the filing machine would be unobstructed and any part of the cam could be filed without adjusting the holding-down clamps. On all kinds of dies and punches it is also especially useful for filing a circular portion. It is often desirable to be able to swing the work through a large arc, which this special bracket permits. D. Sign

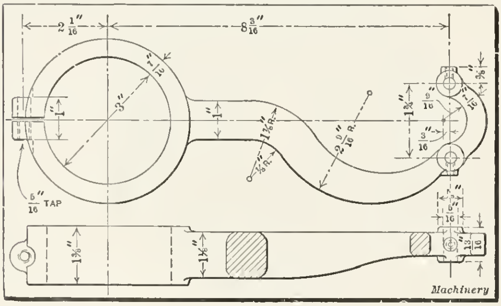


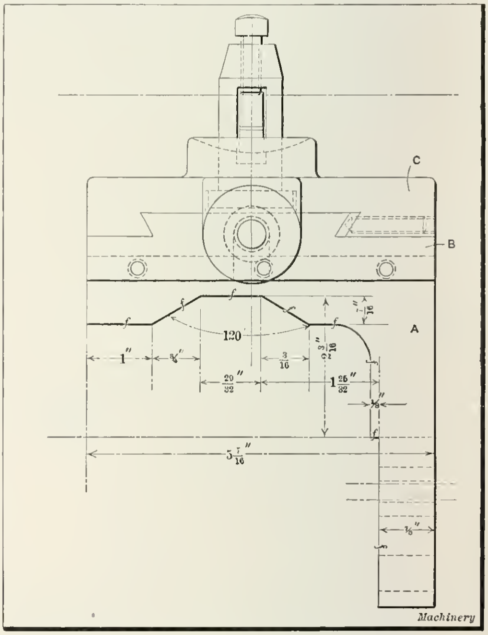
Fig. 2. Dimensions of Bracket

USING GASOLINE ON TRACING CLOTH

It is probably the most common practice in drafting-rooms to use powdered chalk or some similar preparation to absorb the greasy element on the surface of tracing cloth. While the results obtained are satisfactory so far as the object in view is concerned, the gritty preparation rubbed over the cloth will dull the finely sharpened edges of the ruling pen in a comparatively short time. For this reason it is preferable to rub the tracing cloth with a soft cloth slightly dampened with gasoline. When this practice is followed the ruling pen will be found to remain sharp much longer than when the tracing cloth is rubbed with chalk. Gasoline is also useful as an eraser for lead pencil marks and for cleaning a soiled tracing before removing it from the drawing-board.

Manchester, N. H. Clarence Kent

TOOL FOR FINISHING THREADS ON A THREAD MILLING MACHINE



Device for Finishing Threads on a Thread Milling Machine

The accompanying engraving shows a device used for finishing threads on a Pratt & Whitney thread milling machine. By means of this device objectionable milling cutter tooth marks can be removed whenever they become very apparent on the work, as, for example, when maximum feeds are used with such materials as cast iron, bronze and soft steel. The device consists of a bracket *A*, fitted to the carriage of the machine and bolted to the seat used for carrying the follow-rest on regular long work. The bracket bears on the top of the cutter-slide which is planed to an angle of 120 degrees. Mounted on this bracket is a slide *B*, parallel to the work. This slide has provision for adjusting the finishing tool to the threads already roughed out by the milling cutter. This adjustment is accomplished by means of two fillister-head screws, one at each end of the slide. Attached to this slide is the top slide *C* in which the shaving or finishing tool is clamped. This latter is made from 3/8 by 3/8 inch stock, and is held in a regular toolpost. The top slide is operated by a small handle located immediately above the handwheel which operates the cutter-slide. This handle is provided with a graduated dial reading to 0.001 inch.

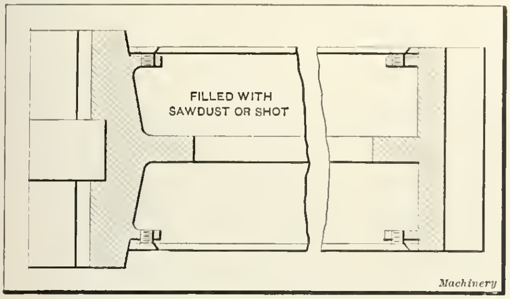
When this device is used, the milling cutter is fed into the work and the work roughed out to within from 0.002 to 0.004 inch of the finish size. The finishing tool is then brought into action, removing the remaining stock and leaving a smoother finish than could be obtained by milling alone with a heavy feed. J. E. Sheuman

Waynesboro, Pa.

ANOTHER CURE FOR NOISY GEARING

In the May issue of Machinery, a cure for noisy gearing is mentioned which appears to combine the advantages of low cost and efficiency. The following method which is used on a large scale in some engineering works in St. Petersburg, Russia, is even more efficient, but it is also far more expensive.

In using this method gears of less than 18 inches in diameter are fitted with two sheets of tin which enclose the space between the hub and the rim of the gear. This space is then filled with sawdust or with No. 4 shot, the idea being to eliminate vibration by this means. In some cases, it has been found advantageous to use a mixture of shot and sawdust. The sheets of tin are fastened to the rim and hub with a number of small screws, as shown in the illustration. When the diameter of the gears exceeds 18 inches, wooden rings are used in place of the tin, the method of attachment being similar in either case. A felt packing is used to prevent the sawdust from leaking out. This arrangement has the further advantage of closing the space between the spokes of a wheel, thus making it impossible for a workman to get his arms or tools caught by the rotating wheel.

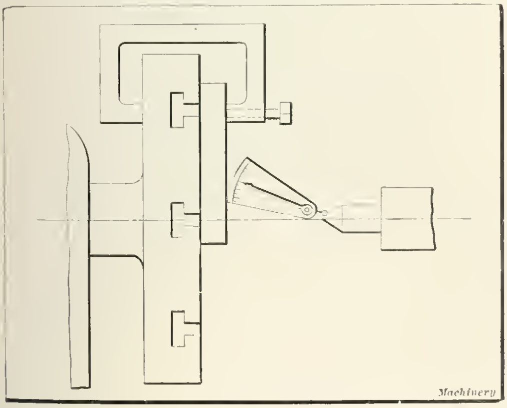


Method of Quieting Noisy Gears

Wolverhampton, England. A. Wind

TESTING THE ALIGNMENT OF LATHE CENTERS

The writer once desired to know the alignment of the dead center of a lathe in which he had a piece of work mounted. This work was of an awkward shape, and after clamping it to the faceplate it was found necessary to bring the dead center forward to a hole which had been drilled, to assist in holding the work. When the lathe was started, a slight vibration of the center hole showed the center to be out of line with the lathe spindle. To bring the dead center into alignment, a test indicator, graduated to read in thousandths, was clamped to the faceplate, in such a position as to enable the indicator point to come into contact with the end of the center. This is clearly shown in the illustration. When the lathe spindle is revolved under these conditions, the amount of error in the alignment of the dead center is accurately shown. This error can then be easily remedied.



Method of Testing the Alignment of Lathe Centers

This is a useful method of lining up centers before starting to turn a straight piece of work. It is far superior to the practice of taking trial cuts and making the necessary measurements and adjustments between cuts, in order to ascertain whether the piece will be straight when finished. Almost every tool-room has some kind of test indicator which is capable of being used for this purpose. F. E. C.

A STEADYREST NOVELTY

In the July issue of Machinery, E. W. Tate has a tilt at the steadyrest proposed by H. Terhune in a previous issue. He enumerates several rather visionary faults, and sets out to abolish them with a design which appears to me to perpetuate rather than remedy the very points he criticises in H. Terhune's design. And it was rather unfortunate, after complaining of the cost of the first design, when he confessed that the application of his own is limited on that account.

This controversy and the editor's trenchant footnote anent the neglect usually accorded these accessories has prompted me to advance a description of a type of steadyrest which is, as far as I know, quite novel, and which is both compact and cheap. This steadyrest can be made in two styles, as shown in Figs. 1 and 2, according to whether the screw is required to work the jaws both ways or not. The construction in each case is practically identical, the difference being that the type shown in Fig. 2 has the screw turned with a second collar, and the hole for the screw in the top of the jaw is milled out to the front. There are no unsightly screws projecting when the jaws are fully out, as in the case of many of the types now in use. The machining of the jaw guides can be done by an ordinary milling cutter going straight through, instead of end-milling them, which is now necessary with the blind end guides. A. H.

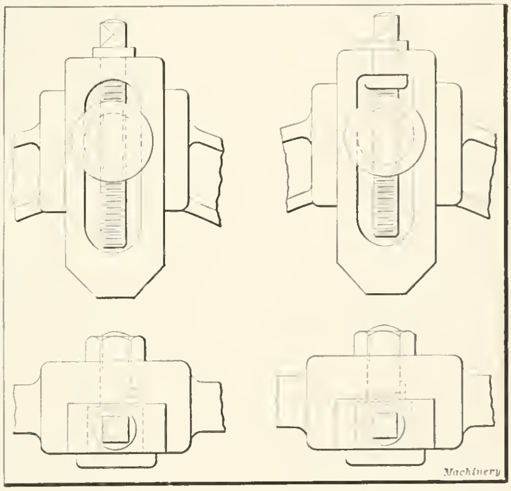


Fig. 1. Steadyrest to work Jaws in One Direction
Fig. 2. Steadyrest to work Jaws in Two Directions

PUNCH AND DIE FOR FORMING ELECTRIC TERMINALS

The punch and die shown in Fig. 2 were designed for forming electric terminals of the type shown in Fig. 1. The arrangement has been so worked out that two terminals are formed and two others sheared off by each stroke of the press. The stock used is copper tubing, ¼ inch in diameter with a wall about 1/32 inch thick.

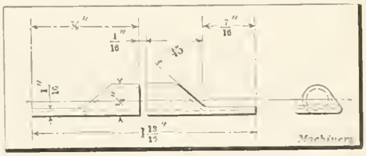


Fig. 1. Two Electric Terminals after being cut apart

Reference to the cross-sectional view of the punch and die shown in Fig. 2 will enable the operation to be readily understood. In this illustration *A* is the punch which forms the work in the die *B*. The shear *C* is bolted to *A* and backed up by a shank to enable it to withstand the blow. The right-hand face of the die *B* acts as the lower shearing plate. *D* is a square block of tool steel which is used to straighten out the formed tube before the punch *A* descends for the next stroke upon the unformed section of the work. The use of this block has been found necessary to bring the flat portions of the double terminal into proper alignment. When the shear *C* is in the act of descending, distortion of the formed tube would be inevitable were it not for the action of block *D*.

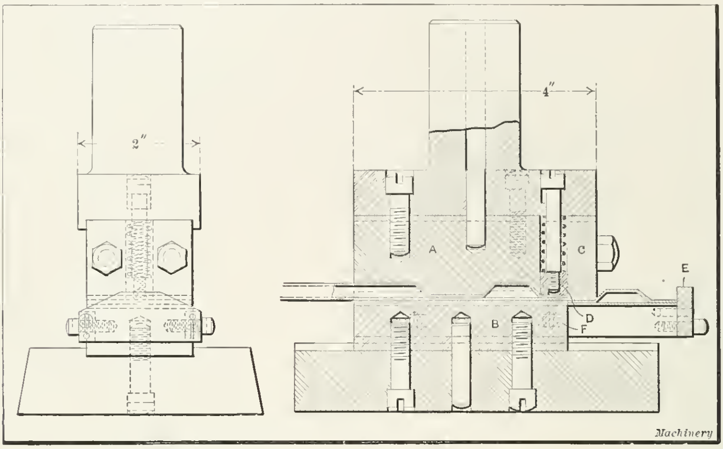


Fig. 2. Punch and Die for Forming Electric Terminals

The work is fed through the die until it comes up against the stop *E* which can be adjusted by means of screws *F* that are located in a suitable elongated hole. With the work in position against the stop *E*, the punch descends, shearing off the end of the stock and forming a double terminal between the punch and die. The work is now advanced to bring it into contact with the stop *E* and the punch is again tripped. This shears off the pair of terminals which were formed in the preceding operation, and at the same time a second pair is formed in the die.

After the terminals are sheared off, they are put into another die and the hole in each end is pierced. They are then run over a saw which cuts them exactly in half, as shown in Fig. 1. Two terminals are thus produced from each piece which is sheared off by *C*.

Chester, Pa. Charles R. Enoel

TAKING OUT BACK-SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

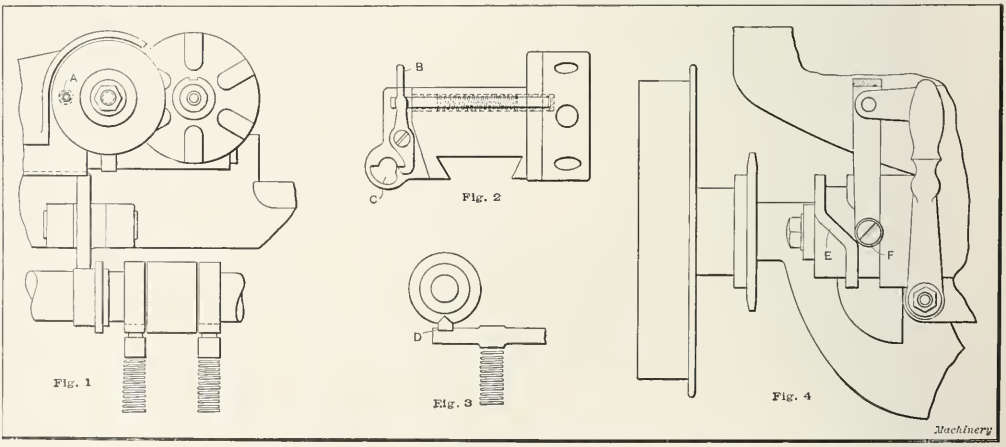
In every screw machine department equipped with Brown & Sharpe automatic machines, it is necessary to take out the back-shaft of at least one or two machines a week. The back-shaft is located in the rear of the machine and carries the various operating gears and clutches, the entire machine being operated therefrom. The reason for removing the back-shaft has nothing whatever to do with the design of the machine, since it is taken out for the sole purpose of removing the gummed oil, etc. In the following, the writer will describe the only practical and correct method of removing the back-shaft, which is a very important item in the training of any screw machine operator.

If a back-shaft is taken out and replaced in such a manner that every gear does not mesh with the same teeth as it did before the shaft was removed, then the machine will be "out of time," and the entire job will have to be set up again. If all the rules stated in the following are not observed when replacing a back-shaft, the machine, although it appears to be running all right, will be running under conditions which will probably cause breakage.

Some screw machine men, when about to remove a back-shaft, mark the gears with a center-punch which is not very satisfactory after the shaft has been removed several times. Fig. 1 shows the first thing to be done when about to remove a back-shaft. The roll on the turret operating disk, the clamp nut of which is shown at *A*, should set in line with the center of the turret. The machine should be operated by hand until this effect is brought about. Fig. 2 shows a view of the turret looking from the spindle; the cam *C* should be set as shown with regard to its radial drop. This cam is used for operating lever *B*, which unlocks the turret.

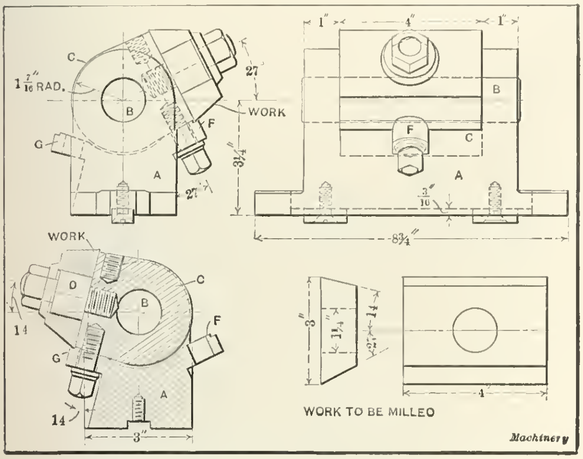
Fig. 3 shows how the clutches on the back-shaft should be set—with the notch down and engaged with the lever *D*. In Fig. 4 is shown a front view of the machine, in which the starting lever will be recognized. The cam for opening the chuck and operating the feeding of the stock is shown at *E*; *F* is the roller which rides on this cam and is shown in the position in which it should be set. When all these conditions have been observed it is safe to take out the back-shaft.

Nevin Bacon



Figs. 1 to 4. Method of Taking Out the Back-shaft of a Brown & Sharpe Automatic Screw Machine

MILLING FIXTURE



A Milling Fixture for Holding Work while milling Beveled Sides

The milling fixture shown in the accompanying illustration was designed for holding the cast-iron piece shown in the lower right-hand corner of the engraving. This piece has its sides milled off at different angles as indicated. The fixture consists of a base casting *A*, the flanges of which are bored out to admit shaft *B*. This shaft passes through the center casting or work-holder *C* and allows it to turn freely from stop *F* to stop *G*. In the upper left-hand corner of the engraving is shown the position of the work in the fixture when milling the 27-degree side on the work. The center block *C* is held in position while milling by a screw passed through the lug *F*. The sectional view indicates the position of the work in the fixture when milling the 14-degree side. The work itself is held to the center block *C* by a stud *D* provided with a nut and collar.

Cincinnati, Ohio HENRY FRANZ

MEASURING SCREW MACHINE CHIPS

A common practice among screw machine workers is to measure the thickness of the chips to determine the feeds of the tools. The writer wishes to point out that this practice is misleading because of the tendency of the metal to compress in one direction and swell and stretch in the other, when separated from the bar by the cutter. In order to obtain data on the difference between the feed of the cutter and the thickness of the chips, some tests were made on a Brown & Sharpe automatic screw machine. A cam, the exact size and travel of which was known, was placed on the machine, and the machine was geared to rotate the cam at a given speed. The exact speed of the spindle was also determined, and in this way the exact feed of the cutter was known.

These tests showed that a form tool, ¼ inch wide, having a feed of 0.001 inch per revolution, cut a chip which measured 0.0025 inch when cutting brass, while a form tool ⅝ inch wide, with a feed of 0.0015 inch per revolution, cut a continuous chip 0.005 inch thick. A cut-off tool ⅛ inch wide, cutting brass and fed 0.001 inch per revolution, produced chips from 0.0015 to 0.002 inch thick. The proportions between the feed and the chip for the turret tools were slightly greater than for the cross-slide tools; that is, the chip expanded slightly more. The tests for steel indicated a smaller expansion than for brass.

Many times a cam designer is criticized by the operators for providing excessive feeds when this is not really the case, the apparent error being due to the erroneous method used by the operators in measuring the feed. The error that would result in the design of cams if the draftsman worked to data obtained by measuring the chips is, however, apparent.

NEVIN BACON

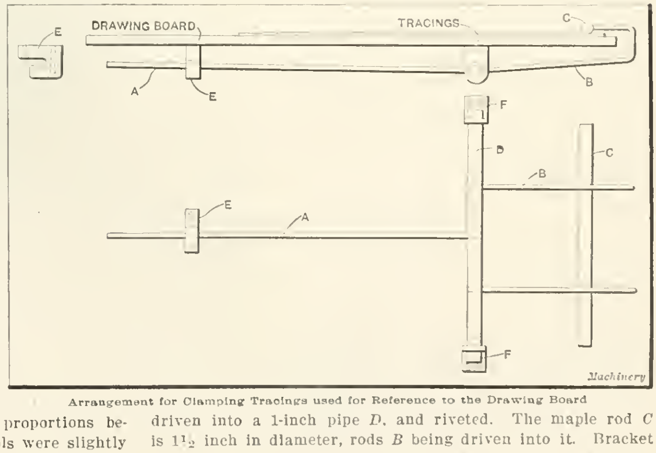
ERASING INK MARKS FROM TRACINGS

The writer wishes to add a few remarks to the discussion concerning the erasure of ink marks from tracings which appeared in the issue of MACHINERY for September. It will be found that the use of an ordinary pencil eraser on tracings will give better results than an ink eraser. The ink eraser will burn the tracing, as Mr. Allison states, if care is not taken in using it; this difficulty will not be experienced with a pencil eraser. Although a pencil eraser does not give as quick results, it will leave a much better finish on the tracing, and the use of soapstone will be unnecessary. If, however, a heavy line is to be erased, it will be found advisable to start with an ink eraser and then finish with a pencil eraser. A rather large detail can be changed on a drawing in this way, without leaving any noticeable mark. All that is required is a little patience. A. H. MYERS

York, Pa.

DRAWING-BOARD CLAMP FOR TRACINGS

When a great many tracings are used on the drawing-board at the same time, as, for example, when an assembly drawing is made, considerable trouble is experienced on account of the tracings sliding off the board. The accompanying illustration shows a special clamp made to take care of this difficulty. The tracings are placed beneath a maple stick *C*, which is located at the top of the drawing-table near the right-hand side. The clamping rod *A* is swung into the bracket *E*, and the drawings are held tightly in place. As each drawing is used it is thrown over the back of the table, the clamp still holding it in place. When a drawing is to be removed, rod *A* is taken out of the bracket, thus removing the pressure of the clamp rod which is immediately raised from the drawing-board on account of the rod *A* being the heavier part of the device. Any number of drawings can then be removed without the draftsman leaving his chair, thus saving considerable time.



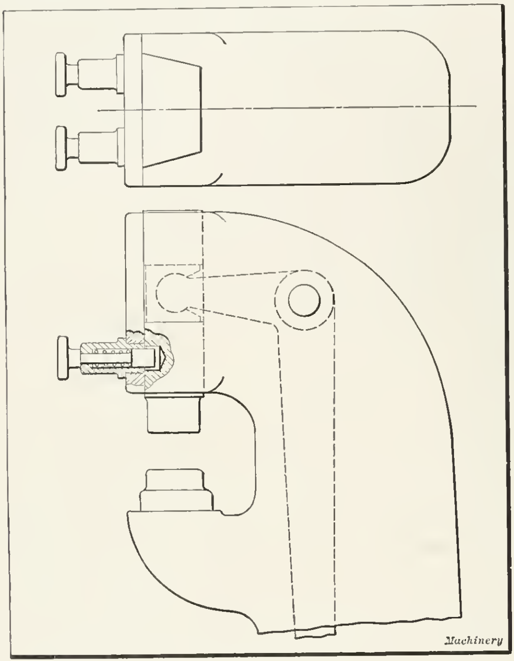
Arrangement for Clamping Tracings used for Reference to the Drawing Board

Rods *A* and *B* are made of ⅜-inch cold-rolled steel and are driven into a 1-inch pipe *D*, and riveted. The maple rod *C* is 1½ inch in diameter, rods *B* being driven into it. Bracket *E* is also made of maple and is fastened to the table with two screws. Brackets *F* are made of cold-rolled steel and screwed to the board. As will be realized from the foregoing description, the whole outfit can be simply and easily made.

F. A.

SAFETY DEVICE FOR FOOT PRESS

In a certain shop where presses were operated by foot power, the girl operators constantly got their fingers trapped between the work and the punch. Whenever this happened, if blood was drawn, about one-half of the girls were inevitably rendered useless for some time; some even fainted at the sight. Hence, it became necessary to devise a safeguard. The simple scheme shown in the illustration was adopted.



A Safety Device for a Foot Press

Two spring plungers were used which remained in the holes in the ram until they were drawn out. As both hands were required for pulling out the plungers, it was no longer possible for the girls to have their fingers in the danger zone when the ram was depressed. As presses of this type are very common in shops doing a variety of light work, the scheme described may prove of service to others.

J. Sysmore

COMBINATION FOLDING AND CURLING DIE

The accompanying illustration Fig. 3 shows a combination folding and curling die used for making the rectangular box shown in Fig. 1, which is produced from 80- to 90-pound tin.

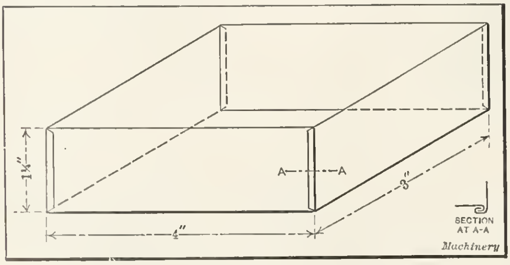


Fig. 1. The Box to be made and Section of Seam

At *A-A* is shown the section of the joint produced at the corners of the box. These corners are curled over nicely while passing through the die. The blank indicated by the lines *B* in Fig. 3 is located against the stop-pins *S* and is folded around a rectangular punch. As this punch descends the stock at the corners is slightly drawn and then follows through the narrow slit in the first section *E* of the die to the conical groove in the second section *F* where it is curled. The curled part is then flattened out in the lower section *G* of the die. The box is completed in one stroke of the die, the joints being made powder-tight. No additional trimming is required. The die can be made of machine steel with the exception of the curling blocks *D*, also shown in Fig. 2, which should be made of tool steel, hardened, and then inserted into the middle section of the die. Four curling blocks are required, two "rights" and two "lefts," of course. The blanks were cut in a previous operation, as it was more convenient than to use a large and cumbersome progressive action die.

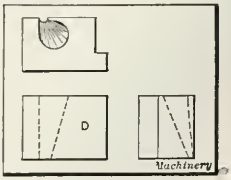


Fig. 2. The Curling Die

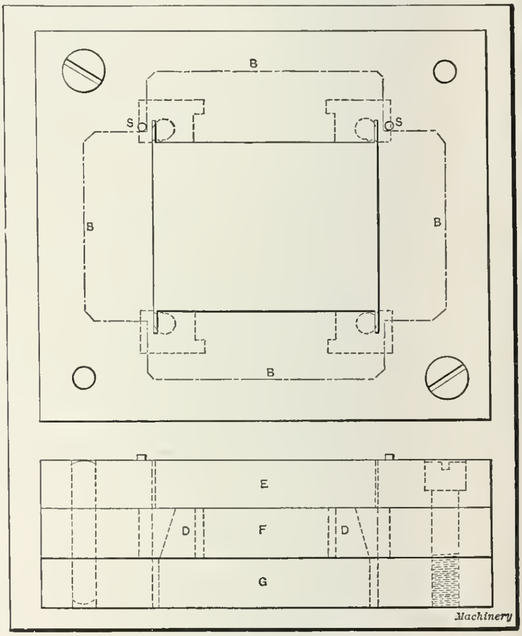


Fig. 3. General Design of Die

Columbus, Ohio. Otto R. Winter

CORRECT METHOD OF HANGING BLUE-PRINTS AFTER WASHING

The writer has noticed that in most cases when blueprints have been washed, they are hung up so that they are as nearly level at the lower edge as possible. This method is not a good one, because when a print is hung so that the lower edge is practically level, the water will gravitate to this edge and hang there in globules, and the print will not be perfectly dry at this edge for hours; and in almost every case the edge is discolored.

The best way to hang blueprints for drying is to place them so that the lower edge is at an oblique angle with the horizontal; then the water will gravitate to the lowest corner. There will be no accumulation of water at other points, and the drying will be far more rapid than in the case when the sheet is hung level. This is a very small detail of drafting-room work, but it is of considerable consequence, both as regards time and the appearance of the blueprints.

St. Louis, Mo. C. H. Casebolt

* * *

A gib key should not be used to fasten a coupling on a shaft. If a key is used, it should be a headless key, or, still better, a feather.

ADVANTAGES OF N. M. T. B. A. MECHANICAL SECTION*

In order to state clearly how the National Machine Tool Builders' Association could be benefited by the formation of a mechanical section, it will be necessary to review briefly the history of the industry with relation to the forces that have been active in bringing it from obscure job shop methods, both as regards manufacturing aand selling, to the proud position of one of the largest manufacturing industries in the land. Judging from the number and character of machine tools of foreign make purchased prior to 1875, and still in use in some railway division shops, the machine tool industry of those days must certainly have been in its infancy. There are men still active or recently passed away who have been in touch with the industry during all the years since then, and who are responsible for the marvelous changes that have taken place. The story of their lives is the story of the development of the industry. Few of these men were distinguished as salesmen. Financiering and accounting in the modern sense were unknown to them, but they were able mechanics—master workmen of their day, possessed of almost egotistical pride in personal accomplishments in their line. Guarding jealously the product of their own brain, they for the most part respected the rights of competitors, whether registered in the patent office or not.

These men had their faults, it is true, growing out of conditions then existing. They traveled little, they never met their competitors face to face, and knew nothing of them except through their dealer, who visited the shops occasionally to place stock orders for the requirements of the next six months or year. It is, therefore, little wonder that a competitor was regarded as an enemy, incompetent and unscrupulous. These were the golden days for the dealer. Factory sales organizations were unknown, and selling costs were at a minimum. The manufacturer knew nothing of shop costs, and sale prices were made to harmonize with the sale prices of competitors, with the result that profits to those engaged in the industry were small in almost any line requiring high-grade effort.

Out of these conditions, bad as they were with relation to the commercial end of the business, came a mighty strength, for as early as 1893 all the nations of Europe had discovered that this country was producing metal working machinery superior to that which could be found elsewhere. Was it superior sales organizations that gave us almost exclusive control of this great market for the next ten years and established a reputation for American tools that still lingers in spite of later developments abroad?

As proof of this statement, it may be well to cite an incident touching this point. The author was present at an interview in the factory office between one of these peerless pioneer mechanics and a European purchasing agent, who was regarded as a joke, and whose proposal to sell quantities of the manufacturer's product abroad was almost turned down. This mechanical man simply could not understand why any one would wish to come all the way from Europe to purchase the product of his little shop. He was inclined to regard his visitor with suspicion.

Since that day the tremendous increase in the demand for metal working machinery both at home and abroad has been working a transformation in the management and ownership of the business. That this transformation is natural, logical, and inevitable, the author shall not attempt to dispute; but it carries with it dangers that must be guarded against. We must occasionally get back to first principles and not lose sight of the reason why Europeans first came to extensively purchase the product of our shops, with practically no solicitation. The familiar title, the old man or the boss, the master workman of yore, who worked at the drawing-board, bench, or desk, is now transformed to the title of "president" or "general manager", and his knowledge of shop conditions is gathered from a condensed record of costs prepared by an expert in his line, all of which is well and necessary, but which marks a distinct change in the relative importance of the commercial and mechanical departments.

Since the organization of the Machine Tool Builders' Association there has been a noticeable improvement in many directions, and all honor to those leaders who have been its promoters and ardent supporters. Competitors now meet on a basis of real friendship; but something has been lost in the passing of the old professional spirit and pride with reference to mechanical things that will ultimately work great injury. This mechanical spirit that once dominated all, is now dominated by the commercial end. And while the author does not expect that the mechanical end can ever be reinstated in its old position of supreme importance, when coping with a sales organization that reaches around the world, we must not lose sight of the fact that in order to be successful in the markets of the world we must be able to offer at all times the best and the most advanced design to be found anywhere. If this can, in a measure, be brought about, great benefit may come to the Machine Tool Builders' Association by the formation of a mechanical section.

It is more difficult in these days when all-around skilled help is at a premium, for the superintendent and foreman to get away from their work, than for any other set of men connected with the plant. However, this does not apply with the same force to men connected with the designing end of the business. Our trade papers are alert to secure and publish anything of general interest to shop men and designers, and nearly all connected with the industry depend largely on these papers for their information, but, of course, there are lacking the benefits that would come from the personal touch.

It would seem that the annual convention could be extended over five or six days, with the last two or three days given up entirely to subjects that would be of general interest and benefit to the builders and designers of machine tools; or in place of the longer session, a three days' session with meetings held by the different departments in separate rooms, would, perhaps, be preferable.

Another subject for discussion is the advisability of holding in New York, by the National Machine Tool Builders' Association, at stated intervals of five or more years, an exhibition of metal working machinery, restricting each exhibitor to one machine of a type, and permitting no machine to be exhibited that did not show noteworthy improvement over the machine shown by the same exhibitor at the previous exhibition. While this thing may not be practical, the author is convinced that if it could be worked successfully, it would not only be a stimulus in the design of new machines, but would be of great value to the sales end of the business, as it would be sure to be attended by buyers of machinery from all parts of the world.

The whole thought is this: We must first have machines, and then salesmen to introduce them, if we are to maintain ourselves in the foreign markets, as well as in the home markets, for our experience during the past year shows clearly whither we are tending as regards protection. Let us develop the highest grade of commercial spirit, and use if possible this same instrumentality to better our product, to the end that in a measure the professional mechanical spirit of yore be re-established, so that our foreign competitor, should he ever find his passage through the customs house unobstructed, will be greeted everywhere with the sign of the uplifted hand.

* * *

In a paper read before the Iron and Steel Institute, Great Britain, Mr. C. Chappell gave some interesting information relating to the influence of carbon on the corrodibility of iron. He stated that in rolled and annealed steels the corrodibility rises with the carbon content to a maximum at the saturation point (0.89 per cent carbon), and falls with a further increase of carbon. In hardened and tempered steel a continuous rise in corrodibility takes place with an increase of carbon up to a carbon content of 0.96 per cent. Quenching increases the corrodibility to a maximum, while annealing tends to reduce it to a minimum.

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* Abstract of paper by E. J. Kearney, of the Kearney & Trecker Co., Milwaukee, Wis., read before the convention of the National Machine Tool Builders' Association, in New York City, October 17, 1912.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE MUELLER 18-INCH HEAVY-DUTY ENGINE LATHE

The Mueller Machine Tool Co., Cincinnati, O., has recently added to its line the 18-inch heavy-duty engine lathe illustrated in Fig. 1. This machine swings 18½ inches over the ways, 13¼ inches over the carriage, and takes work up to 2 feet 4½ inches between the centers.

The headstock is of massive construction and is ribbed and cross-ribbed to secure the maximum rigidity. The cone pulley has three steps of 9 1/4 inches, 11 3/16 inches and 13 5/32 inches diameter, and double belting 3 1/2 inches wide is used for driving, thus providing an abundance of power for the heaviest classes of service. The cone pulley is locked to or released from the face gear by a spring pull-pin.

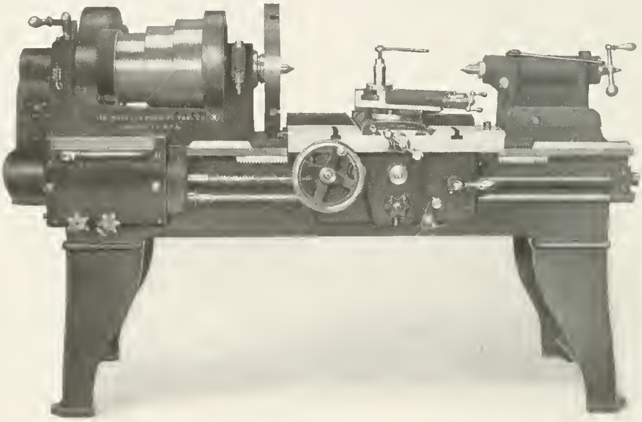


Fig. 1. The Mueller 18-inch Heavy-duty Engine Lathe

The tailstock is arranged with two plug clamps for locking the tailstock spindle without throwing it out of line. Both the headstock and tailstock are set off center, so that large diameters can be turned without having the bottom slide on the carriage overhang its bearings. The tailstock is clamped to the bed by means of two ¾-inch bolts; the tail spindle has a movement of 8¼ inches, and a bearing 2½ inches in diameter.

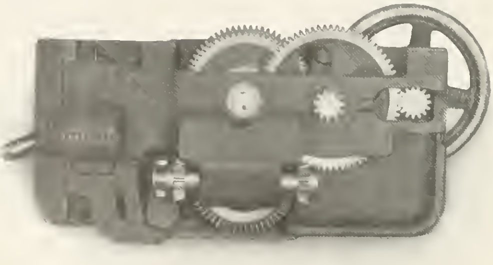


Fig. 2. Rear View of the Lathe Apron

The work spindle is made of high-carbon crucible steel; it has a 1 9/16-inch hole through its entire length, and is fitted for a No. 4 Morse taper. The spindle boxes are of phosphor-bronze, bored and hand scraped to an accurate fit. The bearings are oiled through sight-feed oilers and felt pads which dip into a reservoir. The oil supplied to the bearings by this method is freed from all foreign matter, thus insuring perfect lubrication. The thrust collar is of hardened steel and the end motion is taken up by a nut at the end of the spindle. Nine spindle speeds are provided, ranging in geometrical progression from 13 to 300. The double back-gears on this machine are of the slip-gear type. A lever which is conveniently located at the front of the machine provides means for changing from low to high speed or *vice versa.* The back-gear ratios are 3½ to 1, and 10½ to 1.

This lathe will cut 45 thread pitches ranging from 2 to 60 per inch, including 11½ inch pipe thread. All changes are obtained within the quick change gear box. The ends of the shafts of the gear box and the reversing gears on the head are arranged to receive change-gears for special and metric thread cutting. All threads can be cut without the removal of a gear, and there is a chasing dial on the carriage for "catching" the threads. The turning feeds are positively geared, and are four times the thread feeds. They can be started, stopped or reversed in the apron or head, for either a cross or lateral feed motion, but only when the lead-screw nut is disengaged.

The carriage has exceptionally long bearings on the V's for its entire length. It has an adjustable taper gib the full length of its bearing against the rear side of the bed, thus eliminating the possibility of any twisting of the carriage while extra heavy cuts are being taken. A long shear wiper and oiler is fastened to each end of the carriage bearing on the shear; this arrangement automatically wipes the shear free from all dirt and chips, and oils it as the carriage moves along. The upper slide of the compound rest is bolted to the swivel base with four screws, which insures aosolute rigidity.

The apron is of the rectangular box type, in which all the bearings for the gears and screws are cast integral with the apron itself. All gears are provided with bearings on both sides and the studs are of hardened and ground steel. The feeds are so arranged that only one feed can be in operation at a time. The lead-screw is 1 9/16 inch in diameter, and has a four pitch thread; it is only rotated when the lathe is engaged in screw cutting. The lead- and feed-screws for this lathe are cut from a master screw, thus insuring the greatest possible accuracy.

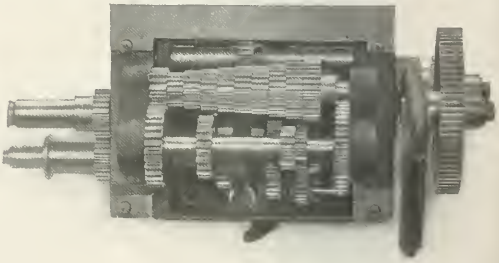


Fig. 3. Gear-box of the Mueller Lathe

The bed is designed with an unusual vertical depth and is firmly braced through its entire length with heavy cross girths, capable of absorbing the vibration of the heaviest cut. The rear bearing is flat. The countershaft has double friction pulleys, 14 inches in diameter. It is fitted with heavy bearings and hangers which insure rigidity and long life.

All gears in the quick change gear box are of steel and have chamfered teeth. Steel gears are also liberally distributed throughout the machine in all places where severe strains are encountered. The greatest care is taken in cutting all of these gears in order to secure the maximum accuracy in the teeth and consequently smooth and noiseless operation. All gearing on the lathe is completely enclosed. The regular equipment consists of two faceplates for large and small stock, steady-rest, follow-rest, countershaft, and the necessary wrenches. The lathe can also be equipped with direct-connected motor drive and with a longer bed, when so required.

MILWAUKEE UPRIGHT DRILLING MACHINES

Two upright drilling machines built by the Richards Machine Co., 1129 Davis St., Milwaukee, Wis., are illustrated in Figs. 1 and 2. Fig. 1 shows the 20-inch machine equipped with back-gears, power feed and a combined wheel-and-lever feed. This machine can also be obtained without the back-gears and power feed, and with either a combined wheel-and-lever feed or a plain lever feed, as desired.

The chief feature of this machine is the method used in disengaging the power feed, when it is desired to use the wheel or lever feed. This device consists of an arm carrying the bevel gear, worm and worm shaft, which is operated by an eccentric for disengaging the bevel driving gears. In the illustration the lever for operating this eccentric is shown in the position it occupies when the power feed is being used. To disengage the power feed, this small lever is simply pulled towards the front of the machine.

There are eight changes of spindle speed and twenty-four changes of feed. The back-gears for the slow speed of the spindle are enclosed in the upper cone pulleys. Power for the automatic feed is obtained from the upper cone spindle, and is transmitted to the drill spindle by belt and the worm and bevel gearing shown.

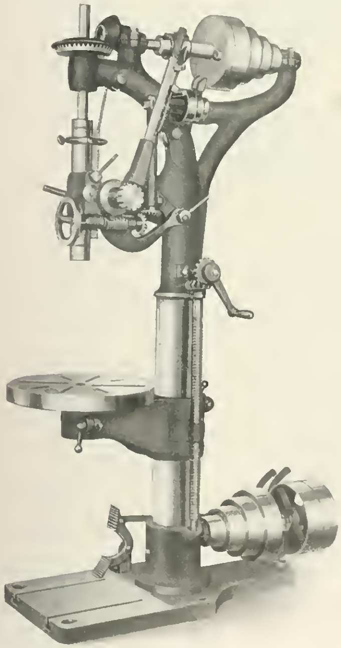


Fig. 1. Upright Drilling Machine built by Richards Machine Co.

The principal dimensions are as follows: Movement of drill spindle, 9 inches; greatest distance from end of spindle to base, 41 inches; greatest distance from end of spindle to table, 25 inches; height over-all, 69 inches; diameter of table, 17 inches; hole in spindle, No. 3 Morse taper. The machine will drill to the center of a 20-inch circle.

The upright drilling machine shown in Fig. 2 is provided with a sliding head, is back-geared, has positive feed and a number of interesting features not found in the other machine. Among these might be mentioned the gear-box for giving a positive feed to the spindle, and the device for effecting the feed changes. This device consists of two levers located directly below the gear-box, which operate a sliding gear for changing the rate of feed. These levers are properly located by a notched plate which they engage. By moving the lower lever up or down, three changes of feed are obtained, and by shifting the upper lever into the "slow" or "fast" notch, six changes of feed are secured. With the top lever in the "slow" notch and the lower lever placed successively in the three notches, the feeds are: 0.003, 0.007 and 0.011 inch per revolution of the spindle. With the upper lever in the "fast" notch and the lower lever shifted to the three positions, the feeds are: 0.023, 0.060 and 0.095 inch per revolution of the spindle.

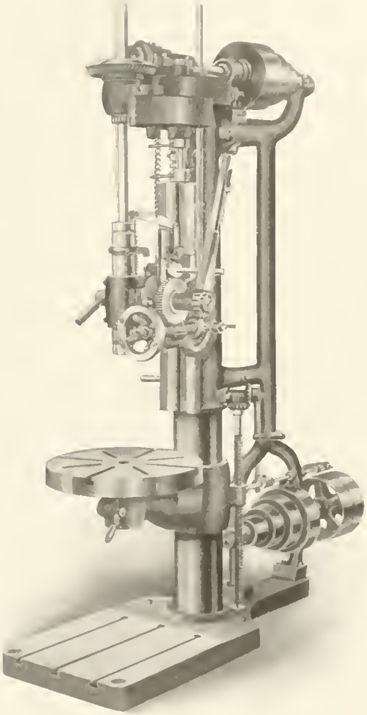


Fig. 2. Upright Drilling Machine of Sliding-head Type

The back-gears are enclosed in the upper cone pulleys and are thus protected from dust and dirt. The principal dimensions of the machine shown in Fig. 2 are as follows: Movement of drill spindle, $10\frac{3}{8}$ inches; movement of sliding head, 20 inches; greatest distance from spindle to base, 50 inches; least distance from spindle to base, 19 inches; greatest distance from table to spindle, 37 inches; diameter of table, 20 inches; height over-all, 84 inches; hole in spindle, No. 4 Morse taper; drilling capacity, to the center of a $24\frac{3}{4}$-inch circle. The weights of the machines shown in Figs. 1 and 2 are 600 and 1500 pounds, respectively.

CINCINNATI PRECISION LATHE WITH SCREW-CUTTING ATTACHMENT

The latest design of friction-driven bench lathe built by the Cincinnati Precision Lathe Co., Cincinnati, Ohio, is shown by the front and rear views, Figs. 1 and 2. This lathe has an improved friction drive and a slide-rest screw-cutting attachment. The difference between the friction-driving mechanism of this lathe and those formerly built is in the control and the construction of the driven disk. The latter, instead of being a solid piece, is formed of two members which are separated by a series of coiled springs, thus forming a spring tension or "cushion" disk. These two parts are shown in detail in Fig. 3. In addition to springs, there are a number of steel guiding studs near the circumference of the disk and a large projecting hub in the center, all of which engage holes in the upper member. The guiding studs and hub are accurately fitted and there is also a bearing fit between the flange on the lower disk and the periphery of the upper disk, which insures a uniform tension at all points on the horizontal friction surface.

A further advantage claimed for this disk is that there is a very slight tendency of the horizontal friction plate to incline with relation to the driving shaft when the friction driving wheel is located outside of the center. This movement, while very slight, is just sufficient to release that part of the friction filler material which would otherwise bear against the outer and more rapidly moving surfaces on the driven disk. In this way the sliding action between the two surfaces, which is common to a rigid-disk friction drive, is obviated and the loss of friction material reduced. As the driving disk is applied on both sides of the driven disk center for obtaining forward and reverse speeds, the face or periphery of the driving disk wears uniformly or parallel to the friction driving shaft. As the driving disk approaches the center of the driven member, the spring tension increases slightly because the wheel comes directly under an increasing number of springs as it approaches the central and higher speed positions. In case a heavier spring tension is desired, the lower driving shaft can be raised by means of eccentric bushings provided.

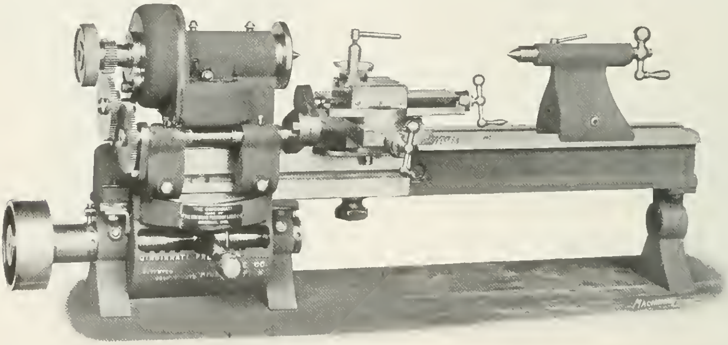


Fig. 1. Cincinnati Friction-driven Precision Lathe with Slide-rest Screw-cutting Attachment

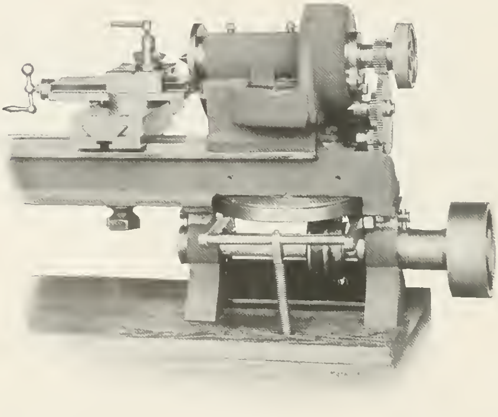


Fig. 2. Rear View of Headstock and Friction Drive, showing Foot-pedal Release

With the horizontal friction disk as the driven member, if the lathe should be overloaded and the frictions caused to slip, the driving disk would continue to revolve and the wear would be uniform instead of forming flat spots. It is claimed that the location of the driving pulley at the base and the use of the cushioned disk reduces vibration to a minimum. The friction hand-control lever for varying the speeds has a circular inner end which engages a recess or slot in the hub of the driving disk. The latter slides easily on the friction driving shaft and a longitudinal key inserted in the shaft, when the friction members are disengaged. The lower side of the control hand lever is so shaped as to readily drop into notches in the front gear cover, for retaining the friction driving wheel in any desired speed location on the driven disk.

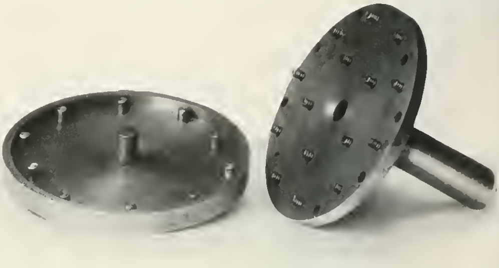


Fig. 3. The Two Parts of the Spring-tension or Cushion Friction Disk

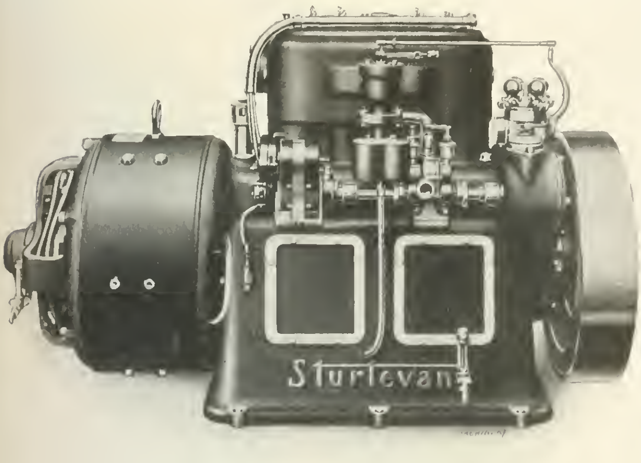
The rear view of the lathe head and friction drive shown in Fig. 2 illustrates the foot pedal release that is applied to this lathe. This releasing mechanism consists of two arms or levers, on the ends of which are bushed fiber rollers so arranged that when pressure is applied to the foot pedal the friction disk surface is raised, thereby disengaging the friction driving member. At the same time, the rollers act as a brake and stop the machine almost instantly. The forward or reverse speed changes can be quickly made, and, as the spindle can be stopped and started very quickly, threads can be cut close to a shoulder with safety. The spring seen between the bench and lever cross-arm is for holding the lifting levers away from the disk when the lathe is in motion. The foot pedal is pushed under a retaining step on the floor when the lathe is to remain stationary.

STURTEVANT GASOLINE-ELECTRIC GENERATING SETS

The B. F. Sturtevant Co., Hyde Park, Mass., is now building gasoline-electric generating sets designed to supply the demand for units that will be easy and inexpensive to operate, in places where electric power is not available. These sets are intended to be used in direct connection with lighting and power circuits and not through a storage battery, although they can be so arranged if desired. The design, workmanship and efficient governor control are said to insure constant voltage through wide variations of load, so that the use of a storage battery to equalize fluctuations of voltage is not necessary.

These generating sets are built in three sizes of five, ten and fifteen kilowatts capacity, capable of lighting 200, 400 or 600 twenty-candlepower tungsten lamps, respectively. The five-kilowatt size is illustrated herewith. These sets consist of a Sturtevant gasoline engine directly connected to a Sturtevant direct-current electric generator. The engine is of the four-cycle, water-cooled, vertical type, having either four or six cylinders, according to the size of the unit. The bore of the cylinders used in the ten and fifteen kilowatt sizes is 4 inches, and the stroke 6 inches, whereas the five-kilowatt engine has a 3¼-inch bore and a 5-inch stroke. The cylinders of the two larger sizes are cast in pairs and have T-shaped heads with inlet valves on one side and exhaust valves on the other. The cylinders of the five-kilowatt engine are cast *en bloc* with inlet and exhaust valves on the same side. In both cases the water jackets are integral.

The cylinders are accurately bored and ground to size, and provision is made for the easy removal of the valves for inspection or regrinding. The pistons have four rings and the piston pins are of large diameter and are made of hardened steel. Both the piston and pin are accurately ground and finished. The connecting-rods are exceptionally long, of I-section and are drop-forged from high-grade steel. The inlet and exhaust valves are of nickel steel. The valves for the ten and fifteen kilowatt units are operated by two camshafts, whereas one camshaft is used on the five-kilowatt size. The cams are integral with their shafts and are hardened and ground to the proper shape. The engine bases of the ten and fifteen kilowatt sets are made of two castings, split horizontally on the center line with the crankshaft bearings. A single casting is used for the base of the five-kilowatt unit and the generator is attached directly to the engine base, as the illustration shows. A separate sub-base for the engine and generator is provided on the larger sizes.



Sturtevant Five-kilowatt Gasoline-electric Generating Set

The crankshaft is made of 3½ per cent nickel steel which is of exceptionally high tensile strength and has undergone careful heat-treatment. All pins and journals are accurately ground. The most improved system of forced lubrication is used, the oil being furnished to all bearings under a pressure of 20 pounds, by means of a gear pump located in the engine base. The oil enters the main bearings and flows through the crankshaft (which is drilled for that purpose) to the crankpins, whence it passes up the connecting-rods to the piston pins. The oil spray thrown off by the centrifugal action of the crankshaft covers the piston and cylinder walls. When the oil falls back into the base it passes through a filter before being used again.

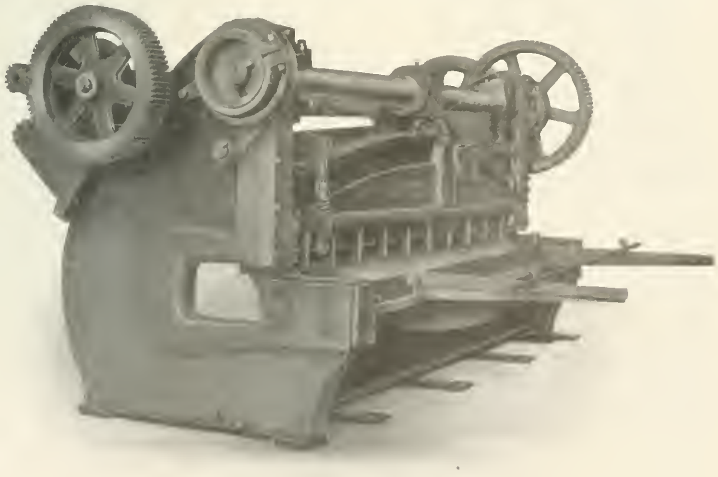
The engine is controlled by a throttling governor of the centrifugal type, operated through bevel gears from the end of the crankshaft. The motion of the governor is transmitted to a throttle valve placed in the inlet manifold. This governor is said to regulate the speed of the engine so accurately between no load and full load, that the voltage variations due to sudden changes in the load are imperceptible and no storage battery is necessary to maintain a constant voltage. The engine is equipped with a high-tension Bosch magneto, which is mounted on the base and is operated from the camshaft. The same type of generator that has been used in connection with Sturtevant steam engines of the U. S. Navy and merchant marine, is used for these gasoline power units. The generator is designed to require a minimum amount of attention. Both the engine and generator are capable of operating under an overload of 25 per cent for two hours.

NIAGARA MOTOR-DRIVEN PLATE SHEAR

A plate gap-shear recently designed and built by the Niagara Machine & Tool Works, Buffalo, N. Y., is shown herewith. This machine has the convenient means for adjusting the bed, crosshead and gibs, common to all large shears built by this company. The motion is controlled by a positive clutch which can be operated by a foot treadle, and the machine stops automatically when the crosshead reaches the highest position. The "hold-down" is raised and lowered by two cams, keyed to opposite ends of the crankshaft. The latter is forged from high-carbon steel.

The arrangement for adjusting the back gage attached to the cutter-bar is a new feature. This gage can be quickly adjusted by the operator, when he stands in front of the machine, by means of the handwheel seen in the center of the shear. The motion is transmitted to the gage by shafting, bevel gears and feed-screws at the rear. The gage always remains in a position parallel to the knives.

This shear is driven by a direct-connected, 15-horsepower motor mounted on a bracket at the rear of the machine, near the gearing seen to the extreme left in the illustration. It has a cutting length of 126 inches and will cut soft steel up to ¼ inch thick. The weight of the shear is about 22.000 pounds

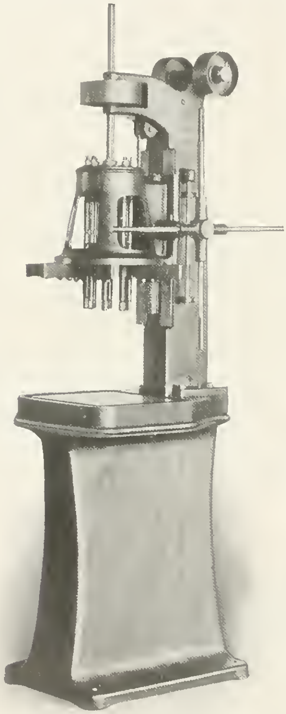


Niagara Motor-driven Plate Shear

THE NATCO NO. 9 MULTIPLE DRILLER

The National Automatic Tool Co., Richmond, Ind., has added to its line of multiple drillers, a smaller machine which includes a number of new features in its design. This machine is known as the Natco No. 9, Type D, and has been designed with a view of replacing multiple spindle drill fixtures which are not only entirely special, but which require a large drilling machine to drive them. This machine can be arranged for either bench or floor use, as it is made with a separate base upon which the machine is mounted for service as a floor drill. The illustration shows the machine set up in this manner, while for use on a bench, it would, of course, be taken from the base.

The method of independently changing the spindle speeds in use on the other multiple drillers made by this company is not used on the present machine, as the maximum size of drills for which it is intended is ¼ inch. The head feeds down to the work by means of a capstan operating a rack and pinion; the head has a bearing 11½ inches in width and a maximum travel of 12 inches. It is counterbalanced by means of a chain and weight, and is provided with adjustable stops for drilling holes to a specified depth. Adjustable gibs provide means to take up any wear that may develop, and the machine has a maximum capacity for a circle 8⅜ inches in diameter.


The National Automatic Tool Co.'s No. 9 Multiple Drilling Machine

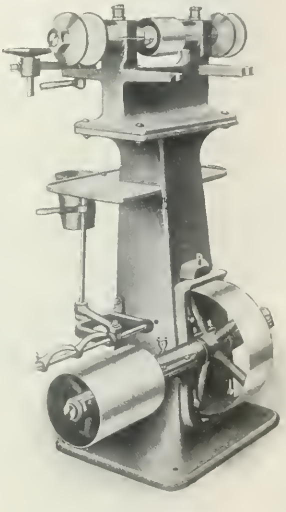
The same rail and joint construction is used on this machine as on the larger sizes of multiple drillers built by this company. The rails are made of steel and have a bearing of 4 inches for the spindle. They are provided with ball thrust bearings, means of adjusting for wear and ample oiling facilities. Two sizes of rails are used which are known as the No. 1 and No. 2 size. The largest drill for the No. 1 size is 3/16 inch, with minimum centers 21/32 inch; for the No. 2 rail, the largest drill used is 1/4 inch, with minimum centers 25/32. If closer centers are desired, special rails can be furnished. The rails are easily changed from one layout to another. The base has a working surface 14½ inches square, and the surface over the oil groove is 17¼ by 18¼ inches. The maximum distance from the end of the spindle to the base is 15 inches, and the minimum distance 3 inches.

This machine can also be equipped with cluster boxes in which all of the spindles are permanently located. With a cluster box equipment, it is possible to drill a larger number of holes than with the rails, the number depending upon the material to be drilled and the size of the holes. The use of these cluster boxes saves the time occupied in changing rails from one layout to another and any number of cluster boxes can be used on a given machine, as all boxes are made interchangeable. The advantages of the cluster boxes for strictly interchangeable manufacturing are apparent. The illustration shows the machine equipped for belt drive, but individual motor drive can be furnished if so desired.

ST. LOUIS GRINDER

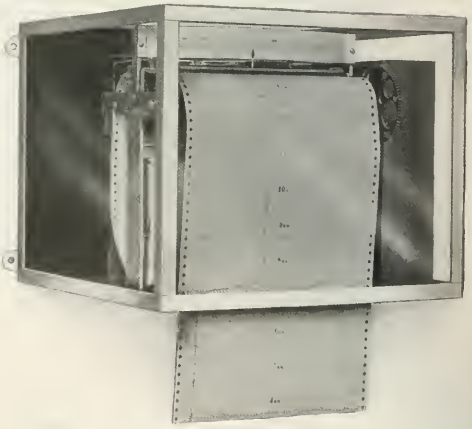
The grinder shown in the illustration is an improved design now being built by the St. Louis Machine Tool Co., 1209 Gratiot St., St. Louis, Mo. The countershaft of this grinder is carried by a frame that is attached to the column by accurately milled square gibs. With this construction, the countershaft is kept in accurate alignment and the tension of the belt can easily be varied by simply raising or lowering the frame, a suitable adjusting screw being provided for that purpose. By driving the spindle from below, the wheels run smoothly, as the pull of the belt is downward against the rigid body of the machine.

The spindle of this grinder is made of 0.40 per cent carbon steel. The boxes are dust-proof and the rests are of an improved design requiring a shorter bracket than the straight type. As the illustration shows, the machine is also equipped with back-rests for attaching wheel guards or fixtures. The wheel guard is a simple and effective design consisting of a steel channel rolled to a segment of a circle and reinforced by a heavy cast-iron bracket riveted to the inside flange. This bracket is attached to the back-rest by a bolt which slides in the slot, thus allowing the guard to be adjusted backward as the wheel wears. The lips of the guard can be kept close to the wheel where they are not in the operator's way. These grinders are made in six sizes.


Rear View of St. Louis Grinder showing Method of Attaching Countershaft

CONTINUOUS-CHART RECORDING PYROMETER

The Brown Instrument Co., of Philadelphia, Pa., and its associate company, the Keystone Electrical Instrument Co., have brought out a new continuous-chart, recording pyrometer.


Continuous-chart Recording Instrument for Indicating Temperatures, Volts, Amperes, etc.

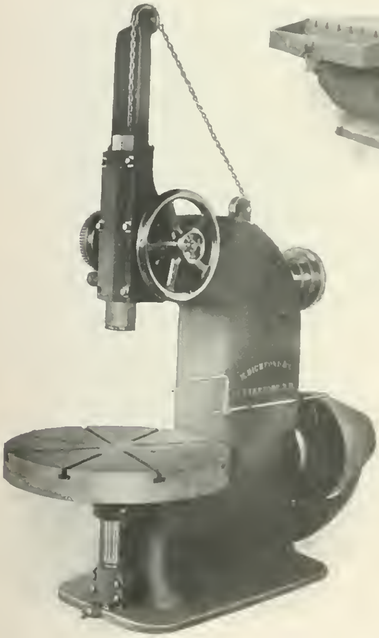
This instrument is designed more particularly for use as a pyrometer, but can also be employed for indicating volts, amperes, revolutions per minute, mechanical operations, etc., where a small current of electricity is required to operate a recording instrument.

The construction of this instrument is simple, and the works are enclosed in a plate-glass case. It is of the frictionless type, the pen forming a line by making single dots of ink on the paper at short intervals of ten seconds or a minute, as desired. These dots practically form a continuous line. The instrument carries a roll of recording paper which will last six months. This paper travels a little over an inch an hour, so that it is not necessary to change the charts daily and a continuous record can be secured.

BICKFORD VERTICAL CHUCKING MACHINE

The vertical chucking machine shown in the accompanying engraving has been designed to supply the demand for a low-priced tool for boring car wheels, gears, pulleys, and similar work. The tool-slide of this machine is octagonal in shape and is counterbalanced. The spindle feed is operated through a large friction worm-gear on the left side of the head, which runs in oil. This worm-gear is driven through a geared feed-shaft connecting with the main driving shaft by the four-step feed cones seen at the rear, which gives four changes of feed. A large handwheel is provided for hand adjustment and a quick-return movement, and the friction feed is engaged by means of a small handwheel in the center of the large wheel.

The table is driven through heavy bevel gears and it has a large spindle fitted with adjustable boxes. The weight of the table and work is taken by a hardened and ground steel step which is submerged in oil and is adjustable. The frame of the machine is very rigid. The driving shaft is mounted in three long bearings and the outer end is supported by a heavy arm attached to the frame. This machine can be equipped with detachable chuck jaws or a special chuck table. The swing is 37 inches, and the total movement of the spindle, 29¼ inches. It is built by H. Bickford & Co., Lakeport, N. H.



Bickford Vertical Chucking Machine

INGERSOLL MILLING MACHINE

The Ingersoll Milling Machine Co., Rockford, Ill., recently installed the large five-head, six-spindle horizontal milling machine shown in Fig. 1, in one of the largest tractor plants in this country. This machine is used for milling forty and sixty horsepower tractor engine frames, as indicated in Fig. 2. These frames are finished complete on this machine and five cutters operate simultaneously. The largest of these cutters has a diameter of 36 inches.

The bed and table of the machine are of the conventional planer-type construction, and the wings upon which the housings are mounted are cast integral with the bed. The housings and cross-rail are also made in one piece, and because of this feature, the machine is known as the "fixed rail" type. The casting forming the housings and cross-rail, is very large and heavy, as the illustration indicates. The face or bearing for the saddles is 21 inches wide and the housings are 36 inches deep. The distance from the top of the table to the under side of the rail is 42 inches.

As previously mentioned, the machine has five heads, three of which are horizontal and two vertical. One of the horizontal heads is mounted on the left-hand housing, and on the right-hand side there is a main head carrying an auxiliary head and also an extra spindle which passes through the main spindle. The horizontal heads on both sides are counterbalanced and can be moved simultaneously or independently.

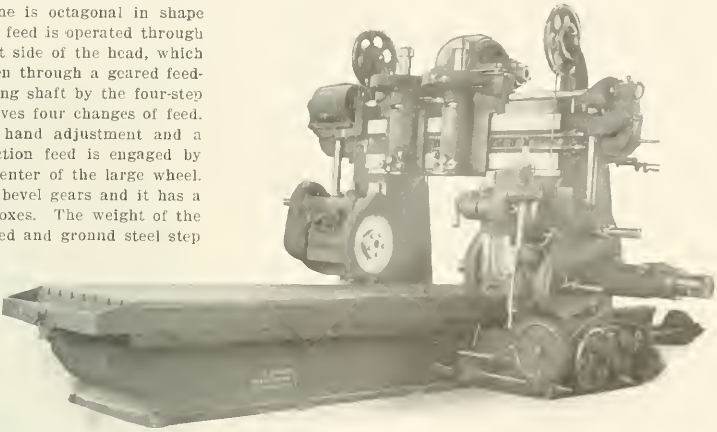


Fig. 1. Ingersoll Five-head, Six-spindle Milling Machine

The right-hand horizontal head is the most massive, as the illustration shows. Its main spindle is of the faceplate-drive type and is arranged to carry cutters varying from 24 to 36 inches in diameter. The spindle which passes through this main spindle, is used for driving small cutters. It is 4½ inches in diameter and has an in-and-out adjustment of 18 inches. The auxiliary head or saddle is in front of the main spindle and also has a 4½-inch spindle which runs in a sleeve or quill 6⅛ inches in diameter. The spindle has an in-and-out hand adjustment of 6 inches, and the saddle itself has a vertical adjustment of 18 inches on the main saddle.

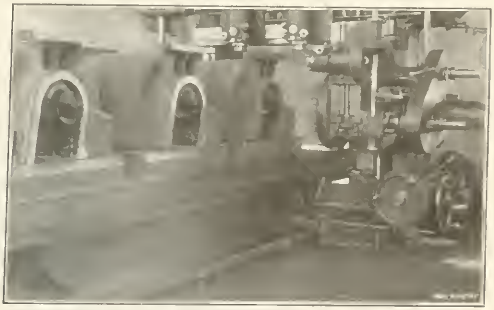
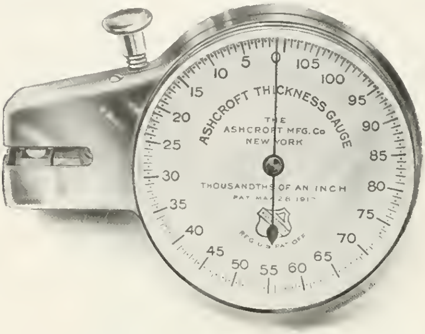


Fig 2. Ingersoll Machine Milling Tractor Engine Frames

The left-hand horizontal head is also of the faceplate-drive type, cutters of large diameter being bolted directly to the spindle driving gear. The vertical spindles are 4½ inches in diameter. The drive is a 40 H. P. direct-connected motor.

ASHCROFT THICKNESS GAGE FOR SHEET MATERIALS

The Ashcroft thickness gage shown in the illustration is a convenient and accurate instrument for quickly measuring the thickness of sheet metal, sheet rubber, leather, paper, boxboard or any sheet material not exceeding 0.110 inch in thickness. It is of a convenient size to be held in the hands, and the material to be measured is inserted between the jaws which are opened by pressing a push-button with the finger. When pressure on the push-button is released, the jaws automatically close and the thickness of the material is indicated on the dial.

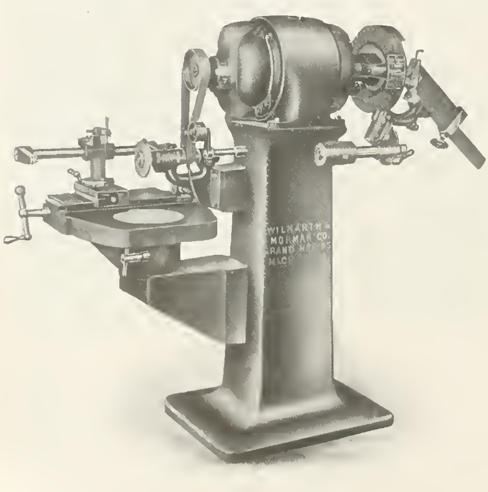


Ashcroft Thickness Gage for Sheet Materiale

The white enamelled dial is easy to read, as the graduations stand out distinctly. The dashes represent thousandths, the dots one-half thousandths, and the points equidistant between the dots and dashes, one-quarter thousandths of an inch. The gage has no sliding parts, the movement being mounted on steel pivots. Friction and wear are thus reduced to a minimum. This gage can be carried in the vest pocket, if desired, and, with proper care, will last for years. It has been placed on the market by the Ashcroft Mfg. Co., 85 Liberty St., New York. The price of the instrument is $10.

WILMARTH & MORMAN MOTOR-DRIVEN CUTTER, REAMER AND DRILL GRINDER

Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has recently equipped its combination cutter, reamer and drill grinder with a direct connected motor drive. The motor on this machine is one horsepower, and is made by the General Electric Co. to meet the special requirements of the present class of work. The controller for the motor is mounted on the column of the machine, and the power switch is located directly beneath the controller. The table and its slide are mounted on a knee, as shown in the illustration, so that it is possible to swivel the table around to enable grinding to be done on either side of a plain wheel, or to provide for the use of a cup-wheel.

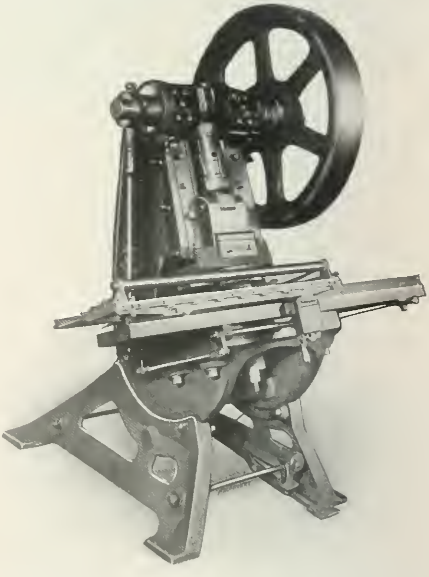


Wilmarth & Morman Motor-driven Combination Cutter, Reamer and Drill Grinder

The machine will grind face and side milling cutters up to 12 inches in diameter, straight or taper reamers up to 17 inches in length with flutes not over 11½ inches, angle milling cutters of any angle up to 8 inches, plain milling cutters of any type up to 8 inches, gear cutters up to 5½ inches, hobs up to 5½ inches, forming cutters of any length up to 5½ inches in diameter, and flutes of taps up to 11½ inches in length. The machine will take cylindrical or taper work up to 7¼ inches in diameter and 11½ inches in length. It has a maximum distance between centers of 17 inches, and a capacity for internal grinding up to 4 inches in depth by 10½ inch swing. The drill grinding attachment is the regular new Yankee non-calipering type, which provides for simply dropping the drill in the holder and grinding it. The capacity for drill grinding runs from No. 60 to ⅝ inch, from 3/32 to 1¼ inch, or from ⅛ inch to 2¼ inches.

STAGGER FEED SPACING TABLE FOR BLISS PRESSES

The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., has recently developed and patented a stagger-feed spacing table for use in connection with inclinable single-crank and three-crank, double-action presses. This attachment is adapted for rapid, accurate feeding of decorated stock for bottle caps, covers, and similar work.



Bliss Inclinable Press equipped with Stagger-feed Spacing Table

The table is moved by the operator after each stroke of the press and is locked by a cam-actuated stop which engages a rack on the table. The table is a light aluminum casting mounted on rollers. This construction allows the operator to cut an entire row of blanks without stopping the press. A handle bar is provided which is used to move the table and also, through eccentric pivots, to control the grippers. The sheet is first placed between the guides on the table and rests on a pair of preliminary stops which locate it for cutting the first row. A twist of the handle bar then closes the grippers, the preliminary stops are lifted clear by a knob at the right and the first row is cut. Subsequent rows are gaged by allowing the sheet to drop against a straightedge at the back. All the operator has to do is to open the grippers, allow the sheet to fall, and close the grippers again.

A pair of scrap cutting dies is used to trim the sheet so that new gage points are made as each row is cut. The scrap is cut into small pieces, and scrap cutters are usually mounted on the same block as the die, to facilitate setting. The table is designed to handle standard sheets 20 inches wide by 28 inches long, and adjustment is provided to take sheets up to 30 inches long. The spacing rack for gaging is clamped over a T-slot and can be removed readily and different spacing racks attached. The speed of the press can range from 120 to 150 strokes per minute, depending on the size and character of the work.

THE CINCINNATI 36-INCH FROG AND SWITCH PLANER

The Cincinnati Planer Co., Cincinnati, O., has recently added to its line the 36-inch frog and switch planer illustrated in Figs. 1, 2 and 3. This machine has been constructed along lines which give it ample strength and rigidity for the heaviest classes of work. The bed is of the modern deep pattern, braced throughout by box girders, and is made with four walls between the housings where the greatest strain is developed. The vees are extra wide and are oiled by a forced lubrication system which maintains a film of oil between the table and bed at all times. The table is 32 inches in width, and has an inside bearing on the bed for its entire length, thus overcoming the pressure of heavy side cuts. Adjustable side gibs are provided on each side to prevent the table from lifting. The housings, which are of box form, have a 10-inch face and extend down to the floor. They are secured to the bed by bolts and dowel pins, and a tongue and groove 1½ inch deep by 5 inches wide. The cross-rail is 20 inches wide and has a deep ribbed box brace on the back to provide increased stiffness. In addition to the usual outside set of clamps, it is secured to the housings by an extra set of clamps on the inside; this design provides a very rigid form of construction. If desired, the cross-rail can be fastened to the housings by large dowel pins at various fixed heights. The rail screw has two long nuts in the saddle, thus reducing the strain on the threads when taking heavy side cuts and also insuring long life for both the screw and nut. The heads have automatic cross and vertical feeds, and are made right and left to bring them close together. The saddle and harp are made in one piece, without a swivel, and have a bearing of 25 inches on the rail. The countershaft is mounted on top of the housings and is driven by a 50 H. P. motor as shown, thus making the machine self-contained. A heavy cast-iron frame is fitted between the upper and lower bearings, and is also fastened to the housings so that there can be no spring in the shafts or bearings when the machine is working on the heaviest cuts. The driving pulleys are 34 inches in diameter and are made of aluminum alloy, thus providing for a quick reverse on short strokes. The four-belt drive used on this planer provides ample power for the heaviest classes of work, and the shifting mechanism is provided with a safety locking de-

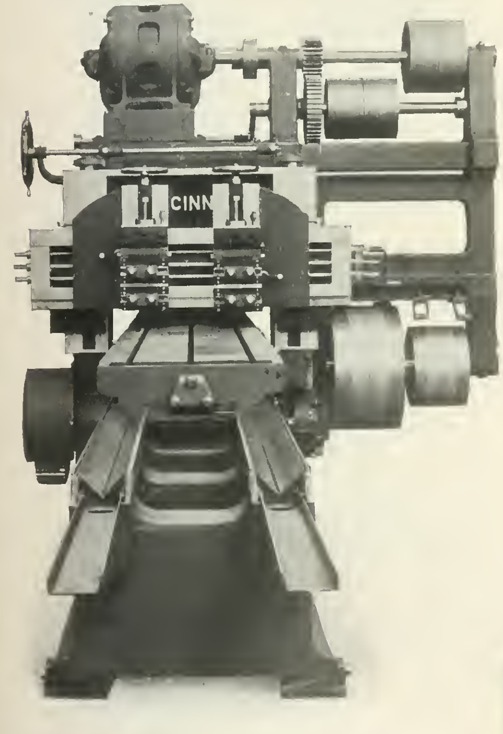


Fig. 1. Front View of Cincinnati 36-inch Frog and Switch Planer

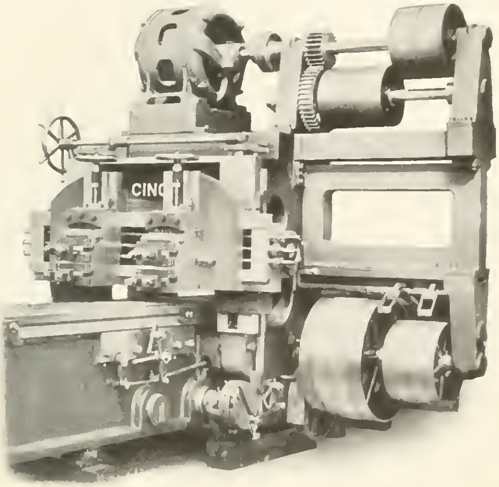


Fig. 2. Operating Side of Cincinnati Planer

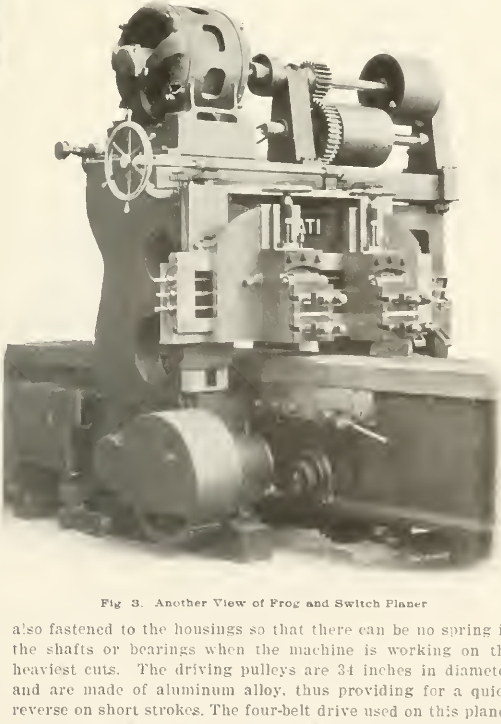


Fig. 3. Another View of Frog and Switch Planer

vice which prevents the table from starting, except at the will of the operator. Levers are so arranged that the machine can be operated from either side. The driving shafts are of unusually large diameter; they are made of special crucible steel. They are accurately ground and run in long bearings which are fitted solidly into the bed. The driving pulleys are so constructed that they only require oiling once in sixty days. The rack and gearing are made of solid crucible steel, to enable them to withstand heavy strains incident to frog and switch work; the bull wheel and rack are 12 inches in width and 1½ diametral pitch.

BLAKE & JOHNSON GANG SLITTING MACHINE

The Blake & Johnson Co., Waterbury, Conn., has brought out an improved gang slitter for cutting steel or other metals into strips. This machine, which is illustrated in Figs. 1 and 2, is so designed that the cutters can be changed in a minimum of time. The upper arbor is hinged on an intermediate shaft and is adjustable to or from the lower arbor, on an arc rather than a straight line. As the driven gear on the upper arbor revolves about the center of the driving gear, both gears remain in mesh regardless of the upper arbor's position. With this arrangement, it makes no difference whether the cutters have a diameter of 5¼ inches, as when new, or are reduced to the minimum diameter of 4½ inches, because the adjustment for changes in diameter can be made without introducing lost motion in the driving gears. The upper arbor is driven by a bronze gear on the intermediate shaft, which is in mesh with the steel gear on the lower arbor.

In order to change the gangs of cutters for slitting different widths, it is only necessary to remove two cap-screws at the foot of the outboard housing, slide the housing clear of the arbor ends, release a lock-pin and adjusting screw and swing the upper arbor up and away from the lower one (see Fig. 2). The ease with which cutters can be changed will be appreciated where different widths of stock are required.

The machine is driven by a sensitive clutch pulley, the clutch of which can be operated either from the front or rear of the machine, or from a considerable distance by means of a suitable rope connection. The clutch pulley is 16 inches in diameter and has a 4-inch face, and the power is transmitted through back-gears having a ratio of 4.2 to 1. All the bearings of the machine are bronze-bushed and the arbors are made of crucible steel. This slitter has a capacity for stock up to 6 inches wide and is especially adapted for slitting steel

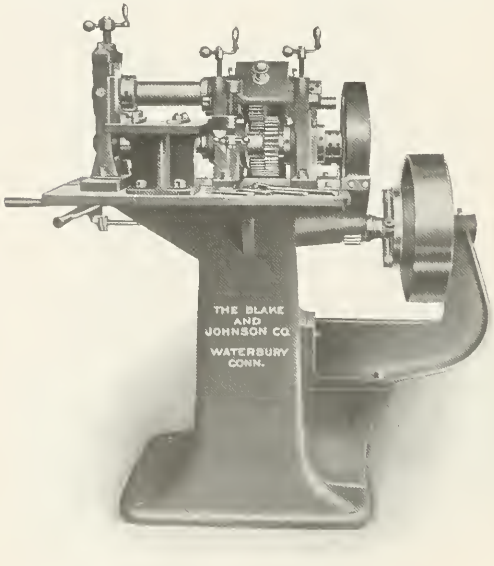


Fig. 1. Blake & Johnson Gang Slitting Machine

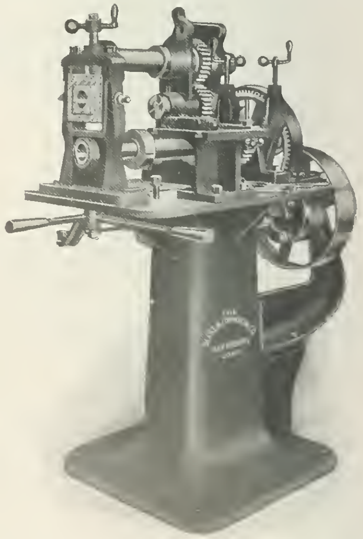
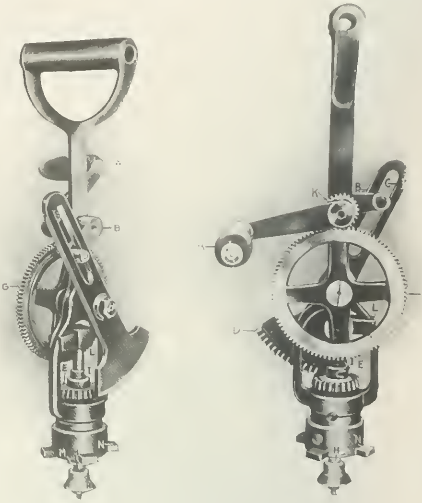


Fig. 2. Slitter with Housing moved back for changing Cuttere

AUTOMATIC VALVE GRINDER

The valve grinder illustrated herewith is intended for grinding the valves of gasoline engines. This grinder gives a continuous cycle of operations, so that the valve is evenly ground and accurately seated. The valve is rotated in opposite directions in its seat and is progressively advanced periodically in one direction. First the valve is reciprocated on its seat a given number of times; it is then lifted, and when released by a suitable cam is automatically placed in a different angular position on the seat, after which it is automatically moved forward through a given angle and again reciprocated. The operation of this grinder is as follows: When the handle *A* is turned, crank *B*, which engages slot *C*, imparts an oscillating motion to segment *D*, which reciprocates the small pinion *E*. This pinion, through clutch *I*, transmits motion to the driving spindle *H*. At the same time, gear *G* is driven by a small pinion *K*. Located on the inside of gear *G* there is a cam which periodically comes under a roller mounted on carrier *L* and lifts clutch *I* from engagement. The clutch remains disengaged until pinion *E* is rotated through a given

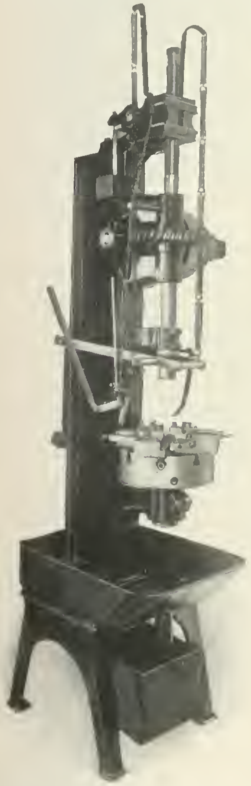


Specialty Machine Co.'s Hand-operated Valve Grinder are, when the cam drops the clutch back into engagement. This movement effected by the cam also lifts the valve from its seat. Spring *M* engages the clutch at the proper time and insures a constant grinding pressure. The compression of this spring varies in accordance with the size of valves which are to be ground. The weight of the tool and downward pressure of the operator is carried by shoulder *N* which rests on the valve opening of the engine. This automatic valve grinder is being manufactured by the Specialty Machine Co., 95 Liberty St., New York.

BICKFORD UPRIGHT TAP-THREADING MACHINE

The Bickford Machine Co., Greenfield, Mass., has placed on the market a new machine for threading taps. This machine is an upright design, as the accompanying engraving shows. The taps are threaded by a die-head located below the spindle and supported by a foot projecting from the vertical column. The spindle rotates the tap blank being threaded, and, at the same time, is fed downward by a lead- or master-screw. The spindle is revolved by means of coarse-pitch worm-gearing having a ratio of about ten to one. The worm is carried by a horizontal shaft located near the top of the machine. This shaft is driven by a three-inch belt connecting with the cone pulley seen to the right of the worm-gear, and the latter transmits the motion to the spindle.

The lead screw is in the form of a threaded shell. It is located on the upper end of the spindle and is engaged by half-nuts operating in a slide which forms part of the main column. The lower end of the spindle carries a holder for driving the tap blank, and the latter, when threaded, drops through the base of the machine. The spindle also carries (but does not revolve) a horizontal bar to which is attached, from above, pull-strings which return the spindle upward to its normal position when the half-nuts are released from the lead-screw. This disengagement of the half-nuts is effected by a trip which can be set to act just after the threaded tap drops from the holder.


Bickford Tap-threading Machine

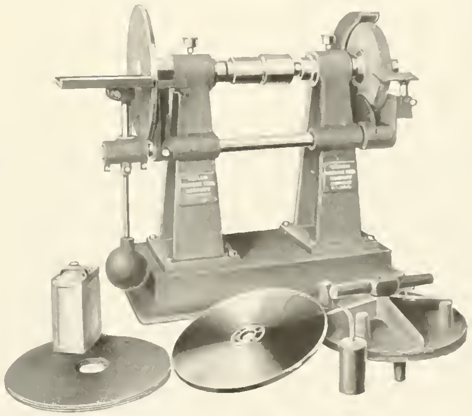
In operating the machine, the square shank of the tap blank is inserted in the holder at the lower end of the spindle, while the machine is running. The tap is held in position with one hand and the spindle is pulled down with the other (until the tap enters the die) by means of the short cross-handle seen in front of the spindle. The tap blank is then released and the lever on the left (which has a chain attached to its short arm) is pulled over, which engages the half-nuts with the lead-screw, thus causing the spindle to feed downward.

Lead-screws and half-nuts of different pitches are easily applied to the machine, and, if desired, they can be furnished with an increased lead to compensate for shrinkage in hardening the taps. A generous stream of oil is supplied to the work by a pump at the rear, which is driven from the countershaft. The lower bearing for the spindle can be removed easily, and, when this is detached, a much longer spindle travel is obtained. This feature adapts the machine to the threading of stay-bolt or other taps having long threads. The machine has a capacity for taps varying from one-half to two inches in diameter, and the same set of chasers can be used on any size tap having the same pitch of thread.

The company recommends the installation of two machines so that when threading large taps which require two cuts, the machines can be used in conjunction with each other. The threading die employed is a solid adjustable type having milled chasers. This die is efficient and produces accurate work. The total height of this machine is 8 feet 4 inches, and the weight about 1200 pounds.

SELLEW COMBINATION DISK GRINDER

The disk grinder shown in the accompanying engraving is built by the Sellew Machine Tool Co., Pawtucket, R. I. This is a combination grinder, one end having a 14- by 2-inch carborundum wheel for general work, and the other, a 20-inch disk wheel. The grinding wheel is enclosed by a substantial safety guard, carrying an adjustable support with rests so arranged as to enable the operator to work either on the front or side of the wheel. This equipment can be removed quickly for attaching buffing wheels, drums, etc. The spindle has a safety cap nut on its threaded end. The twenty-inch disk has a swinging table on the outer or finer side, which can be tilted for angular work and clamped in its tilted position. On the inner or coarse side of the disk, there is a stationary rest which can be used for supporting the work while taking roughing cuts or, if necessary, it can be swung down out of the way altogether. If desirable, both ends of the machine can be equipped either with disks and swinging tables or with grinding wheels.

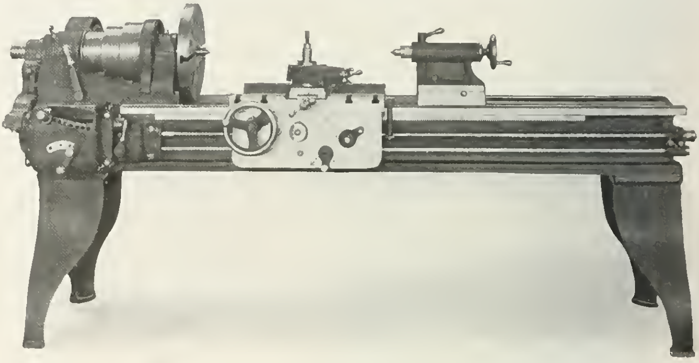

Sellew Combination Disk Grinder

The spindle of this grinder was made exceptionally long in proportion to the diameter of the disk, to eliminate excessive wear of the journals and vibration. The length of the spindle over-all is 40 inches and the journals measure 2 by 7¼ inches. The journals are self-oiling and have ball bearings to take endwise thrusts. These bearings are protected by felt dust-guards. The spindle driving pulley is somewhat larger in diameter than the loose pulley, in order to relieve the tension of the belt when it is shifted to the loose pulley. The weight of the machine, complete with the necessary equipment, is 1600 pounds.

CONOVER-OVERKAMP QUICK CHANGE GEAR LATHES

The Conover-Overkamp Machine & Tool Co., Dayton, Ohio, is now manufacturing the quick change gear lathe shown herewith. This design is made in 14- and 16-inch sizes and with either a large three-step cone and friction double back-gears, as shown in the illustration, or with a five-step cone and single back-gears. These machines can also be equipped either with a quick change gear box, as illustrated, an all-geared feed-box, or a standard belt feed-box and change-gears. Each of these boxes is an independent unit and they are interchangeable. This feature makes it possible to attach any one of these three units to the lathe at any time; that is, either a quick change gear box, a geared feed-box or a belt feed-box.

All gears in the boxes are steel and the bearings are bronze-bushed and can easily be renewed, in case of wear, without affecting the center distances or alignments. The boxes are fastened to the bed by four bolts and can easily be attached or removed. The change gear box, the geared feed-box, and the belt feed-box, are simple designs and there are no overhanging parts at the end of the lathe. The quick change gear box contains a driven shaft carrying a tumbler gear which can be engaged with any one of the eight cone gears. In constant mesh with the cone gears, there is an intermediate shaft provided with four gears, and a set of sliding gears can be engaged with any one of the intermediate gears by means of the lower lever seen at the front of the box. With this arrangement, thirty-two changes are obtained with but two operating levers and without removing or changing a single gear. A stud is provided on the reverse quadrant for compounding or for the introduction of special gears, so that special or metric threads can be cut with the standard lead-screw. The geared feed-box has four changes and is operated by one lever. The changes are obtained through sliding gears and positive clutches. The belt feed-box is equipped with a belt tightener.



Quick Change Gear Lathe built by Conover-Overkamp Machine & Tool Co.

These lathes can be furnished with standard legs, cabinet legs and also with short legs and oil pans. A taper attachment can be added at any time, as all carriages are planed and drilled for this purpose before the lathe is shipped.

NEW MACHINERY AND TOOLS NOTES

Precision Boring Head: Precision Tool Co., Lansing, Mich. A new precision boring tool for use in fine miller work and similar classes of service. This tool is equipped with an adjusting screw to adjust it for any size of radius work, the screw being provided with a micrometer attachment for securing any radius that is required.

Spiral Cutter Grinder: Sloan & Chace Mfg. Co., Newark, N. J. A spiral cutter grinder, semi-automatic in its action, which has an emery wheel four inches in diameter. The machine will grind an eight tooth 45 degree angle cutter in three minutes. The wheel spindle is fitted with S. K. F. ball bearings and the work is held between centers.

Mandrel Press: G. T. Eames Co., Kalamazoo, Mich. A mandrel press provided with a leverage system which multiplies the applied force by three hundred. This press is equipped with a square ram and is operated by a rack and pinion; it has a lock-nut that enables the ram to be clamped in any position while adjusting the work. These presses are made in a variety of lines and sizes.

A Group of Special Lathes: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. A special manufacturing lathe, designed with the jack shaft under the bed so that the machines can be grouped together and arranged for any desired speed. The driving pulley is loosely mounted on the spindle and is engaged by means of a friction clutch; the lathe headstock is cored out to permit the passage of the driving belt.

Metal Cutting Machine: Racine Tool & Machine Co., Racine Junction, Wis. A new type of metal cutting machine equipped with a three speed attachment designed to give speeds of 60, 90 and 125 R. P. M. respectively, when cutting unannealed tool steel, annealed high-speed steel and mild steel. The general construction of the machine follows the lines which are now generally recognized as standard for equipments of this type.

High-Speed Hacksaw Machine: E. C. Atkins & Co., Indianapolis, Ind. A high-speed hacksaw machine known as the No. 7 "Kwik Kut," equipped with a swivel vise and independent motor which has a speed range of 550-1100 R. P. M., and drives by means of a Morse chain running over hardened steel gears. The machine is provided with the most modern type of lubrication system and method of raising the saw on the idle or return stroke.

Electric Drilling Machine: Van Dorn & Dutton Co., Cleveland, O. An electrically operated drilling and reaming machine which has a drilling capacity of one-half inch in steel and one inch in wood, and a reaming capacity of 7/16 inch. The machine is 14 inches high from the top of the handle to the bottom of the chuck, and weighs 17 pounds. It is designed to operate at a speed of 700 R. P. M. and can be furnished for connection with either 110 or 220 volt lines.

Multiple Drilling Machine: Taylor & Fenn Co., Hartford, Conn. A machine equipped with a multiple head that is built with from two to fourteen spindles. The position of these spindles is not adjustable, so that special heads are required for each class of multiple drilling that is to be done. The spindles are gear-driven, and as the gear ratio is arranged to provide the proper speed for various sizes of drills, it is necessary to specify the size of drills that are to be used.

Double Arbor Buffing and Polishing Machine: Excelsior Tool & Machine Co., East St. Louis, Ill. A special design of buffing and polishing machine which has two independent spindles, giving a combination of handiness of operation, simplicity, and large capacity. The entire machine is enclosed by dust-proof covers and has a solid bracket for attaching the dust hood. The machine is designed to run at a speed of 300 R. P. M., although this figure may be varied slightly to meet the requirements of individual classes of work.

Revolution Counter: American Ever Ready Co., 304 Hudson St., N. Y. City. A new type of revolution counter that is shaped somewhat like a revolver and of about the same size. The starting and stopping of the counting mechanism of this device are not dependent upon the amount of pressure applied in holding the counter against the revolving spindle. The counting mechanism is started and stopped by operating a trigger, and the recorder indicates in the forward direction regardless of the direction of rotation of the shaft.

Belt Surface Grinder: Peerless Surface Machine Co., Newark, N. J. A line of belt surface grinders of both vertical and horizontal types, and of different sizes for a variety of classes of work. These machines are provided with an endless belt upon which the abrasive material is mounted, and a work table that can be swung to any desired angle. The bearings in which the spindles of the belt pulleys run are provided with boxes of the sliding type, which enables any stretch in the belt to be taken up. A dust collector is arranged to catch the metal dust which is removed from the work.

Plain Radial Drilling Machines: Dreses Machine Tool Co., Cincinnati, O. These machines are of the 3- and 3½-foot size, and are similar in construction to the 5-, 6-, and 7-foot sizes illustrated in November, 1911. They are designed for the use of high-speed drills, are convenient to operate and substantially built. The outer column swings on a fixed inner column extending to the top, and there is a third bearing in the middle which greatly increases the strength and rigidity. The arm is of box, parabolic shape and the lower rib is double-webbed, thus giving great resistance to bending and torsional strains. The head has long and wide bearings on the face of the arm, and, in addition, a third bearing at the rear. This third bearing gives extra support to the head, prevents bending the rear shaft, reduces the wear of the bevel gears and bearings and distributes the torsional strain over the entire arm. The spindle has twenty-one speeds, runs in phosphor-bronze bearings and is driven by two keys. The driving gear of the spindle rests and revolves on a ball bearing, which is said to effect a power saving of 15 per cent. The feed is all-geared and there are eight changes which can be varied while drilling, by a handle located on the head. There is an automatic stop and depth gage; a quick-return having four handles, either of which can be used for engaging or disengaging the feed; and a tapping, starting and stopping mechanism of the frictional type, operated by a conveniently located lever.

* * *

BORING MORTAR CARRIAGES

At the Builders' Iron Foundry, Providence, R. I., some interesting work is going through in connection with the making of disappearing carriages for mortars for the U. S. Government. These mortars are of the 12-inch size, model 1896—M—III, and will be used for coast defense. One of the trunnion castings is shown in Fig. 1. This casting weighs 5620 pounds, and the boring operations on it well illustrate the general character of the work.

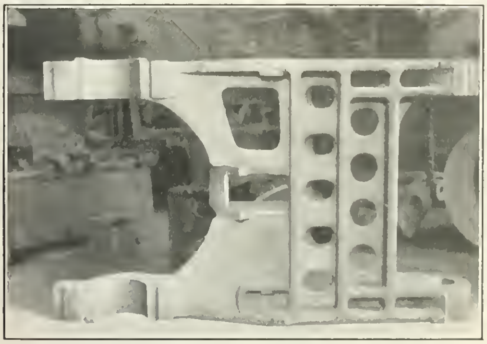


Fig. 1. Disappearing Mortar Carriage Casting being bored in Fig. 2

This work consists in the boring of the large trunnion holes at one end, the fulcrum pin holes at the opposite end, and miscellaneous smaller holes between the two ends to receive the intermediate and elevating shafts. In doing this work a universal boring machine is used, as shown in Fig. 2. In order to facilitate the handling of the work upon this machine a special table was made to assist in supporting the work while being operated on. This will be observed in place on the machine beneath the casting. Before the casting is bored, however, the trunnion ends are milled and fitted with the bearing caps. This being done, the casting is mounted on a fixture and the fixture supported on the machine in position for boring the trunnion holes, which are finished to a size slightly over 13 inches. It is important that this dimension be very accurate. It will be observed that the casting is too large to be supported wholly on the table of the machine, and it is necessary to support the outer end upon jacks which may be seen in Fig. 2. This part of the work being done, the casting is reversed, and, by supporting a test-bar in bearings which have been provided in the trunnion end of the fixture, a convenient means is afforded for taking measurements when boring the fulcrum pin holes. This is the operation shown being done in Fig. 2. After both ends have been bored, the several smaller bearing holes for the intermediate and elevating shafts are bored at intermediate positions between the ends of the casting.

The work is under the direction of a government inspector, and the limits allowed are extremely close in regard to diameters of holes, distances between holes, and parallelism.

* * *

TO DISTINGUISH BRASSES BY COLOR

The composition of the brasses (copper and zinc alloys) may be readily determined, approximately, by the color. The method gives a brass founder a simple and rapid means for ascertaining what his brass contains. The following shows the color of the various percentages of copper and zinc:

When the brass contains 5 per cent of zinc, it has a red color scarcely differing from that of pure copper. When 10 per cent of zinc is present, the mixture has a true bronze color. With 15 per cent of zinc, the brass has a light orange shade. When the amount of zinc reaches 20 per cent the color of the mixture is greenish-yellow and is known as "green brass." With 25 per cent zinc, the color is practically that of the 20 per cent mixture so that this, too, is a "green brass." Brass with 30 per cent zinc has the true yellow brass color. The same is found with 35 per cent of zinc, but at about this point the yellow color begins to disappear, for at 40 per cent zinc a reddish yellow color is found. Brass, therefore, that has a reddish-yellow shade will always contain more than 35 per cent zinc. The "dead line" seems to be about 38 per cent zinc, for at this percentage, the transition from the real yellow to the reddish-yellow begins.

When the zinc is increased to 45 per cent, the color of the brass is a rich golden shade and, strictly speaking, it may be called "orange." The mixture containing 50 per cent zinc has also a golden shade, but even richer than 45 per cent zinc alloy. At 55 per cent zinc, the color resembles that of 14-karat gold. When 60 per cent of zinc is reached, the brass has a yellowish white shade, and as the quantity increases, the color becomes white and finally gray.

It becomes possible, then, to make an approximate determination of the composition of a brass by the color. If it is very soft and red or orange color, then the amount of zinc is from 10 per cent to 15 per cent. If greenish-yellow, the quantity of zinc ranges from 20 per cent to 25 per cent. The true brass color is found when the zinc amounts to from 30 per cent to about 38 per cent. If, however, it is found that the brass is hard and has an orange yellow color, then the zinc must be present in an amount greater than 38 per cent. To cite an instance of this kind, a concern may be purchasing yellow-brass ingot. If, upon cutting or filing it, the color is found to be orange, then the zinc in it is excessive and may run from 40 per cent to 50 per cent.

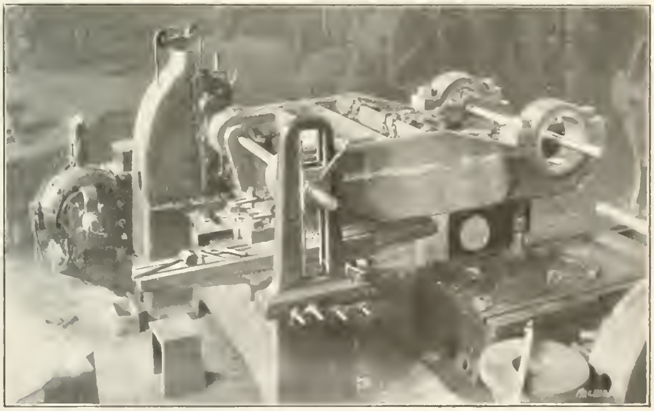


Fig. 2. Boring a Disappearing Mortar Carriage Casting on a Universal Boring Machine

In comparing the color of the brasses, a highly polished surface is not as suitable as a dead one for the reason that false reflections are apt to deceive the observer. A surface that has been filed or ground is preferable, and in order to avoid tarnishing the metal should be freshly cut when a comparison is to be made.—*Brass World.*

* * *

The following method for preventing short-paid postage on letters to foreign countries has been adopted by a large firm having a considerable amount of foreign correspondence: Different-colored envelopes are used by the stenographers when addressing letters to foreign countries. The stamping clerk first of all segregates the letters according to the color of the envelopes and then stamps them as required. Mistakes become very rare under this system, and the simplicity of the system recommends it for use.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The eleventh annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, Wednesday, Thursday and Friday, October 16 to 18. The meeting was called to order at the morning session on October 16 by the president, E. P. Bullard, Jr., who referred to the work of the association in a brief address. The remainder of the session was given over to the reports of committees. The membership committee reported applications for membership from the following firms:

Beaman & Smith Co., Providence, R. I.
Blake & Johnson Co., Waterbury, Conn.
Turner Machine Co., Danbury, Conn.
Union Twist Drill Co., Athol, Mass.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Zeh & Hahnemann Co., Newark, N. J.

These firms were elected to membership, making the total number of members 188. Reports were also submitted by the committee on standardization, foreign relations, patents, and investigation of cutting tools. A resolution was passed, after some discussion, making a change in the membership fee—graduating it according to the capital and surplus of the respective members.

During the afternoon session, October 16, and the morning session, October 17, the following papers were read:

"Export Trade," by W. A. Viall, of the Brown & Sharpe Mfg. Co., Providence, R. I. (See abstract in this number.)

"The Use of an Association Catalogue in the Development of Foreign Markets," by Stanley H. Bullard, of the Bullard Machine Tool Co., Bridgeport, Conn.

"How United States Patents might be made of Greater Value to Patentees," by Samuel W. Banning of Banning & Banning, patent attorneys, Chicago, Ill.

"Tariff Legislation and its Influence on the Machine Tool Trade," by C. Wood Walter, of the Cincinnati Milling Machine Co., Cincinnati, Ohio.

"How could the Association be benefited by the Formation of a Mechanical Section?" by E. J. Kearney of the Kearney & Trecker Co., Milwaukee, Wis. (See abstract in this number.)

The sessions on the afternoon of October 17 and the morning of October 18 were devoted to committee meetings on lathes, sensitive drilling machines, boring machines, gear cutting machines, grinding machines, hand screw machines, planing machines, radial drilling machines, milling machines, shaping machines, vertical drilling machines, and turret lathes.

It was decided to hold the next spring meeting in New York City. The following officers were elected for the coming year: president, E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, A. T. Barnes, of the W. F. & John Barnes Co., Rockford, Ill.; second vice-president, R. K. LeBlond, of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio; treasurer, A. E. Newton, of the Reed-Prentice Co., Worcester, Mass.; and secretary, C. L. Taylor, of the Taylor & Fenn Co., Hartford, Conn.

The Association Catalogue

The paper by Mr. S. H. Bullard aroused considerable interest on account of the novelty of the idea presented, and was followed by an animated discussion. The idea proposed is, briefly, that the association should publish a catalogue for distribution mainly in foreign countries, in which the product of every member should be represented, this catalogue to be printed in English, German, French and Spanish. Apparently most of the members present favored the idea. A committee was appointed to further work out the details, and this committee reported at the last session, October 18, the report being to the effect that a permanent committee should be appointed and that the details of the issuing of a catalogue as proposed should be taken up by letter ballot with the members. At the same meeting a special committee was decided upon to report to the association at its next meeting on the question relating to the formation of a mechanical section raised by Mr. Kearney's paper on the subject.

Patents and Patent Legislation

The paper on patents and patent legislation, by Mr. S. W. Banning, contained a review of the Oldfield bill now before Congress, which is designed to eliminate certain alleged abuses which have grown up during the old patent law. The speaker referred to the main features of the bill (see MACHINERY, July, 1912, "Proposed Changes in Patent Laws"), and particularly gave attention to the compulsory license clause against which he presented an argument. The section of the bill referring to restrictions with respect to the resale or use of patented machines after the title to such machines has passed from the manufacturer, was also referred to, as well as the conditions where contributory infringement is claimed on account of the use of accessories with the patented machine which are not secured from the seller of such machine. The stand taken by the speaker was that when the restriction is one that relates exclusively to the patented invention, it should be amenable to the remedy provided for enforcement of the inventor's rights in an infringement suit; but when the restriction is one that relates to supplies of a general nature, the question is one outside the realm of patent infringement and one that should simply be decided as a question of breach of contract, the validity of the contract to be decided in ordinary court proceedings. It was pointed out that under present practice the patent may be used as a weapon to enforce control of the use and sale of articles that are not even accessories to the machine patented and which are wholly unrelated to its use. As an example, the patentee of an adding machine may sell it with the restriction that its use is conditional upon the purchase from the same source of all typewriters required by the user, and under penalty of suit for infringement of the adding machine patent. In this way, the present law would permit the patentee to extend his monopoly to cover a device upon which he has no patent and which bears no relation to the invention actually protected. Reference was also made to some questions not included in the Oldfield bill.

Under the present practice the inventor is required to append to his specification one or more claims which point out and limit the invention, and which are intended by their language to distinguish it from all prior inventions. The invention is considered as a concrete embodiment of certain mechanical parts or elements, and the claim is restricted to this physical combination. The real invention, however, may go a great deal deeper than this, and in the case of basic inventions it is the underlying principles and not the mechanical embodiment which is of value and importance; but under present practice, inventions of this kind are the more difficult to adequately protect. Minor improvements are easily claimed in mechanical language, even when they are merely new mechanical embodiments of old basic ideas.

The speaker advocated that the inventors should be allowed to claim the functional co-relation of the parts in such a way as to cover every physical embodiment of the same fundamental principle. In this respect, the German practice is quite the reverse of the American practice. In Germany, the claim is directed to the basic functions of the elements involved, and this the speaker considered ought to be the case also under our patent laws. Under the present practice, the unnecessary strictness in claiming the invention, and the oftentimes ill-advised liberality of the courts in construing the claims, renders it extremely difficult to determine the rights of the patentee.

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AMERICAN MACHINIST'S THEATER PARTY

The *American Machinist* followed its custom of some years standing by entertaining a theater party of several hundred machine tool builders, mechanical engineers and representative men in metal manufacturing lines, during the meeting of the National Machine Tool Builders Association in New York. The party saw the French comedy "Oh, Oh, Delphine!" played at the Knickerbocker Theater, Thursday evening, October 17, and was highly entertained by the spicy witticisms and catchy songs of this brilliant hit of the season.

* * *

The *Boletin de l'Industrie Minerale* states that aluminum wire is being extensively used in Europe for electric transmission lines, on account of the saving in first cost. The initial cost of an aluminum line is about 25 per cent less than an equivalent copper line, all items considered.

MACHINERY'S 1912 OUTING

MACHINERY'S tenth annual outing for machine tool builders, dealers and others connected with the machine tool industry, including many superintendents of manufacturing plants, took place on October 19.

MACHINERY'S steamer left the foot of East Twenty-fourth St. at 11 A. M., stopping first at the Brooklyn Navy Yard, the most important naval station in the United States, where Uncle Sam's new super-dreadnought, the 27,000-ton battleship *New York* is now under construction. The keel was laid in September, 1911, and she will be launched before this item is read. The Commandant and his aide had been suddenly ordered to Washington the night before, and through some oversight the arrangements made for the entertainment of the party were not carried out; but opportunity was afforded to inspect the yard and go aboard the battleships *Utah*, *Florida* and *Connecticut*.

Luncheon was served while at the Navy Yard, and immediately afterwards the steamer started up the East River and around Manhattan Island, passing through the Harlem River and shooting some fourteen bridges that span it, returning to the foot of East Twenty-fourth St. on time. The steamer was the largest that ever passed through the Harlem River, and it was a close call getting through High Bridge.

An unexpected feature of the outing which was highly enjoyed by the friends of Mr. Charles E. Hildreth, for some years secretary of the National Machine Tool Builders Association, was the presentation to him of a cake well covered with candles, in honor of his birthday, which happened to fall on October 19. A song especially written for the occasion was sung with gusto, and Mr. Hildreth responded feelingly.

MACHINERY'S outing was started ten years ago with a tally-ho ride given to twenty-one manufacturers and others present at the convention in New York at that time, and the attendance has now increased so that between five and six hundred representative men in the machinery industry meet each year to renew and extend their acquaintance and to spend a few social hours on that occasion.

* * *

PRICE SHEETS FOR SALESMEN

Loose-sheet price books have come into common use by machinery salesmen in the past few years. The page most used is of thin paper printed on one side only, cut to the standard, 4 inches wide and 7½ inches long, with three holes punched on three-inch centers, and with round corners. A sample page was shown in the April, 1912 number of MACHINERY on page 593, engineering edition. A well-known western machinery dealer is establishing among machine tool manufacturers for the use of their salesmen similar sheets printed on both sides and made of light weight tag stock, that is, white filled linen, which, of course, is much stronger and more durable than the thin paper commonly used. These sheets carry illustrations of machines on one side and the specifications on the other. The texture of the stock being coarse, it is advisable to illustrate with wood cuts or coarse screen half-tones, the illustrations being used simply to identify the machines and not to show details of construction clearly.

* * *

Thin steel saws for slotting heads of machine screws and bolts are tools which require frequent renewal. The work is very destructive and, ordinarily, the tools do not last long. However, one of these slitting saws, made of "Ark" high-speed steel, recently slotted 477,000 stove bolts before giving out.

NEW YORK ELECTRICAL EXPOSITION

The sixth annual electrical exposition, held in the Grand Central Palace, New York City, October 9 to 19, included a variety of interesting applications of electricity. The majority of the exhibits were of a nature to interest non-technical visitors, as they consisted of electrical devices used for household and office purposes. The exposition was opened with a luncheon in honor of Thomas A. Edison, commemorating the completion of thirty years of Edison service in New York City, given by the New York Edison Co., October 9. Mr. John W. Lieb, Jr., general manager of the New York Edison Co., related how the industry has grown since the opening of the historic Pearl St. plant, September 4, 1882. Electrical plants thoughout the country are capitalized at $2,500,000,000, having an annual capacity of 12 000,000,000 K. W., and gross earnings of $4,000,000,000.

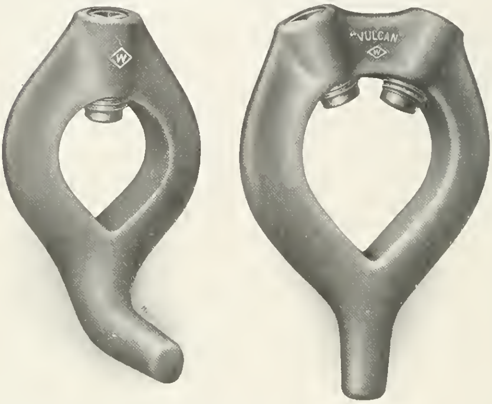
The exhibit of the New York Edison Co. showed the wonderful development in the application of electricity which has taken place in the past decade. This fact will be readily brought out by touching upon the statistics presented by this company's commercial engineering department. Without entering into detail, an idea of this development may be gained from the fact that in 1899 the total horsepower of the motors connected to the Edison Co.'s system in New York City was 34,457, while in 1911 this figure had increased to 312,863. This is but one of the increases in consumption of electric power which have taken place, and it will be evident that to keep pace with such an increase of power consumption corresponding increases in generating equipment were necessary. The developments which have been made along this line are clearly set forth by models of the old Edison station on Pearl St., N. Y. City, which was built in 1882, and the Waterside stations which are carrying the load at the present time. These models are constructed on a scale of one inch to two feet, and show the complete plants together with the arrangement of the equipment. The old "Jumbo" generators of the first Edison station in New York, which were built by Armington & Simms, Providence, R. I., and placed in operation September 4, 1882, were run under the following conditions: rated capacity, 126 K. W.; capacity in 16-candlepower lamps, 1000; square feet of floor space occupied, 122.5; R. P. M., 350; weight of generating set in pounds per K. W., 488; K. W. per square foot of floor space occupied, 1.03. The present type of Curtiss turbine generators were built by the General Electric Co., Schenectady, N. Y., to operate under the following conditions: rated capacity, 20,000 K. W.; capacity in 16 candlepower lamps, 1,000 000; square feet of floor space occupied, 297; R. P. M., 750; weight in pounds per K. W., 42; K. W. per square foot of floor space covered, 67.34.

Another particularly interesting exhibit is that of the Electrical Testing Laboratories of New York City. Among the apparatus shown, there was a series of twenty-seven electric meters which cover a range of design from the old-fashioned electrolytic type, which was the first used in New York City, up to the most modern type of instrument. In this connection it may be of interest to mention that the method of measuring current with the old electrolytic type consisted of shunting a part of the current through a cell; the amount of current passed was then measured by the weight of metal deposited from the solution. The Electrical Testing Laboratories have one of the original balances which were used to weigh the metal deposited in this way.

One of the interesting features of the exposition was the exhibit of the American Museum of Safety. A large number of wax models of different parts of the human body affected by a variety of vocational diseases were shown. This is a subject which has not received much attention in this country, but which has been studied in detail in Germany. Dr. Wm. H. Tolman, director of the American Museum of Safety, has recently been in Germany making a study of the results of investigations of this subject which have been made there, and the models exhibited were brought back by him from Germany. It is the intention of the American Museum of Safety to issue circulars at a later date showing the causes of such vocational diseases and the means of prevention.

DOGS AND DRIVERS

A review article was published in the October number, engineering edition, illustrating a large number of dogs and drivers for lathe and milling machine work held on centers. Unfortunately, a description of the meritorious safety lathe dog illustrated in two styles in Figs. 1 and 2, which is made by J. H. Williams & Co., Brooklyn, was omitted. In this lathe dog, the square-head set-screw so dangerous to the workman's hands and arms, is displaced by square socket set-screws always lying flush with the surface of the screw hub or below it. Inasmuch as the set-screws do not project above the surface, they cannot catch the workman's sleeve or other parts of his clothing and thus cause injuries.



Figs. 1 and 2. J. H. Williams & Co.'s Safety Lathe Dogs

This lathe dog is essentially the same in design as the form used in the works of the National Tube Co., and illustrated in the April, 1911, number of MACHINERY. A feature of the design of the drop forged dog is the reinforcement at each side of the screw hub made to strengthen it at a critical point and to eliminate the part of the boss which would project if the lines were the same as on the square-head set-screw type. These safety dogs are made in the same sizes as the regular square-head set-screw type dogs.

Another dog worthy of notice which is especially adapted for milling taper work, spiral taper reamers and other taper parts held on centers, is the Hill compensating dog made by the Ready Tool Co., of Bridgeport, Conn., and shown in Fig. 3. Features of this dog are a forked driver mounted on the spindle or faceplate and a dog having a tail with a ball-shaped part engaging the fork of the driver. The point of application of the forked driver on the ball is in approximately the same plane as the end of the piece being indexed. The object of this is to eliminate the irregularity of action in indexing tapered work that inevitably follows the use of the ordinary bent tail dog when engaged with an ordinary driver, and arises from the sliding of the taper tail of the dog in and out of the slot and the necessary looseness of engagement of the tail in the slot.

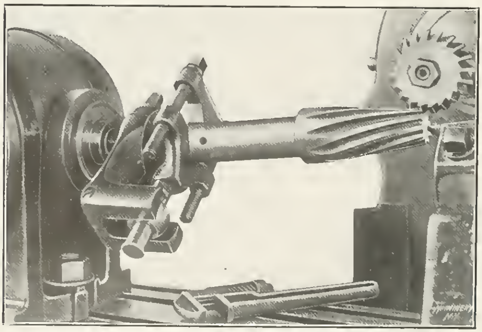


Fig. 3. Ready Tool Co.'s Milling Machine Dog

PERSONALS

Frank Koester, consulting engineer, has moved his office from 115 Broadway to larger quarters at 50 Church St. (Hudson Terminal Building), New York.

F. Mandon, manager of Fenwick, Freres & Co., Paris, France, is making a short visit to American machine tool building centers in the interests of his company.

E. G. Buckwell, secretary and manager of sales of the Cleveland Twist Drill Co., Cleveland, Ohio, sailed on the *Carmania* October 5, for a two-months' business trip abroad.

V. Brockbank, a British contributor to MACHINERY, has come to America and joined the National Twist Drill & Tool Co., Detroit, Mich., in the capacity of assistant superintendent.

E. J. Lees of the Lees-Bradner Co. Cleveland, Ohio, maker of gear hobbing machines, sailed for Europe October 1, on the *Mauretania*, for a five or six weeks' business trip in England and France in the interests of his company.

D. O. Barrett, superintendent for the past year-and-a-half of the Manitoba Engines Ltd., Brandon, Manitoba, and an occasional contributor to MACHINERY, has resigned to take charge of the experimental work of the Heer Engine Co., Portsmouth, Ohio.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, Ohio, who sailed for Europe May 25, returned early in October, having made an extended tour of British and Continental manufacturing centers in the interests of his company.

Ralph E. Flanders, advertising manager of the Fellows Gear Shaper Co., Springfield, Vt., has resigned to become manager of the Fay automatic lathe department of the Jones & Lamson Machine Co., Springfield, Vt., and also manager of the company's advertising.

Howard G. Carter will have charge of the equipment of the new $300,000 high school building in Hamilton, O. The school will have a completely equipped technical department including a machine shop, forge shop, foundry, pattern shop, stockroom, bench room and drafting-room.

Louis M. Pawlett has recently left the Locomobile Company of America, where he held the position of executive engineer, to enter upon a consulting practice in motor transportation engineering. For this purpose, Mr. Pawlett has opened offices in the new building of the U. S. Rubber Co., 1786 Broadway, N. Y.

John S. Myers, known to readers of MACHINERY as an occasional contributor of articles on machine design and other subjects, has resigned his position with the American Engineering Co. (successor to the Williamson Bros. Co. and the American Ship Windlass Co.) to go with the Southwark Foundry & Machine Co., Philadelphia, Pa.

J. McA. Duncan has been appointed district manager of the Westinghouse Electric & Mfg. Co. for the Pittsburg district, in place of Mr. W. F. Fowler, resigned. Mr. Duncan has been employed by the Westinghouse Electric & Mfg. Co. about twenty-five years, and is one of the group of eight men taken over from the Union Switch Signal Co., then located in Garrison Alley, Pittsburg, to form the electric company, which was first established at the same place.

* * *

OBITUARIES

William H. Corbin, vice-president of the Joseph Dixon Crucible Co., Jersey City, N. J., died at his country home in Sullivan Co., N. Y., September 25, aged sixty-one years.

Stephen Holman, founder of the Holyoke Machine Co. of Worcester and Holyoke, Mass., died at his home in Swampscott, October 13, aged ninety-two years. Aside from his machine building industries, Mr. Holman was also for many years in the cotton industry, and was a leader in the National Association of Cotton Manufacturers. He was a graduate of Williams College.

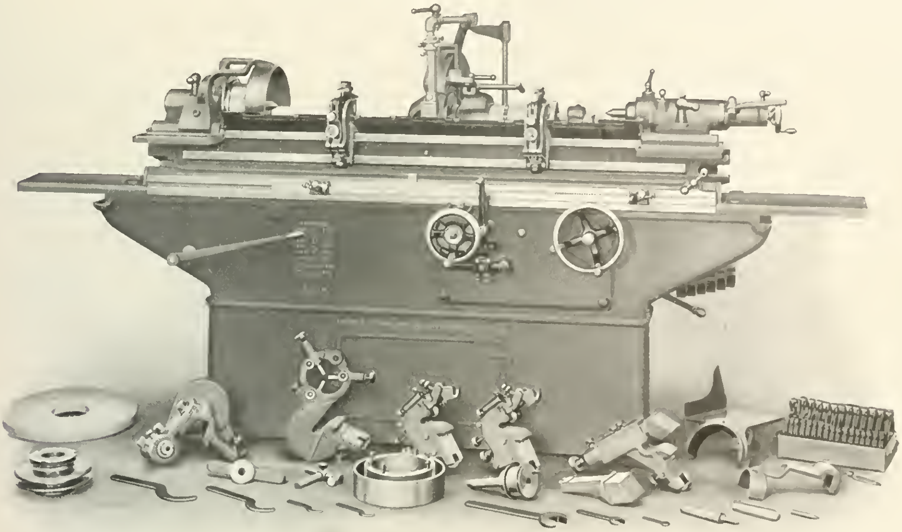
Horace Inman, president of the Inman Mfg. Co., Amsterdam, N. Y., died October 16, aged seventy-three years. Mr. Inman was widely known because of his invention of automatic and semi-automatic paper box machinery. He was one of the three mechanics who received a diploma at the World's Columbian Exposition at Chicago, the other two being Ambrose Swasey and Edwin Reynolds.

* * *

The replacing of forty-four consolidation engines by twenty-five Mallet compound locomotives on the Hinton Division of the Chesapeake and Ohio Railroad, has resulted, it is stated, in a saving of 37.55 per cent of the cost of handling the freight traffic on this division. As the Mallet locomotives are more costly than were the consolidation locomotives, this saving is reduced by the amount of the interest and depreciation of the excess cost of the Mallet engines. Nevertheless, there appears to be a clear saving of more than 30 per cent of the total cost of handling the freight traffic.

No. 14 Plain Grinding Machine

Built in two sizes, 10" x 30" and 10" x 48"



If your work calls for a machine to grind spindles, shafts, rolls, etc., up to the sizes above, the advantages of this one are worth considering.

The rigidity of all parts enables heavy cuts to be taken at fast speeds and coarse feeds. An automatic cross feed and universal back rests insure accurate duplicate pieces. The work speeds and table feeds are independent of one another so a correct feed is available for any speed. Simplicity of all parts makes the machine easy to operate. The few handwheels and levers on the front are handy for the operator and do not come in his way when changing or gauging work.

Folding guards on the 10"x30" size

economize greatly on floor space required—a factor of considerable importance in the average shop.

Write for a special circular.

BROWN & SHARPE MFG. COMPANY
PROVIDENCE, R. I., U. S. A.

A NEW METHOD OF REVEALING SEGREGATION IN STEEL INGOTS

The description given by Sir Robert Hadfield in a paper on the above subject, presented before the September, 1912, meeting of the Iron and Steel Institute, is closely related to the text of his paper describing his methods of producing sound ingots, which was also presented at this meeting. The object of the present paper is to describe a method of studying the conditions under which segregation takes place with the view of arriving at some method of eliminating, or at least checking, the formation of segregated sections.

Segregation may be briefly described as the tendency for objectionable impurities in steel—particularly sulphur and phosphorus—to be concentrated at the center of the ingot. The material constituting such segregated sections is defective in strength, and when rails or structural material are rolled from ingots containing such defects, the strength of the resulting product is seriously impaired. Like piping, segregation is caused by the unequal rate at which the solidification of the ingot takes place. It will be remembered that the inner portions are last to solidify, and experience has shown that there is a tendency for the sulphur and phosphorus to be concentrated in these sections by liquidation.

In starting to investigate the conditions responsible for segregation, it was reasoned that the addition of some metallic material could be made to the steel while in its molten form which would throw light upon the subject. A number of experiments were conducted with various metals, and copper was finally selected for the purpose because its specific gravity is slightly greater than that of steel, and also because its color would make its presence apparent when the ingot was broken up. The results of experiments conducted along this line brought out several interesting points. A sand head was used on the ingot molds in order to maintain a liquid riser at the top, and additions of molten copper made at different lengths of time after pouring the steel penetrated those portions of the ingot where piping usually takes place, and thus indicated the exact location where inter-crystalline unsoundness or segregation is developed. It may be mentioned in this connection that such inter-crystalline unsoundness is not seen in the fracture of an ordinary ingot when cold; it is revealed upon a polished and etched section. By making additions of copper at different lengths of time after pouring the ingot, the rate at which the solidification of the steel takes place was determined, as the copper was unable to penetrate steel which had already reached the solid form. It may be mentioned in this connection that these experiments proved that the steel in the inner portions of the ingot remains in a liquid condition for a far longer period of time than was supposed. It can, therefore, be readily understood why there is a greater tendency towards segregation in large ingots. The obvious conclusion is that the greater length of time in which the metal remains in a molten condition offers a greater opportunity for the concentration of sulphur and phosphorus in the central section. This is in line with a long-known fact that the more rapidly solidification takes place, the greater is the reduction of the tendency towards segregation.

The author believes that these experiments should throw some light upon the nature of the phenomena which occur in the cooling down of molten steel to a solid condition, and it would appear that the method outlined presents a valuable source of information in regard to conditions affecting the rates of cooling, segregation and liquidation of steel.

* * *

A pin should not be put through a shaft that transmits a considerable amount of power. If collars or other parts have to be fastened to the shaft, it is better to hold them with one or two keys, as the weakening effect on the shaft of the keyways is not as great as that of a pin hole.

* * *

COMING EVENTS

November 11-16.—Second International Exposition of Inventions in St. Louis, Mo. F. W. Payne, secretary-manager, St. Louis Coliseum Co., St. Louis. Inventions covering a wide scope will be shown, applicable to every profession or trade.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

National Machine Tool Builders' Association. Official report of the semi-annual convention at Atlantic City, N. J., May 16 and 17. James H. Herron, general manager, Cleveland, O.

American Association of Commerce and Trade, Berlin, Germany. Year-book giving officers, board of directors, roll of members, standing committees, annual reports, proceedings at annual meeting and statistics.

American Society of Engineer Draftsmen held its annual meeting in Teachers College, Columbia University, October 1. This meeting was the most important yet held by the organization. A chart was displayed by the president, Mr. E. Farrington Chandler, showing that the membership had quadrupled in the past year. A program comprising interesting constructive features was adopted for the coming year, which included the establishment of a mutual benefit section. The officers elected for 1913 are: Prof. Charles W. Welck, of Columbia University, president; William B. Harsel, first vice-president; and Charles A. Clark, of the Crocker-Wheeler Co., second vice-president. Walter M. Smyth, 116 Nassau St., New York, is the secretary.

NEW BOOKS AND PAMPHLETS

Digest of Workmen's Compensation Laws. 56 pages, 6 by 9 inches. Published by the National Association of Manufacturers, 30 Church St., N. Y. Library edition, 30 cents; paper cover, 15 cents.

A large number of bills concerning compensation of injured workmen have been presented to the state legislatures for enactment during the last two years. The purpose of this work is to form a reference work for the legislator, lawyer, insurance expert, employer and employe in the form of a synopsis of each law, so arranged that a comparison of the laws can be made easily. It is a work that should be available in every manufacturing plant.

The Freezing Point, Boiling Point and Conductivity Methods. By Harry C. Jones. 75 pages, 7¾ by 5½ inches. 15 illustrations. Published by the Chemical Publication Co., Easton, Pa. Price $1.

In preparing the second edition of this book, the author has gone over the text with the view of correcting a few minor errors which existed in the first edition, and has also made the necessary changes to bring the work up to date. The usual texts dealing with this subject have been prepared to meet practical requirements of the laboratory or the theoretical considerations which are dealt with in the class-room. The present book has been compiled with a view of combining the theoretical discussions and practical laboratory methods in the same volume, as it is believed that this is the only way in which an adequate knowledge of the subject can be secured.

Steam Boilers. By W. Inchley. 412 pages, 7½ by 5¼ inches. 140 illustrations. Published by Longmans Green & Co., New York City. Price $2.40.

An attempt has been made in the presentation of this text, to produce within the confines of a book of reasonable size, the principles governing the construction and operation of steam boilers and their accessories. The object in so doing has been to present information in a form suitable for the use of steam users and engineering students generally. Technical details of boiler construction, such as the pitch of rivets, strength of plates, etc., have been purposely omitted, as few readers will find themselves called upon for expert knowledge on such questions. Only the general principles of the strength of parts has been entered into, and higher mathematics has been eliminated wherever possible. It was obviously out of the question to include a complete discussion of all types of boilers and boiler accessories in a book of this size, but an effort has been made to include those types of equipment which have proved most satisfactory in practice.

The Theory of Machines. By Robert W. Angus. 238 pages, 9¼ by 6¼ inches. 147 illustrations. Published by the Engineering Society of the University of Toronto, Toronto, Canada. Price $2.25.

During the writer's experience as an engineer and instructor in engineering subjects, he has had frequent occasion to enter into a discussion of the general theory of the operation of various machine parts. In many cases, it is merely a question of designing such parts to give them sufficient strength, and the principles involved in work of this kind are naturally of the utmost importance in the engineering profession. In such work, however, no direct attempt is made to analyze the conditions under which the machine operates with a view of determining the requirements of size and strength. It was the author's appreciation of the need of such training for engineering students that led to his writing the present book. He does not claim complete originality in the material which he presents, as the current periodicals have been drawn upon wherever desirable information was available. But the quantity of such information was extremely meager and the majority of the text has been developed by the writer, for presentation in this volume.

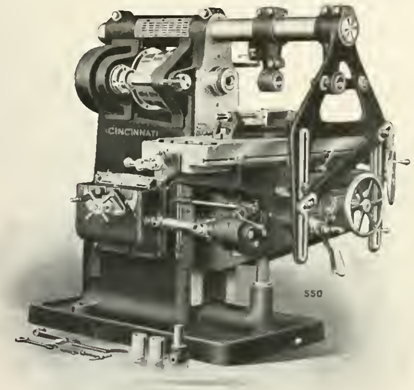
Elementary Machine Drawing and Design. By Wm. C. Marshall. 320 pages, 6¾ by 9⅜ inches. 181 illustrations. Published by McGraw-Hill Book Co., New York. Price $3.

The material in this book has been arranged in such a way that the work can be undertaken by students of engineering who have already had a course in orthographic projection but who are not yet familiar with simple machine elements or with the subjects of mechanics or strength of materials. The simple forms of machine elements are taken up and current drafting-room methods of drawing them are presented, together with the standard practice in proportioning them for different operating conditions. In connection with this part of the work, test problems are presented at the end of each chapter to give the student practice in applying the principle of design which he has gone over. The book is not intended for home study but rather as a supplement to class-room talks on the subject matter presented. On this account detailed instructions have been omitted in many cases in order to allow the instructor the opportunity to vary the presentation of his subject according to individual requirements.

Modern Organization. By Charles De Lano Hine. 110 pages, 7½ by 5¼ inches. Published by the Engineering Magazine Co., New York. Price $2.

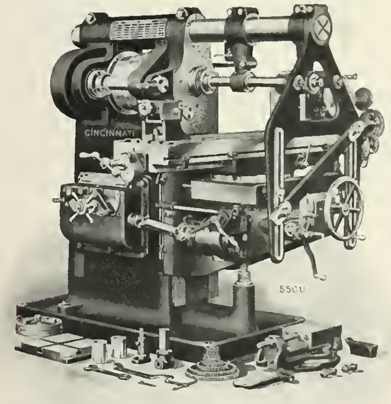
The text of this book was originally presented in a series of articles published in the *Engineering Magazine*, during the period from January to July, 1912, and represents the philosophy of management which Major Hine has had peculiar opportunities of demonstrating. This philosophy, as expressed in the unit system of organization directed toward promoting efficiency in operation in one of the great engineering industries, has been applied upon a scale of magnitude

Much of the Milling in most Shops is not Heavy Cutting



The No. 4 Plain High Power Miller with Cone Drive

Front or operator's side showing arrangement of all operating levers



The No. 4 Universal High Power Miller with Cone Drive

On this work the very powerful single pulley millers do not increase production.

An up-to-date, properly designed, cone-driven machine like our No. 4 Horizontal often proves the better investment.

It is our High Power Miller with cone-driven spindle.

We have simply replaced the Single Pulley, Geared Spindle Drive box with a Double Back Geared Cone of large diameter.

It has ample power for all that work requiring a large machine, but not excessively heavy cutting.

It can be depended upon for long, hard, continuous service, because of its massive "High Power" construction.

Its maintenance cost is low because of its simplicity.

AND IT IS HANDY.

The Feed Changers and Back Gear Lever are where the operator stands to shift the belt.

The Table always feeds in the direction in which the Engaging Lever is set.

This same lever also reverses the feed.

All Controlling Levers are at the front of the knee and saddle. So is the Quick Return.

Everything that has to do with its operation is within easy reach.

And there is an additional lever at the side of the knee controlling the feeds from behind the table, for end-milling or boring or similar work which can't be successfully done when the operator stands in front, as he must do on all other Millers.

Let us help on your milling problems. We make the largest variety of machines and therefore can recommend the ones best suited for your work.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.

CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana.

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which has only been approached in one other case. Its success was declared with conviction in specially informed circles, but outside of a chosen audience, the characteristics of Major Hine's work had not been effectively presented until the publication of the articles previously referred to. The ideas embodied are so fundamental in character, that it appears certain that they will exercise a powerful influence in many fields of industrial organization. The policies advocated are most interesting because they depend so little upon mechanism of any kind, so little upon systems affecting the rank and file of equipment, and so much upon the psychological influence, bearing first upon, and then through, the directing officials.

Mechanism. By Robert McArdle Keown. 169 pages, 9⅜ by 6⅜ inches. 168 illustrations. Published by McGraw-Hill Book Co., New York. Price $2.

The material presented in this book is original in its method of presentation rather than in the actual information contained. The advisability of developing this text suggested itself to the writer owing to the desirable results which were obtained in class-room work based upon this arrangement. The distinctive features may be briefly outlined as follows: A discussion of motions, velocities and linkages are first taken up as they are comparatively simple for the student to understand, and problems can be given out in early stages of the class-room work. Cams are dealt with in detail, as they form part of a subject in which considerable practice is required. The involute system of gearing is taken up before the cycloidal system because it is generally easier for the student to grasp the subject when presented in this way. When the underlying principles of the involute system are thoroughly understood, it is generally an easy matter to master the cycloidal system. Furthermore, the use of the involute system is the more general in current practice. Problems are given at the end of each chapter in order that the student may familiarize himself with all of the principles which have been presented.

Elements of Drawing. By George F. Blessing and Lewis A. Darling. 193 pages, 6¼ by 9¼ inches. Published by John Wiley & Sons, New York. Price $1.50.

This book was prepared by the authors at the request of Dexter S. Kimball, professor of machine design and construction, Cornell University. The object in view was two-fold. First, to obtain a book exactly suited to the needs of an elementary course in mechanical drawing for those who were entering upon courses in engineering at Cornell University. Second, to put into permanent form a collection of ideas on the subject which had been accumulated as the result of past years experience. The authors have had experience both as technical educators and as practical engineers. This combination gives them an intimate knowledge of the requirements of the work in hand. Where the book is used as a text in teaching mechanical drawing, the object may be summed up by saying it is to instruct the student: First, how to select, care for, and use drawing instruments; second, how to make and read technical drawings; third, how to think over the drawing-board; fourth, to consider the relation a drawing bears to design, shop processes, and shop organization. In endeavoring to attain the last two objects, the parts of a wood-turning speed lathe have been adopted for models because it is believed that the average student's familiarity with these objects will enable him to combine with his drawing the necessary attention to design and manufacture of the part in question which is essential to the attainment of satisfactory results. The book also gives particularly good treatment to the subject of freehand lettering of drawings and to freehand sketching, both of which are points in which the average draftsman lacks proficiency.

NEW CATALOGUES AND CIRCULARS

Illinois Stoker Co., Alton, Ill. Catalogue of chain grate stokers.

Pneumatic Jack Co., Paul Jones Bldg., Louisville, Ky. Circular of the Taylor pneumatic tandem jacks for car repair work and other railway uses.

National Scale Co., Chicopee Falls, Mass. Folder illustrating the National counting machine for counting screws, bolts, nuts, pins, small castings, printed matter, etc.

Ready Tool Co., Bridgeport, Conn. Circular illustrating the Hill compensating milling machine dog, designed especially for use when indexing taper work held on centers.

J. G. Blount Co., Everett, Mass. Catalogue No. 14 on grinding and polishing machinery, and speed lathes, tailstocks, slide-rests, turrets, countershafts and other accessories.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa. Circulars Nos. 140 and 141 on appliances for burning fuel oil, which apply to all purposes for which oil is used as fuel.

Vulcan Engineering Sales Co., 2014 Fisher Bldg., Chicago, Ill. Circular of QMS jib cranes with hand and power hoists; QMS hand power traveling cranes; and QMS pneumatic hoists.

Keuffel & Esser Co., 127 Fulton St., N. Y. Circular entitled "How to Select Drawing Instruments," illustrating the "Paragon" instruments, and describing their mechanical features.

Crocker-Wheeler Co., Ampere, N. J. Bulletins Nos. 155 and 156 on Form Q induction motors for operating on 60-cycle polyphase alternating-current circuits, and motor-generator sets for all purposes.

W. S. Rockwell Co., 50 Church St., New York. Catalogue No. 15 on rotary annealing and hardening furnaces for annealing, hardening, tempering, blowing or other heat-treatment of brass, copper, steel and other metals.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 84 on hydraulic accumulators and fittings, special hydraulic apparatus, reservoirs, etc. Seven principal types of accumulators are illustrated and described.

Fidelity & Casualty Co., 92 Liberty St., New York. Pamphlet entitled "Steam-Boiler Explosions" by Wm. H. Boehm, an illustrated lecture delivered at Cornell University before the student branch of the A. S. M. E. May 3, 1912.

Lucas Machine Tool Co., E. 99th St. & L. S. & M. S. Ry., Cleveland, O. Circular describing new model No. 31 "Precision" horizontal boring, drilling and milling machine. The machine is furnished with a vertical milling attachment to order.

Reading Iron Co., Reading, Pa. Pamphlet on characteristics of wrought iron pipe and steel pipe, showing the superior qualities of wrought iron pipe. The results of investigations are both interesting and valuable to users of steel and iron exposed to weather conditions.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 501 on "Triumph-Monitor" reversing motor planer drive, showing its application to a Cincinnati planer, the monitor controller, speed curves during reversal of the dynamic brake type, and the "Triumph-Monitor" equipment.

H. Bickford & Co., Lakeport, N. H. Leaflet illustrating and describing the 36-inch Bickford vertical chucking machine, designed and placed upon the market to supply the increasing demand for a low-priced, well made tool, suitable for chucking car wheels, gears, pulleys and work of this character.

Landis Machine Co., Waynesboro, Pa. Catalogue No. 20 on pipe and nipple threading machinery, illustrating the Landis tangent thread chaser, details of the Landis all-steel die-head, and other features of the machine. Six styles and sizes of the machines are illustrated, and specifications given.

Ph. Bonvillain & E. Ronceray, Paris, France. Catalogue No. 6 on foundry equipment and supplies, comprising cupolas, ladles, molding machines, furnaces, blowers, molders' tools, core-making machines, core ovens, blow-torches, pneumatic rammers, tumbling barrels, air compressors, templet cutting machines, pyrometers, etc.

Vulcan Engineering Sales Co., 2014 Fisher Bldg., Chicago, Ill. Circular illustrating "Type 1M" cold metal sawing machine, the smallest metal sawing machine made by the company. This machine is especially adapted to meet the requirements of small shops. The machine has a capacity for rounds up to six inches diameter; squares, six inches diameter; and I-beams, ten inches vertical.

American Blower Co., Detroit, Mich. Catalogue No. 343 entitled "Mechanical Draft Forced and Induced by 'Sirocco' and 'A B C' Blowers and Exhaust Fans." The catalogue calls attention to the natural advantages realized with artificial draft produced by mechanical means. It is illustrated with photographs of actual installations with a view to making clear the various methods of applying fans to steam boilers.

Fairbanks, Morse & Co., Wabash Ave. and Eldredge Pl., Chicago, Ill. Pamphlet on the electrical equipment of the Louisville Planing Mill & Hard Wood Flooring Co.'s mill, showing the application of Fairbanks, Morse & Co.'s electric motors to double surfacers, inside molder, and Sturtevant blower. A schedule of all the motors in the installation giving horsepower and names of machines is included.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin 4209 describing the Temple-Ingersoll electric air drill; Bulletin 4023 describing the 4-E type electric air rock drill; Bulletin 4025 describing the 5-F electric air rock drill; Catalogue 384-F giving instructions for installing and operating the Temple-Ingersoll electric air rock drills; and Form 601 giving instructions for operating 5-F machine and list of duplicate parts.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue No. 10 on small motors for household and other purposes; descriptive leaflet No. 2444 on motor-generator flywheel sets; descriptive leaflet No. 2457 on commutating-pole rotary converters; descriptive leaflet No. 2359-A on direct-current commutating-pole motors—type SK; and descriptive leaflet No. 3506 on installations of paper mill motors for pulp mill service.

General Electric Co., Schenectady, N. Y. Bulletin No. 4958 on Direct-Current Railways of 1200, 1500 and 2400 volts. This bulletin comprises 129 pages descriptive of electric railway installations and equipment, profusely illustrated with halftones and line engravings; Bulletin No. 4978, Irrigation with Electrically-driven Pumps; Bulletin No. 4932, Electricity in the Brewing Industry; Bulletin No. 4976, Electric Drive in Grain Elevators and Flour Mills.

Brown & Sharpe Mfg. Co., Providence, R. I. Booklet entitled "Points About Grinding Wheels and Their Selection," taking up abrasives, bond, grade of wheels, selection of wheels, speed of wheels, combination of wheel and work speeds in cylindrical grinding, mounting wheels, balance of wheels, truing wheels, safety, use of water, suggestions for ordering grinding wheels, list of grinding wheels, suggestions on selection of wheels for use on B. & S. grinding machines, etc.

Mesta Machine Co., Pittsburg, Pa. Booklet entitled "Brief Description and Illustrations of the Plant and Product of the Mesta Machine Co., Pittsburg, Pa." This booklet is illustrated with halftones showing the buildings and interior views of the various departments of the company's plant, as well as a great number of illustrations of machines of various types built by the concern, including Corliss engines, air compressors, blowing engines, condensers, hydraulic forging presses,

Travelers Insurance Co., Hartford, Conn., have begun the publication of a periodical called the *Travelers' Standard* which will deal with engineering matters of all kinds, but will be mainly concerned with safety engineering, as applied to construction work, manufacturing, mining, power generation and transmission, the electrical and chemical industries, and every other form of activity in which machinery or tools are used. The October number contains an article of general engineering interest entitled, "The Factor of Safety."

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 205 on gasoline electric generating sets for isolated electric generating plants. These sets are built in 5 K. W., 10 K. W., and 15 K. W. capacities. They are admirably suited for electric lighting and power purposes on farms, country clubs, and other places remote from cities and sources of electric power supply. The catalogue illustrates details of construction, and will be found of general interest to all concerned with the problem of generating electric power with small units.

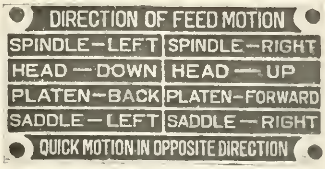
Pennsylvania Railroad Co., Philadelphia, Pa., has issued a booklet for distribution in connection with the semi-centennial of the loyal war governors' conference of September 24, 1862, which was held in Altoona, Pa., September 24-26, 1912. The booklet is illustrated with views of the Conestoga wagon, canal packet on the old Pittsburg line, locomotive "Lancaster" and first steam train to the West; facsimile of original poster advertising schedule and rates to Pittsburg, and facsimile of original poster of schedule Philadelphia to Pittsburg trips in four and one-half days.

Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. Catalogue of tool-holders, comprising lathe, planer, shaper, slotter and other tool-holders; boring tools, drill-holders, cutting-off tools, side tools, lathe tool cabinets, knurling tools, grinding holders, cutting-off and grinding machines, high-speed steel, lathe dogs, boxed C clamps, planer jacks, drill drifts, blacksmiths' drill sockets, ratchet drills, drilling posts, drop-forged open-end wrenches, hexagon box wrenches, square box wrenches, construction wrenches, automobile wrench sets, socket wrenches, alligator wrenches, etc.

Crocker-Wheeler Co., Ampere, N. J. Booklet on Ampere, showing its situation relative to New York and Newark, illustrating the plants, railway station, U. S. post office, interior of shops, and other features of mechanical interest, including one of the C. & C. motors made by the Curtis & Crocker Electric Co., the forerunner of the present Crocker-Wheeler Co. The history of the company includes brief biographies of Dr. Schuyler S. Wheeler and Prof. Francis B. Crocker. The booklet is an unusually interesting and attractive piece of literature on the physical and personal characteristics of a large manufacturing plant.

Travelers Insurance Co., Hartford, Conn. Pamphlet on grinding wheels, being one of a series of text-books on safety of operation of plants and machinery. The pamphlet treats of emery wheels, stands, bearings, spindles, belt drive, flanges, washers, fitting of wheels, inspection of wheels, tightening nuts, tool-rests, speed, truth and balance, hoods, goggles, causes of accidents, grindstones, proper mounting and safe speed for same, and polishing wheels. Tables of speeds of emery wheels and grindstones, and illustrations of exhaust hoods,

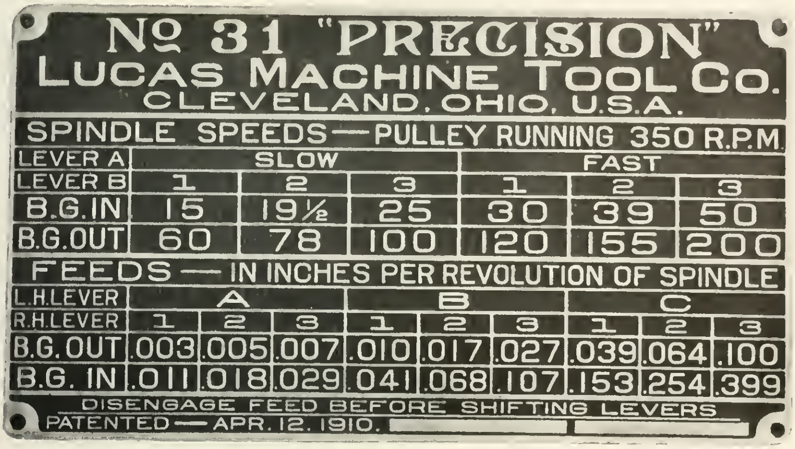
ONLY TWO PLATES



DIRECTION OF FEED MOTION

SPINDLE—LEFT	SPINDLE—RIGHT
HEAD—DOWN	HEAD—UP
PLATEN—BACK	PLATEN—FORWARD
SADDLE—LEFT	SADDLE—RIGHT

QUICK MOTION IN OPPOSITE DIRECTION



Nº 31 "PRECISION"
LUCAS MACHINE TOOL Co.
CLEVELAND, OHIO, U.S.A.

SPINDLE SPEEDS—PULLEY RUNNING 350 R.P.M.

LEVER A	SLOW			FAST		
LEVER B	1	2	3	1	2	3
B.G. IN	15	19½	25	30	39	50
B.G. OUT	60	78	100	120	155	200

FEEDS—IN INCHES PER REVOLUTION OF SPINDLE

L.H. LEVER	A			B			C		
R.H. LEVER	1	2	3	1	2	3	1	2	3
B.G. OUT	.003	.005	.007	.010	.017	.027	.039	.064	.100
B.G. IN	.011	.018	.029	.041	.068	.107	.153	.254	.399

DISENGAGE FEED BEFORE SHIFTING LEVERS
PATENTED—APR. 12. 1910.

—— ON THE ——

"PRECISION" BORING, DRILLING AND MILLING MACHINE

One to show the speeds and feeds, and the other to show the direction of feeds, as the design of the machine is such that no other plates than these are necessary, the function of every lever being obvious and the feeds being of the same number and same value wherever used.

SIMPLICITY SECURES SUPERIOR SERVICE

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

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safety hoods, mounting for grinding wheels, etc., are included. The practical information and safety matters given in this little book, make it well worth the attention of every mechanical engineer, superintendent, foreman and mechanic.

Pratt & Whitney Co., Hartford, Conn. General office, 111 Broadway, New York. Catalogue of grinding machines, comprising four-inch by thirty-inch automatic cylindrical sizing grinder, six-inch by forty-eight-inch automatic sizing grinder, and three-foot and six-foot vertical surface grinders; circular illustrating and describing the Pratt & Whitney three-foot vertical surface grinder, and double and quadruple magnetic chucks for the rapid production of ground parts; circular of the Pratt & Whitney vertical shaper, designed to supply the needs of a machine suitable for doing regular slotting work which can also handle the work performed on the horizontal shaper; circulars of thread milling machines, spline milling machines and automatic profiling machines.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. Catalogue No. 71 of Barnes upright drills and other machine tools, comprising friction disk drills of 8- and 10-inch swing; upright drill No. 7, 15-inch swing with cone pulley drive, no back-gears, with or without gear tapping attachment; upright drills Nos. 1, 6, 1½, 2, 5 and 9 of 20, 22, 22½, 25 and 26 inches swing respectively; Nos. 2½ and 3 of 28 and 32 inches swing, respectively; upright drills Nos. 4 and 8 of 42 and 50 inches swing, respectively. Gear tapping attachments are furnished for all sizes of drills from 15 to 50 inches swing. The catalogue also illustrates and describes gang drills, horizontal radial drills, adjustable screw presses, motor drives for upright drills, water emery grinders, chucks, drill sockets, Barnes universal sliding chuck attachment, etc.

TRADE NOTES

National Machine Tool Co., Cincinnati, Ohio, will move into its new plant on Spring Grove Ave., about January 1, 1913.

Herbert L. Towle, advertising specialist, has removed to new offices in the Philadelphia National Bank Bldg., 421 Chestnut St., Philadelphia.

S. A. Woods Machine Co., Boston, Mass., the controlling interest in which was recently purchased by Messrs. C. W. H. Blood and H. C. Dodge, now has the following officers: H. C. Dodge, president, and C. W. H. Blood, vice-president and treasurer. The management in other respects will remain practically the same as before.

Ideal Case Hardening Compound Co., United States Rubber Bldg., New York. Pamphlet on casehardening, pack-hardening and annealing steel, containing in condensed form much useful information on the heat-treatment of steel and practical rules for securing the desired results. The pamphlet is one that should be welcomed by all concerned with the heat-treatment of steel. Sent free upon request.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., is compiling a hand-book for the use of blacksmiths and forge-shop workers, which is expected to fill a long-felt want. The compilers request that blacksmiths and forge-workers send in handy receipts and shop kinks. Credit will be given for all these in the book. The effort is being made to compile the ideas of the leading blacksmiths throughout the country and thus make the book the best of its kind.

Brown Instrument Co., Philadelphia, Pa., and its associated company, the Keystone Electrical Instrument Co., have found a large increase in their shop facilities necessary and have arranged to triple the space after January 1. The two companies have had a very large increase in the demand for their pyrometers, thermometers and electrical instruments, and an increase in their factory equipment is necessary to meet the needs of the constantly growing business.

Walter H. Foster Co., 50 Church St., New York, has opened an office in the McCormick Bldg., Chicago, Ill., under the management of Mr. William Brewster, formerly associated with the Celfor Tool Co. The Walter H. Foster Co. will have the exclusive sale in that section for the Baush Machine Tool Co.'s multiple and radial drills, and the Lassiter bolt machinery; also the Quigley Furnace & Foundry Co. furnaces for all industrial requirements, complete furnace equipments, etc.

Sawyer Tool Mfg. Co., Fitchburg, Mass., maker of machinists' small tools, steel scales, etc., will move about November 1 to Ashburnham, Mass. eight miles from Fitchburg. The company has been in business in Fitchburg over ten years, and better facilities are now required to provide for the growth of the business. Three large brick buildings, affording 84,000 square feet of floor space or about seven times the area of the Fitchburg plant, will be occupied. Mr. Carl H. Hubbell is president of the company.

Hess-Bright Mfg. Co., Philadelphia, Pa., has built a new factory and office at Front St. and Erie Ave., having a frontage of 200 feet and a depth of 235 feet. The entire second floor, to the depth of 35 feet, is devoted to offices. Back of the offices the building is one-story high with sawtooth roof. The bulk of the company's product is imported, and the output of the shops will represent but a small proportion of the entire business. The present building forms the nucleus of a much larger plant which is eventually to be erected.

Greenfield Tap & Die Corporation, Greenfield, Mass., a holding company that controls the stock of the Wiley & Russell Mfg. Co. and Wells Brothers Co., acquired the entire stock of the A. J. Smart Mfg. Co. on October 1. The A. J. Smart Mfg. Co. was organized six years ago and quickly established a name for the manufacture of the highest class of taps, dies and screw plates. The company will be continued as a separate organization, and conditions are extremely favorable for the continuation of its rapid growth. The new officers are: President, F. O. Wells; vice-president, Rollin S. Bascom; treasurer and clerk, F. H. Payne; directors, the above, and M. Pratt and J. W. Stevens.

Taylor Iron & Steel Co., High Bridge, N. J., has acquired the business of Wm. Wharton, Jr., & Co., Inc. of Philadelphia, with works at Philadelphia and Jenkintown Pa., and its subsidiary corporation the Philadelphia Roll & Machine Co. The Taylor Co. and the Wharton Co. have both been in business more than fifty years. During the last eighteen years, the business of each company has been largely supplementary to the other in the application and manufacture of manganese steel, and the relations have become so close that a unity of interest has been found advisable. The new concern will be known as the Taylor-Wharton Iron & Steel Co., and the officers will be as follows: President, Knox Taylor; vice-presidents, A. E. Borie, Prof. H. M. Howe and V. Angerer; secretary and treasurer, W. A. Ingram.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

AN EXCEPTIONAL OPPORTUNITY FOR THE RIGHT MAN.—I want a foreman for my California jobbing shop, doing experimental work, making inventors' models, dies and tools for novelty manufacturing, repairs and other jobbing work. The seven men already employed are above the average ability for this locality. I want

Supplement to MA

Tables for Article in this number entitled

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ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—I

Number of Teeth in Cutter to be Fluted = 6										
Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	70	23° 18′	0.020	0.7575	0.040	0.7395	0.080	0.7011	0.120	0.6651
	80	39° 40′		0.5251		0.5125		0.4875		0.4625
30	70	16° 32′	0.020	0.7751	0.040	0.7575	0.080	0.7200	0.120	0.6832
	80	29° 22′		0.5750		0.5605		0.5329		0.5020
40	70	11° 58′	0.020	0.7875	0.040	0.7661	0.080	0.7295	0.120	0.6920
	80	21° 48′		0.6035		0.5877		0.5590		0.5310
45	70	10° 12′	0.020	0.7900	0.040	0.7700	0.080	0.7320	0.120	0.6968
	80	18° 44′		0.6120		0.5970		0.5678		0.5395
50	70	8° 39′	0.020	0.7912	0.040	0.7710	0.080	0.7330	0.120	0.6980
	80	15° 59′		0.6190		0.6039		0.5725		0.5450
60	70	6° 2′	0.020	0.7925	0.040	0.7750	0.080	0.7360	0.120	0.6998
	80	11° 12′		0.6300		0.6155		0.5850		0.5551
70	70	3° 49′	0.020	0.7960	0.040	0.7782	0.080	0.7390	0.120	0.7005
	80	7° 10′		0.6340		0.6200		0.5900		0.5595
80	70	1° 52′	0.020	0.7965	0.040	0.7787	0.080	0.7395	0.120	0.7010
	80	3° 30′		0.6355		0.6210		0.5910		0.5601
Number of Teeth in Cutter to be Fluted = 8										
20	60	31° 53′	0.020	0.6380	0.040	0.6210	0.080	0.5901	0.120	0.5478
	70	43° 53′		0.4550		0.4434		0.4219		0.3900
	80	53° 45′		0.2895		0.2825		0.2682		0.2481
30	60	24° 12′	0.020	0.6555	0.040	0.6397	0.080	0.6071	0.120	0.5650
	70	31° 25′		0.4849		0.4725		0.4490		0.4162
	80	42° 55′		0.3298		0.3224		0.3052		0.2835
40	60	18° 15′	0.020	0.6681	0.040	0.6501	0.080	0.6172	0.120	0.5715
	70	26° 33′		0.5048		0.4925		0.4675		0.4331
	80	33° 36′		0.3582		0.3491		0.3319		0.3067
45	60	15° 48′	0.020	0.6701	0.040	0.6530	0.080	0.6205	0.120	0.5754
	70	23° 8′		0.5111		0.4983		0.4740		0.4391
	80	29° 25′		0.3710		0.3608		0.3433		0.3170
50	60	13° 33′	0.020	0.6724	0.040	0.6541	0.080	0.6235	0.120	0.5767
	70	20° 0′		0.5190		0.5032		0.4778		0.4438
	80	25° 30′		0.3785		0.3680		0.3507		0.3240
60	60	9° 37′	0.020	0.6761	0.040	0.6600	0.080	0.6281	0.120	0.5801
	70	14° 20′		0.5249		0.5112		0.4860		0.4485
	80	18° 24′		0.3900		0.3801		0.3600		0.3349
70	60	6° 10′	0.020	0.6810	0.040	0.6626	0.080	0.6300	0.120	0.5804
	70	9° 14′		0.5335		0.5187		0.4930		0.4552
	80	11° 55′		0.4021		0.3910		0.3690		0.3425
80	60	3° 2′	0.020	0.6750	0.040	0.6646	0.080	0.6250	0.120	0.5800
	70	4° 30′		0.5350		0.5225		0.4961		0.4595
	80	5° 50′		0.4065		0.3980		0.3777		0.3497

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—II

Number of Teeth in Cutter to be Fluted = 10										
Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	24° 18′	0.020	0.7340	0.040	0.7091	0.080	0.6591	0.120	0.6091
	50	32° 0′		0.6215		0.6019		0.5627		0.5235
	60	43° 18′		0.4606		0.4451		0.4140		0.3829
	70	51° 50′		0.3204		0.3094		0.2875		0.2656
	80	59° 4′		0.1947		0.1881		0.1749		0.1617
30	45	18° 14′	0.020	0.7422	0.040	0.7160	0.080	0.6636	0.120	0.6112
	50	24° 45′		0.6430		0.0204		0.5742		0.5299
	60	34° 30′		0.4800		0.4630		0.4290		0.3950
	70	42° 3′		0.3433		0.3312		0.3070		0.2828
	80	48° 30′		0.2225		0.2135		0.1956		0.1777
40	45	12° 30′	0.020	0.7680	0.040	0.7421	0.080	0.6903	0.120	0.6385
	50	18° 55′		0.6500		0 6275		0.5826		0.5376
	60	27° 3′		0.4918		0.4746		0.4403		0.4060
	70	33° 31′		0.3601		0.3431		0.3210		0.2953
	80	38° 50′		0.2439		0.2355		0.2187		0.2019
45	45	11° 47′	0.020	0.7500	0.040	0.7235	0.080	0.6705	0.120	0.6175
	50	16° 10″		0.6591		0.6394		0.5999		0.5604
	60	23° 40′		0.4975		0.4700		0.4450		0.4100
	70	29° 24′		0.3682		0.3553		0.3294		0.3036
	80	34° 20′		0.2528		0.2439		0.2260		0.2081
50	45	10° 7′	0.020	0.7465	0.040	0.7206	0.080	0.6687	0.120	0.6168
	50	14° 10′		0.6539		0.6311		0.5856		0.5400
	60	20° 31′		0.5000		0.4826		0.4479		0.4131
	70	25° 40′		0.3725		0.3594		0.3333		0.3072
	80	30° 1′		0.2601		0.2510		0.2327		0.2145
60	45	7° 8′	0.020	0.7500	0.040	0.7240	0.080	0.6720	0.120	0.6200
	50	10° 5′		0.6595		0.6363		0.5898		0.5433
	60	14° 50′		0.5049		0.4875		0.4528		0.4181
	70	18° 37′		0.3804		0.3673		0.3411		0.3149
	80	21° 56′		0.2709		0.2613		0.2422		0.2231
70	45	4° 34′	0.020	0.7503	0.040	0.7243	0.080	0.6723	0.120	0.6203
	50	6° 30′		0.6598		0.6389		0.5920		0.5451
	60	9° 36′		0.5101		0.4924		0.4568		0.4212
	70	12° 8′		0.3872		0.3730		0.3460		0.3190
	80	14° 20′		0.2785		0.2688		0.2494		0.2300
80	45	2° 14′	0.020	0.7498	0.040	0.7238	0.080	0.6719	0.120	0.6200
	50	3° 10′		0.6603		0.6376		0.5923		0.5469
	60	4° 45′		0.5078		0.4902		0.4550		0.4198
	70	6° 0′		0.3875		0.3740		0.3470		0.3200
	80	7° 5′		0.2820		0.2724		0.2532		0.2340

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—III

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Number of Teeth in Cutter to be Fluted = 12							
			Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	36° 0′	0.020	0.5718	0.040	0.5480	0.080	0.5004	0.120	0.4528
	50	40° 40′		0.5017		0.4807		0.4387		0.3967
	60	49° 19′		0.3620		0.3470		0.3170		0.2870
	70	56° 1′		0.2475		0.2371		0.2163		0.1955
	80	61° 50′		0.1454		0.1393		0.1271		0.1149
30	45	28° 8′	0.020	0.5806	0.040	0.5566	0.080	0.5086	0.120	0.4606
	50	32° 32′		0.5128		0.4912		0.4480		0.4048
	60	40° 12′		0.3760		0.3602		0.3286		0.2970
	70	46° 15′		0.2649		0.2537		0.2313		0.2089
	80	51° 25′		0.1657		0.1589		0.1453		0.1317
40	45	22° 0′	0.020	0.5890	0.040	0.5612	0.080	0.5146	0.120	0.4650
	50	25° 33′		0.5191		0.4973		0.4537		0.4101
	60	32° 2′		0.3870		0.3708		0.3384		0.3060
	70	37° 15′		0.2769		0.2653		0.2421		0.2189
	80	41° 44′		0.1803		0.1727		0.1575		0.1423
45	45	18° 55′	0.020	0.5981	0.040	0.5729	0.080	0.5225	0.120	0.4721
	50	22° 13′		0.5260		0.5040		0.4600		0.4160
	60	28° 19′		0.3920		0.3752		0.3416		0.3080
	70	33° 0′		0.2832		0.2714		0.2478		0.2242
	80	37° 6′		0.1865		0.1787		0.1631		0.1475
50	45	16° 31′	0.020	0.5980	0.040	0.5728	0.080	0.5224	0.120	0.4720
	50	19° 27′		0.5261		0.5039		0.4595		0.4150
	60	24° 43′		0.3950		0.3784		0.3452		0.3120
	70	28° 54′		0.2878		0.2757		0.2515		0.2273
	80	32° 33′		0.1937		0.1857		0.1697		0.1537
60	45	12° 12′	0.020	0.5960	0.040	0.5652	0.080	0.5156	0.120	0.4660
	50	14° 13′		0.5245		0.5001		0.4573		0.4145
	60	18° 0′		0.4000		0.3834		0.3502		0.3170
	70	21° 10′		0.2950		0.2826		0.2578		0.2330
	80	23° 58′		0.2021		0.1935		0.1763		0.1591
70	45	8° 0′	0.020	0.5875	0.040	0.5629	0.080	0.5137	0.120	0.4645
	50	9° 8′		0.5300		0.5080		0.4640		0.4200
	60	11° 45′		0.4035		0.3865		0.3525		0.3185
	70	13° 54′		0.2986		0.2864		0.2620		0.2376
	80	15° 45′		0.2082		0.1994		0.1818		0.1642
80	45	3° 46′	0.020	0.6005	0.040	0.5753	0.080	0.5249	0.120	0.4745
	50	4° 30′		0.5298		0.5078		0.4638		0.4198
	60	5° 48′		0.4049		0.3879		0.3539		0.3199
	70	6° 51′		0.3040		0.2912		0.2656		0.2400
	80	7° 48′		0.2120		0.1932		0.1756		0.1680

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912

ANGLE OF ELEVATION AND DEPTH OF CUT FOR FLUTING ANGULAR MILLING CUTTERS—IV

Angle of Cutter Blank, in Degrees	Angle of Fluting Cutter, in Degrees	Angle of Elevation of Head	Number of Teeth in Cutter to be Fluted = 14							
			Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Width of Land, Radius = 1	Depth of Cut, Radius = 1
20	45	42° 5′	0.020	0.4755	0.040	0.4525	0.080	0.4065	0.120	0.3605
	50	46° 0′		0.4132		0.3932		0.3532		0.3132
	60	53° 4′		0.2960		0.2817		0.2531		0.2245
	70	58° 40′		0.2000		0.1902		0.1706		0.1510
	80	63° 30′		0.1150		0.1094		0.0982		0.0870
30	45	33° 51′	0.020	0.4860	0.040	0.4630	0.080	0.4170	0.120	0.3710
	50	37° 27′		0.4226		0.4019		0.3607		0.3195
	60	43° 50′		0.3069		0.2921		0.2625		0.2329
	70	48° 52′		0.2128		0.2024		0.1816		0.1608
	80	53° 15′		0.1294		0.1232		0.1108		0.0984
40	45	26° 39′	0.020	0.4945	0.040	0.4705	0.080	0.4225	0.120	0.3745
	50	29° 50′		0.4296		0.4086		0.3666		0.3246
	60	35° 20′		0.3150		0.2996		0.2688		0.2380
	70	39° 40′		0.2231		0.2123		0.1907		0.1691
	80	43° 30′		0.1410		0.1342		0.1206		0.1070
45	45	23° 24′	0.020	0.4959	0.040	0.4719	0.080	0.4239	0.120	0.3759
	50	26° 10′		0.4360		0.4146		0.3718		0.3290
	60	31° 19′		0.3198		0.3042		0.2730		0.2418
	70	35° 18′		0.2275		0.2165		0.1945		0.1725
	80	38° 45′		0.1470		0.1398		0.1254		0.1110
50	45	20° 30′	0.020	0.4970	0.040	0.4730	0.080	0.4250	0.120	0.3770
	50	22° 59′		0.4370		0.4156		0.3728		0.3300
	60	27° 27′		0.3225		0.3069		0.2757		0.2445
	70	31° 0′		0.2320		0.2208		0.1984		0.1760
	80	34° 10′		0.1510		0.1436		0.1288		0.1140
60	45	15° 14′	0.020	0.4980	0.040	0.4740	0.080	0.4260	0.120	0.3780
	50	16° 45′		0.4384		0.4168		0.3736		0.3304
	60	20° 5′		0.3280		0.3120		0.2800		0.2480
	70	22° 50′		0.2371		0.2257		0.2029		0.1801
	80	25° 15′		0.1572		0.1496		0.1344		0.1192
70	45	9° 45′	0.020	0.4986	0.040	0.4746	0.080	0.4266	0.120	0.3786
	50	10° 55′		0.4410		0.4192		0.3756		0.3320
	60	13° 11′		0.3325		0.3163		0.2839		0.2515
	70	15° 0′		0.2437		0.2317		0.2077		0.1837
	80	16° 39′		0.1632		0.1552		0.1392		0.1232
80	45	5° 0′	0.020	0.4990	0.040	0.4750	0.080	0.4270	0.120	0.3790
	50	5° 21′		0.4420		0.4202		0.3766		0.3330
	60	6° 32′		0.3330		0.3170		0.2850		0.2530
	70	7° 29′		0.2474		0.2348		0.2096		0.1844
	80	8° 15′		0.1676		0.1594		0.1430		0.1266

Contributed by George W. Burley

No. 160, Data Sheet, MACHINERY, November, 1912

MACHINERY

DECEMBER, 1912

THE "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE*—1

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON†

THE multiple spindle automatic screw machine built by the National-Acme Mfg. Co., Cleveland, was the first automatic screw machine of the multiple spindle type to prove a commercial success. It was designed and originated in the early '90's in Hartford, Conn., by Reinhold-Hackewessell and E. C. Henn. In 1901 the National-Acme Mfg. Co. was incorporated, and in 1902 moved to its present site in Cleveland. This machine was supplied with a single pulley or motor drive in 1908, in which form it will be described in this and following articles.

Principle of the Design

In principle, the "Acme" multiple spindle automatic screw machine comprises four work spindles, which are held in a cylinder and rotated by gears, the cylinder being indexed to bring these work spindles consecutively into position in front of the side-working and end-working tools. It requires one-quarter cycle of the cylinder to complete one piece, this being accomplished in the time required to perform the longest cut, which is usually a drilling, forming or box-tool turning operation. In frequent cases, it is possible to complete the piece in much less than the time required for the longest cut. Take, for instance, a long milling cut, which can be divided between the box-tools in the "first" and "second" positions. In that case, the time for the completion of the piece is considerably less than the usual time for box-turning, being slightly more than one-half. In drilling, three tools are frequently used in this manner, so that only a trifle over one-third of the time necessary for drilling the hole is required to complete the piece. The feeding of the bar takes place between the "first" and "fourth" positions, when the cylinder is indexing (on the smaller machines), and in the "first" position (on the larger machines), the stop swinging out of the way before the tools approach the work.

By referring to Fig. 1, it will be seen that there are eight standard tool positions, *viz:* Four end-working tools, two horizontal forming and cut-off slides, and two top slides working in the "second" and "third" positions. With this arrangement, it is possible to have two tools working on each of the four bars at one time—obviously, from a production standpoint, a great advantage over the single spindle type of automatic screw machine. The idle or non-productive movements in this machine are: withdrawing the tools, and indexing the cylinder carrying the work spindles; these movements occur at the completion of each piece.

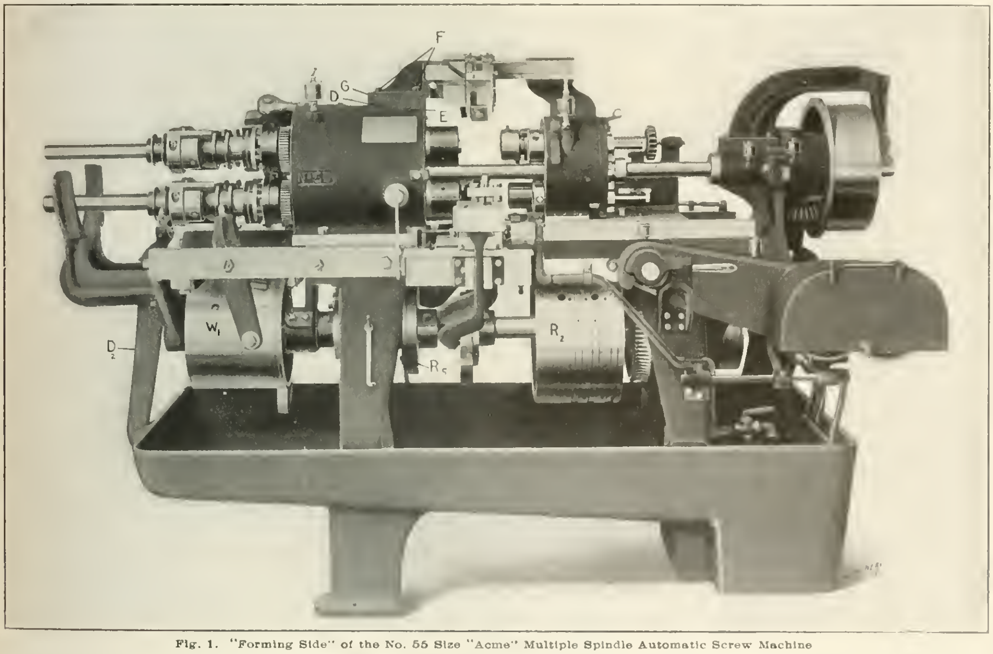

Fig. 1. "Forming Side" of the No. 55 Size "Acme" Multiple Spindle Automatic Screw Machine

Cylinder and Casing

The cylinder *A*, Fig. 3, which is carried in the head of the machine, is made from a gray iron casting, ground to standard size, and is enclosed in a casing *B* that is bolted to the frame of the machine. This casing is ground internally and is split, as shown at *C*, to provide for wear. Adjustment for wear is controlled by screws *D* and *E*, Fig. 1. The casing is contracted by loosening the screws *F* in the top bracket *G;* then turning the screw *D* to the left, screw *E* to the right, and when the proper adjustment is obtained, again turning screw *D* to the right. To expand the casing turn screw *E* to the left, screw *D* to the right, and then turn screw *E* to the right.

The cylinder *A* is held lengthwise in the casing *B* by the

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* For articles on screw machine work previously published in MACHINERY see "Magazine Attachments," March, 1912, and accompanying references at end of article.

† Associate Editor of MACHINERY.

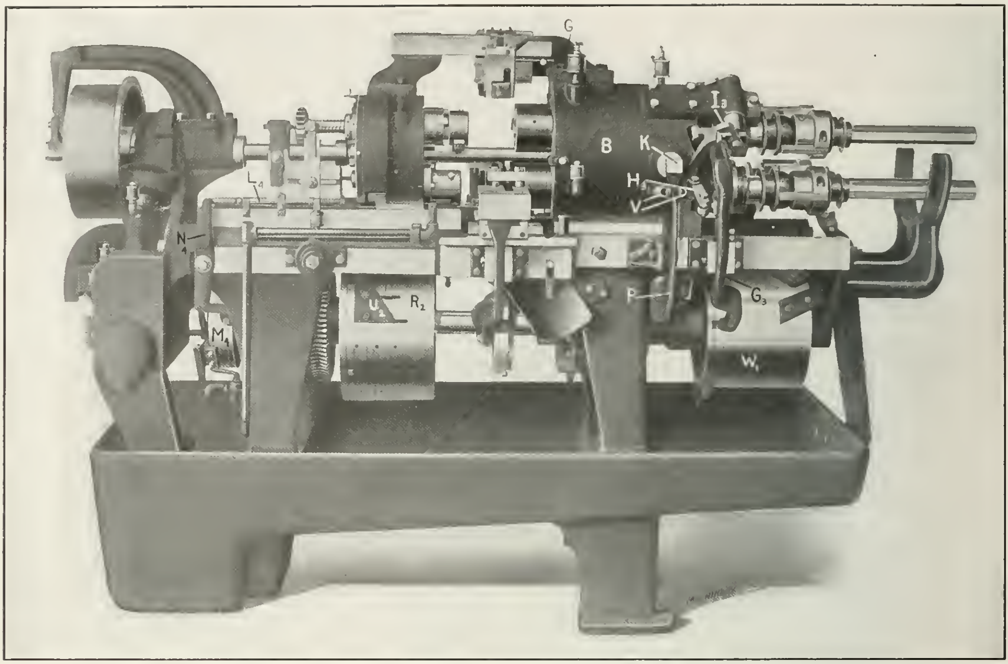


Fig. 2. "Cut-off" Side of the "Acme" Multiple Spindle Automatic Screw Machine

flange *H*, Fig. 3. The indexing of the cylinder is accomplished by a fan-gear *J*, Figs. 4 and 5, which meshes with teeth cut in the back of the cylinder at *I*. This fan-gear is held on a cam-shaft *M*, which makes four revolutions to one complete cycle of the cylinder. When the cylinder is indexed by the fan-gear, it is forced into the correct position by the bevel-end bolt *K*, which seats on a hardened beveled stud *L*, located in the cylinder; and when in proper alignment, the screw *N* is seated upon the flattened portion of the bolt *O*. The bolt *K* is withdrawn by an arm *P* fulcrumed at a point *Q*, and operated by a dog *R* held on the cam-shaft. This dog should engage fully with the shoe-end of the arm, before the first tooth of the fan-gear comes in contact with the cylinder, and should drop onto the dog *T* in the first step *U*, just as the adjustable tooth *S* begins to withdraw from the last tooth in the cylinder.

In operation, as the bolt *K* is withdrawn by arm *P* and dog

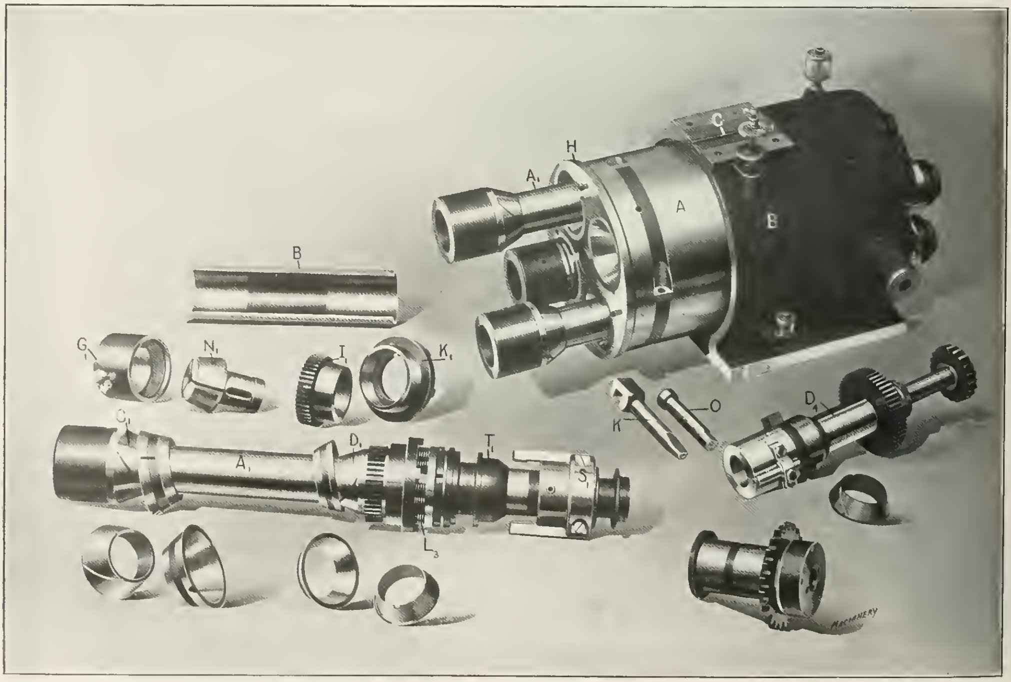


Fig. 3. The Head, Cylinder and Work-spindles partly dismantled

R, the first tooth in the fan-gear J comes in contact with the cylinder, rotating it and at the same time forcing back the bolt O. Then as the cylinder revolves around to the next position, the bolt O is forced into the cavity in front of the aligning screw N by a coil spring, the adjustable tooth S on the fan-gear having swung the cylinder around so that the aligning screw passes the top face of the bolt O. Then as the arm P drops off the dog T, the bolt K is forced "home" by the coil springs V, drawing the cylinder back and seating the aligning screw N on the flattened portion of the bolt O.

Machines leave the factory with these adjustments properly made, but after being in operation for some time, they limber up so that re-adjustment may sometimes be necessary, especially on the smaller machines, where allowance must be made for setting the dogs for extreme speed. The screw N is the only part made adjustable, so that after the machines have been in constant use and require overhauling, it is possible to preserve the alignment of the work spindles with the tool spindles by simply adjusting this screw. The only parts which require adjusting, after the machine has run for some time, are the dogs R and T and the tooth S on the fan-gear, which should be set to operate at the proper time. The order in which these should operate has previously been described.

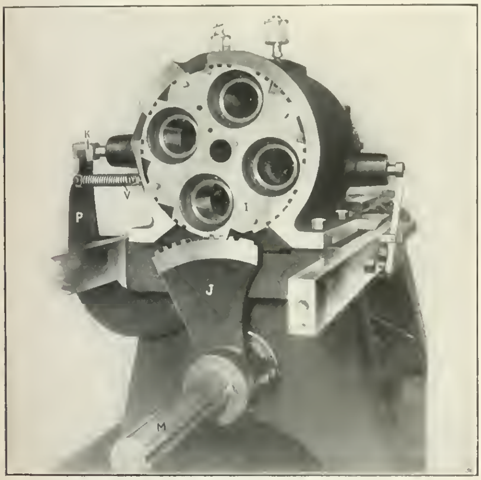


Fig. 4. View showing the Fan-gear in the Act of Indexing the Cylinder

Work Spindles

The work spindles A_1, one of which is shown removed from the cylinder in Fig. 3, are made from hardened and ground steel. These spindles run in phosphor-bronze parallel bearings B_1, which are forced into the holes in the cylinder under pressure, and are prevented from turning by brass screws set through from the outside of the cylinder. These bearings are accurately reamed after insertion. The front and rear tapered bearings C_1 and D_1 are also made from phosphor-bronze, and are run in hardened and ground tapered steel bushings inserted in the cylinder. The front ends of the spindles are provided with shoulders, and are threaded (right-handed) for the reception of the caps G_1 that are internally tapered to suit the push-type of chucks used for holding the bars.

The spindles are driven by spur gears from the central shaft. These gears I_1 are free to rotate on the bronze bushings, and are provided with tapered projections or shoulders which form the internal member of a friction driving clutch. The other member of this driving clutch consists of a cup K_1, which is keyed to a sleeve that, in turn, is keyed to the spindle. The cup is held in engagement with the friction gear I_1 by coil springs L_3. The operation of this friction clutch will be described in connection with the threading mechanism.

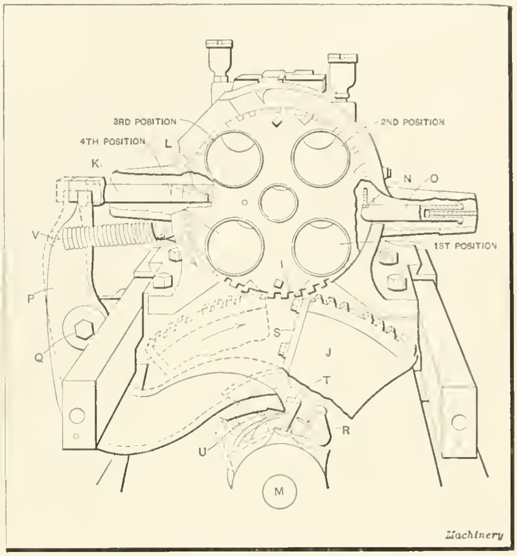


Fig. 5. View showing how the Cylinder is Indexed and locked in Position

The spindles are adjusted for end play by means of adjusting nuts M_1, Fig. 6, which are separated by a bronze washer Z_2 and screwed onto a split nut Z_3 held on the spindle. Care should be exercised in adjusting these nuts to see that they do not bind the spindles too tightly to prevent their free operation. There should be no perceptible shake in the bearings, but the spindles should turn free enough by hand so that the "back lash" of the gears can be felt. It will be seen, upon reference to Fig. 6, that as the split nut Z_3 is moved to the right it forces the sleeve Z_1 inward. Then, as this sleeve bears against the bronze tapered bushing D_1, it is evident that the spindle must be drawn in, and, as it is provided with a collar on its outer end, it carries the other bronze bushing E_1 with it, thus compensating for end play and providing for a smooth action of the machine.

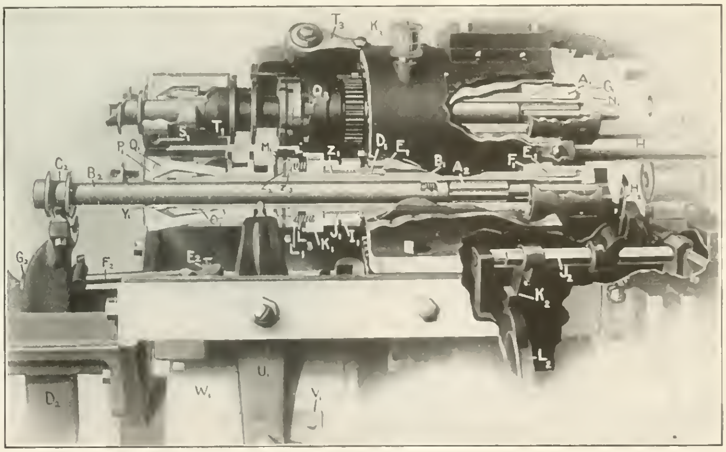


Fig. 6. Part Section of Head and Cylinder, showing Construction and Operation of the Work-spindles

Chuck Closing, Stock Feeding and Gaging Mechanism

The spring chucks X_1, which are of the push-type, are closed in on the bars by being forced into the caps G_1, by means of the steel sleeves O_1 and fingers P_1. These fingers are fulcrumed on pins Q_1 located in collars S_1, and opened by tapered collars T_1 operated by lever U_1 and cam block V_1 held on drum W_1. The short ends of the fingers bear against hardened caps Y_1, which are spun onto the rear ends of the chuck-closing sleeves O_1.

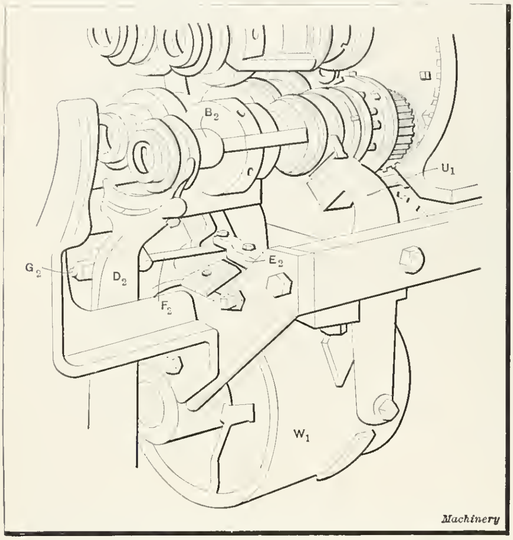


Fig 7. View showing Operation of the Stock Feeding Mechanism

To tighten the spring chucks on the bars, the hollow set-screws in the collars S_1 should first be unscrewed and then the collars are turned to the right. As these collars are screwed onto the ends of the spindles, the fulcrum point of the levers is changed, allowing the short ends of the levers to force the sleeves further forward in closing the chucks. The fingers P_1 always travel up the full incline of the tapered collar T_1 and onto the flat portion for a lock. After the proper tension has been obtained, the hollow set-screws in the collars S_1 should be moderately tightened to force the brass shoes beneath them tightly into the threads on the spindles.

The feeding of the stock is accomplished, as shown in Fig. 6, by a split and spring tempered feed finger A_2, which is screwed (right-handed) into the feed tube B_2. This tube extends from the rear end of the spindle, and is provided with a collar C_2 in which a shoe is fitted, that is held to the upper end of the lever D_2. This lever, as shown in Fig. 1, is hinged to a bracket fastened to the base of the machine.

Movement is transmitted to the lever D_2 by a cam block held on the drum W_1, through positive feed lever E_2 and rod F_2. (See also Fig. 7.) The length of the feed is controlled by adjusting the stop G_2 on the rod F_2, which regulates the distance that the rod F_2 travels through the lever D_2 before moving it. When the cylinder is indexing from the "first" to the "fourth" positions (on the Nos. 51 and 52 machines) and when in the "first" position (on the larger machines), the lever D_2 withdraws the feed tube B_2, causing the feed finger A_2, Fig. 6, to slip over the bar, which is held tightly in the spring chuck X_1.

Cam lever U_1 now withdraws the collar T_1 from contact with the fingers P_1, thus allowing the latter to drop down into the position shown in Fig. 6. At this instant, the spring tension confined in the chuck X_1 causes it to fly back, expanding and releasing its grip on the rod and allowing the latter to be fed out. The lever E_2 is now acted upon by a cam on drum W_1 which, through the medium of the lever E_2, rod F_2 and lever D_2, propels the feed tube B_2 forward. Then by means of the spring tension on the bar, the feed finger A_2 forces the latter through the chuck until it comes in contact with the gage stop H_2.

Just before the lever D_2 has reached the forward end of its stroke, and after the bar has come in contact with the stop, the cam-lever U_1 brings the collar T_1 in contact with the fingers P_1, spreading them apart. The resulting action on the short ends of the fingers forces the sleeve O_1 against the end of the chuck X_1, which is pressed into the tapered cap G_1 and thus made to grip the bar.

The stop H_2 is fastened to a holder which can be adjusted along the hexagon rod J_2, the latter being retained in the brackets shown in Fig. 6. Located on the hexagon rod is a dog K_2, which is operated by a cam L_2 to bring the stop into and out of operation, on the Nos. 53 and 56 machines. This stop, which is off-set towards the spindles, does not occupy one of the eight tool positions, and on the smaller machines it acts when the cylinder is indexing. On the larger machines, the stop H_2 can be reversed on the holder to accommodate long work. The accuracy of the blank, for length, depends on the correct adjustment of the stop in relation to the cut-off tool, except, of course, when the end-working tools are used for facing the work.

End-working Tool Slide

The main tool slide M_2, shown in Fig. 8, carries the end-working tools—otherwise known as the turret tools—to and from the work. There are four tool spindles, to correspond with the four work spindles, held in the revolving cylinder. To make clear the following description, these will now be named in the order of their working positions. Spindle N_2 is called the "first" position, O_2 the "second," P_2 the "third" and Q_2 the "fourth" position. The uses of these various tool positions, or in other words, the operations performed from them will be explained later.

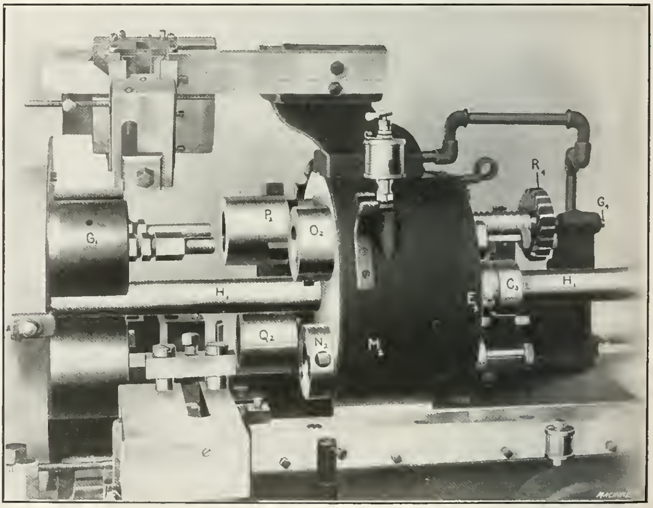


Fig. 8. Main Tool-slide and End-working Tool-holding Spindles

As shown in Fig. 9, the main tool slide M_2 is moved to and from the work by cam blocks held on the drum R_2. These cams move the tool slide through the medium of the roll S_2, which is held to an adjustable roll holder T_2 bolted to the lower face of the tool slide. It is good practice to have the shanks of the end-working tools extend as far as possible into the tool spindles. This insures that they will be held more rigidly, and facilitates the production of better work. To make this possible, two methods of adjustment are provided, to be used in changing over from short to long work and *vice versa.*

First, by changing the position of the lead cam U_2 on the drum R_2 (see Fig. 2), and second, by changing the position of the roll holder T_2. This subject will be dealt with more fully in the description pertaining to the operation of the machine.

End-working Tool Spindles

The tool spindles N_2 and Q_2, Fig. 8, are held stationary in the main tool slide, while the spindles O_2 and P_2 can be revolved. The tool spindle O_2 is revolved when it is necessary to drill a small hole in a comparatively large piece of work; otherwise it would be necessary to increase the speed of the work spindle sufficiently to give the small drill a speed high enough to give the best results. This tool spindle is also used for holding a threading tool when the character of the operations on the work demand it.

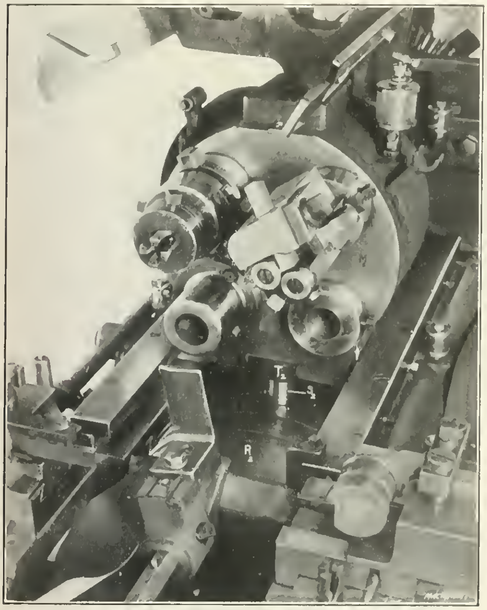


Fig. 9. End View of the End-working Tool-slide, showing how it is advanced to bring the Tools in Contact with the Work

The method of holding the end-working tool spindles N_2 and O_2 in the tool head is shown in Fig. 10. The rear ends of the tool spindles are reduced in diameter and threaded, and nuts V_2 and W_2 screwed onto these ends hold the spindles in the head. The end-working tools are retained in the spindles by set-screws, and are adjusted longitudinally by the knurled thumb-screws Y_2. These thumb-screws also serve as gage stops for setting the tools, after they have been removed for grinding, etc. That is, the tool which has been ground is returned to the same relative position in the holder. When the end-working tool is held in the tool spindle in the position corresponding to the one where the cut-off tool is being used, it is necessary to use a shorter cam. The take-back cam for the end-working tool slide should also be set forward. This is done to allow the tool to clear the work before the piece is cut off.

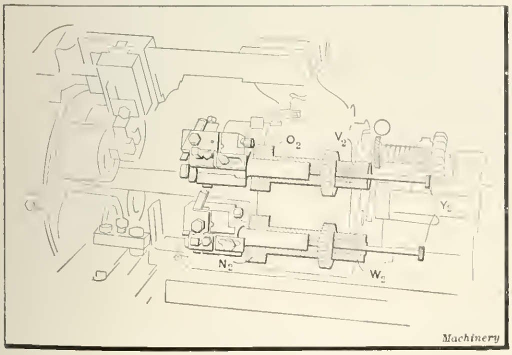


Fig. 10. Construction of the End-working Tool-holding Spindles and Method of Adjusting the End-working Tools

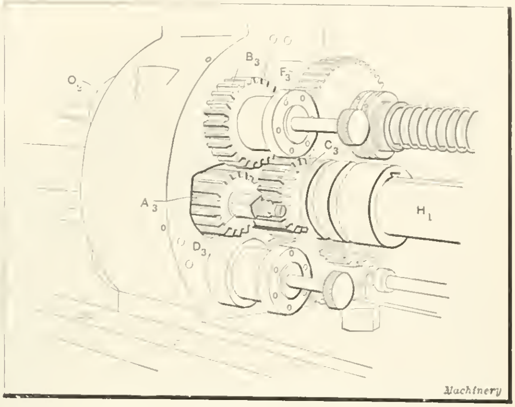


Fig. 11. View of the Tool-slide with Back-plate removed, showing how the Spindle in the "Second" Position is rotated

When it is desired to use the tool spindle O_2, Fig. 11, for revolving a drill or other tool, it can be rotated by gears A_3 and B_3 which are driven by the sliding gear C_3 keyed to the driving shaft H_1. The intermediate gear A_3 is carried on a stud D_3, which is located in the back plate, removed in Fig. 11. To drive this spindle, loosen the set-screw and the nut F_3 to allow the spindle to rotate freely. Then unscrew the nut on the intermediate stud D_3, moving the latter to bring the intermediate gear into mesh with the sliding gear C_3. Now clamp the stud D_3 by screwing the nut up tightly.

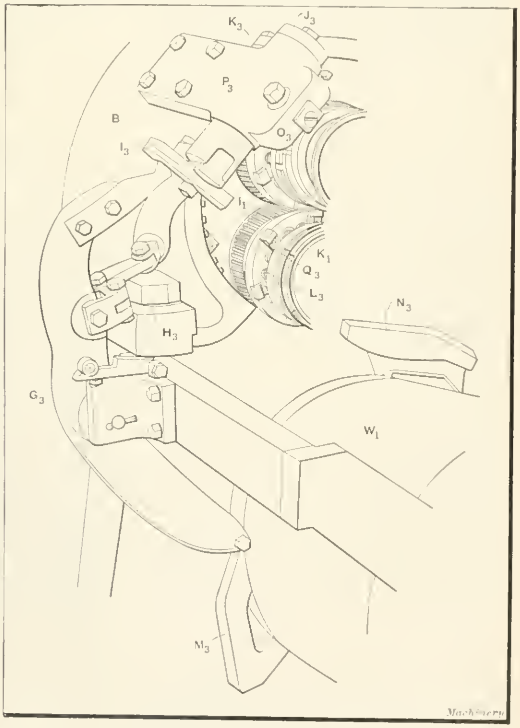


Fig. 12. Spindle Locking and Disengaging Mechanism

Threading Mechanism

The method of cutting a right-hand thread in the "Acme" multiple spindle automatic screw machine is to stop the rotation of the work spindle when in the "third" position, and hold it rigidly while the thread is being cut with a die or tap held in the tool spindle P_2. This provides for the use of a proper speed for the threading tool, regardless of the speed at which the other tools are working—producing a better thread and not taking any extra time to do so—a feature peculiar to the "Acme" multiple spindle automatic screw machine.

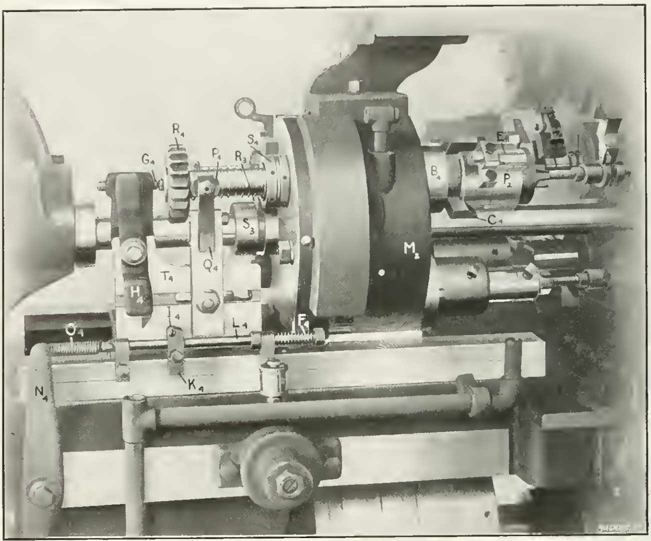


Fig. 13. View of the Main Tool-head, showing the Right-hand Threading Mechanism

This is accomplished as shown in Figs. 2, 6, 12 and 13, where different views of the same parts are represented by the same reference letters. The work spindles are stopped, one at a time, as the cylinder indexes them to the "third" position, when the gear I_1 and cup K_1 are disconnected. This action is controlled by a cam M_3 on the drum W_1, operating through the lever G_3 and the special locking device H_3. This device, in turn, operates the levers I_3 and J_3 bringing the roller K_3 into contact with the cup K_1, thus compressing the coil springs L_3 and separating the cup from the gear. The opening or friction disengaging cam M_3 is positive, while the closing or friction engaging cam N_3 is adjustable on the drum W_1.

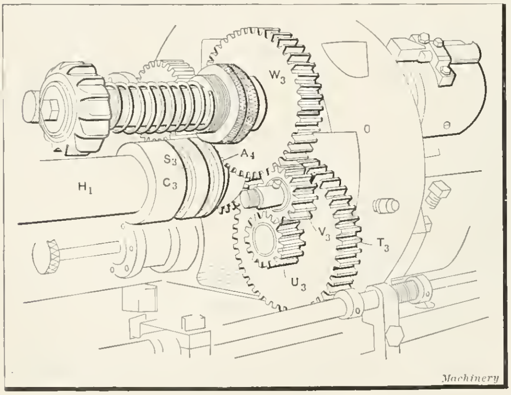


Fig. 14. Gears arranged to drive the Right-hand Threading Mechanism at its Slowest Speed

The length of time that the work spindle must be held stationary in the "third" position is determined by the duration of the threading or other special operation performed from this position. To hold the spindle rigidly in this position, the adjustable plunger in the block O_3 (located on the under side of the bracket P_3 which is bolted to the casing B) is brought in contact with the lugs Q_3. These lugs are inserted in the cup K_1, and overlap the plunger in the block O_3 about ⅛ inch when the springs L_3 are compressed. These springs may require replacing after continuous use, but usually a thorough cleansing of the gears I_1 and cups K_1 with kerosene, to let them come close together, will prove effective in holding these parts in contact.

Now that the method of stopping the rotation of the work spindles preparatory to threading has been described, the next step is to explain how the threading spindle is rotated. This is accomplished by the sliding gear C_3 keyed to the shaft H_1; this gear drives the spindle in a right-hand direction, through a train of gears as shown in Figs. 14 and 15, giving two speeds to the threading spindle for each speed of the work spindles.

When the shoe R_3, see Fig. 13, is in the groove S_3 of the sliding gear, the drive is transmitted from the sliding gear through the gears T_3, U_3 and V_3 to the gear W_3 on the threading spindle, as shown in Fig. 14, rotating the latter at its slowest speed. When the shoe R_3 is in the groove A_4 in the sliding gear, the drive is direct from this gear to the gear W_3, as shown in Fig. 15, rotating the threading spindle at its highest speed.

In threading brass, or cutting very fine threads on soft steel, the highest speed may be used. It is generally advisable to run the threading spindle at its slowest speed, that is, through the compound gears, as shown in Fig. 14. When it is desired to prevent the threading spindle from rotating, the shoe R_3 is drawn up, and the gear C_3 slid along the shaft H_1 out of contact with the other gears. As shown in Fig. 13, the threading spindle P_2 is driven by a block C_4 attached to the holder B_4. This block engages with an adjustable pin E_4 attached to the threading spindle P_2. The pin E_4 is adjusted out when the forward travel of the threading tool must be faster than the speed at which the main tool slide is traveling.

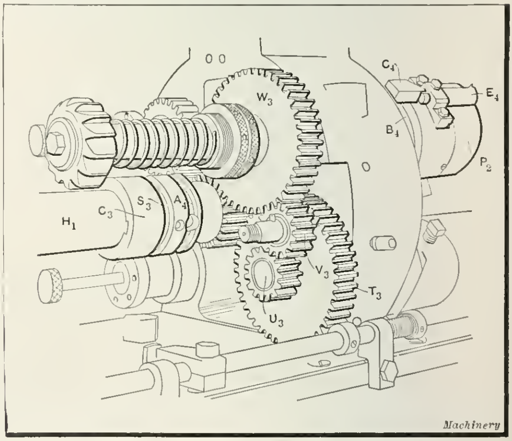


Fig. 15. Gears arranged to drive the Right-hand Threading Mechanism at its Fastest Speed

Now as the main tool slide does not always travel at a speed equal to the lead of the threading tool, it is necessary, especially when the threaded portion is short or the thread is of a fine pitch, to provide some means of giving the threading tool a proper start, so that it will "lead" onto the work without being forced. The device used for this purpose is shown in Fig. 13, and consists of a plunger G_4, and auxiliary mechanism, which is operated just as the threading tool approaches the work. This plunger G_4 is operated by a swinging pawl H_4, which is given an impulse at the proper moment by a roll I_4 held in the block K_4, the latter being adjustable on the rod L_4; this rod, in turn, is operated by a cam on the drum M_4, see Fig. 2 (with the exception of machines Nos. 51 and 52, where the cam is on the drum R_2), through the lever N_4 and cushion spring O_4, the latter breaking the mechanical action of the starter, and allowing the threading tool to follow the pitch of the thread. This makes the starting of the threading tool positive, and the operation of the mechanism flexible. The spring F_4 returns the rod L_4 to its "back" position.

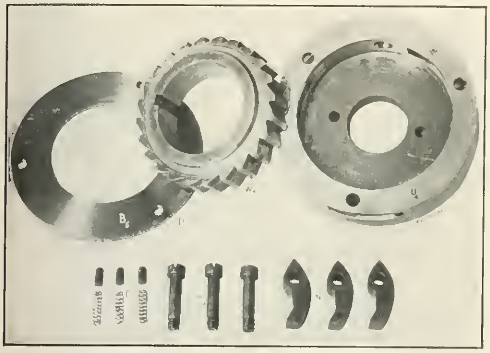


Fig. 16. Part of the Left-hand Threading Mechanism dismantled

After the starting mechanism operates in the manner described, the threading tool "leads" onto the work to the required distance. When it reaches this point, the main tool slide drops back, but the threading spindle P_2 is prevented from doing so, because of the grip of the threading tool on the work, thus compressing the coil spring P_4. When the tool slide drops back disengaging the driving pins, flexible pawl Q_4 (the holder retaining it being adjustable on the bracket T_4) comes in contact with the ratchet R_4 on the rear end of the threading spindle, preventing the latter from rotating, when the work spindle is rotated in the manner previously described, to run the threading tool off the work.

Now as the work spindles revolve in a left-hand direction, the threading tool, being right-handed, is run off the work when the spindles are revolved. Then spring P_4, which has been compressed by the tool slide dropping back, returns the threading spindle to its normal position, after the threading tool leaves the work. The adjusting nuts S_4 are used to take up the end play in the threading spindle holder, which is shown dismantled from the tool head at D_4 in Fig. 3.

To cut a left-hand thread, it is necessary to change the device shown in Fig. 13. To do this the nuts S_4 are removed, and are replaced by a special collar U_4, Fig. 16. A special washer V_4 also takes the place of the ratchet R_4 on the end of the threading spindle, as shown in Fig. 17; this illustration shows the left-hand threading mechanism assembled in the tool head.

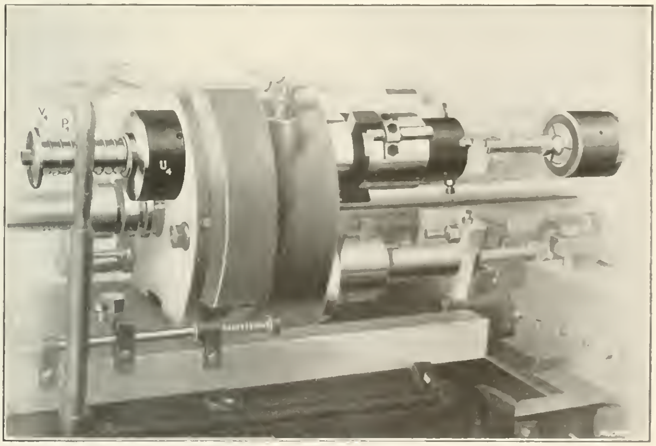


Fig. 17. Left-hand Threading Mechanism assembled in the Main Tool-slide

Fig. 16 shows the principal parts of this left-hand threading device. Here, U_4 is the collar which screws onto the threading spindle; W_4 is the ratchet (keyed to the threading spindle), which in conjunction with the pawls Y_4, screws A_5, plungers and springs C_5, prevents the threading spindle from revolving independently of the driving pins when the thread is being cut. The washer B_5 is used to enclose the mechanism. The block C_4, Fig. 13, and the pin E_4 are also removed, and are replaced by similar blocks shown in Fig. 17, which are designed especially for left-hand threading.

The method of cutting a left-hand thread is to revolve both the threading spindle and the work spindle. The work spindle is rotated left-handed faster than the threading spindle, thus producing a relative motion between the spindles that cuts the thread by the work spindle gaining on the threading tool. The tool slide brings the threading tool up to the work, when the tool "leads" on, compressing the coil spring P_4. When the threading tool advances to the required distance, the work spindle is stopped by means of a cam on drum W_1 (Fig. 2), but the threading spindle is still revolved by the same gears that are used for rotating the spindle for right-hand threading. As the threading spindle in backing off revolves in a right-hand direction, it is evident that the pawls Y_4 will allow the ratchet W_4 to rotate with the spindle. When the threading tool leaves the work, the spring P_4 returns the threading spindle to its normal position.

* * *

REDUCING FIRE RISK IN WOODWORKING PLANTS

The great inflammability of materials and products in a woodworking plant, together with the inevitable collection of dust and sawdust liable to flash into flame from spontaneous combustion, or the careless use of matches, makes this type of property an extremely hazardous one from the fire point of view. Insurance rates of 8 per cent per annum are not at all uncommon, and a rate as high as this is justified in many of these properties.

Elimination of fire risk is of extreme importance, as it would result not only in absence of danger from fire but a very material decrease in the cost of insurance. The placing of an engine and boiler room close to the plant increases the fire risk, particularly as inflammable dust is always carried from the plant into the engine room by the heavy belt and is liable to cause an explosive fire. Electric drive does away with this inflammable dust, and if induction motors are used, also eliminates danger of sparking. The saving effected in insurance premiums alone is sometimes sufficient to warrant the erection and electric equipment of new fireproof buildings.

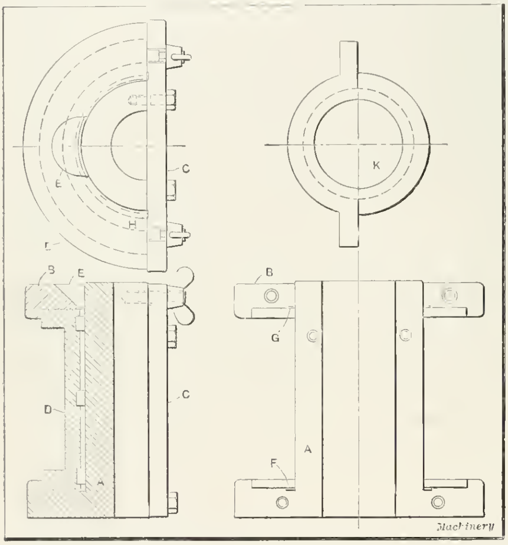
This is so, however, only if the buildings are adequately protected by a complete system of automatic sprinklers. Recent figures on the cost of cheap wooden buildings with engine drive as compared with the best fireproof construction driven electrically and protected by automatic sprinklers, show that for a certain plant the cost of the former including all machinery will represent \$28,800 as against \$38,300 for the latter. The difference in insurance premiums, however, amounts to more than \$2000 a year in favor of the more expensive plant. It is seen that this difference is more than twenty per cent dividend upon the difference in cost, and that the additional expenditure on first cost is more than justified on every ground.

MAKING BABBITTED BEARINGS IN HALVES

BY S. THERESA

When babbitting, it is usual to retain the lining either by holes or by peripheral and longitudinal grooves which are generally undercut. The writer has found after long experience that neither holes nor undercut grooves are necessary, and that plain grooves turned when the bearings are bored are sufficient if proper precautions are taken in the preparatory tinning of the bearings. Some thousands of bearings have been made in the manner to be described without the slightest difficulty.

Before the tinning, which is a dipping process, the bearings are well cleaned by buffing and by scraping in the corners. Every trace of grease is then removed by immersing them in boiling soda water. When dry, and while still warm, the parts which are not to be tinned are painted with a mixture of oxide of iron and water. The inner surface is smeared with paste rosin, and then the bearing is dipped into a bath of solder. If the solder does not adhere to some portions, these are further cleaned and the dipping is repeated. The bearings are then allowed to cool and any solder adhering to the joint is removed by a touch on the disk grinder.



A Fixture for Babbitting Bearings in Halves

It must be understood that prior to tinning, the bearings have been turned and bored and the joints ground. To insure that the joint is exactly on the center line of the hole, the bearings are bored in a fixture similar to an angle plate, with its face exactly in line with the lathe centers. Two half bearings, one having lugs, are soldered together, as shown at *K* in the illustration. The joint faces of these lugs are bolted to the face of the angle plate. After boring and cutting the three peripheral grooves, the bearings are turned to accurate dimensions on an ordinary mandrel and afterwards split apart.

As a mold for casting the babbitt, the jig illustrated was designed. It consists of a mandrel *A*, two of which are made together by a method similar to that by which the bearings are produced. Two jigs are required when the output is large. The lower flange of the mandrel and the top locating flange *B* are recessed to the diameter of the flanges of the bearings. The upper flange, having an inlet for pouring at *E*, is clamped in the manner shown, so as to be readily put into place or removed. The brass is also prevented from moving by the back plate *C* being screwed onto the mandrel; the small grooves *F*, *G* and *H* are intended to allow some surplus babbitt at these points. It was found that the babbitt sometimes failed to run up into the sharp corners which produced a bad appearance in the finished bearing.

Prior to pouring, the jigs were slid into a small gas heating furnace, one at a time. While one half was being poured and the finished work removed, the other was heated in the furnace to a moderate temperature, not sufficient to cause any appreciable distortion in the jig. No trace of red heat was permitted. After pouring, the small projecting parts at *F*, *G* and *H* were removed on the disk grinder. About 3/32 inch on the diameter was allowed for boring after the bearings were fitted into position in, say, a lathe headstock. The bearings were then bored to the exact size of the journals, or a little smaller, but never larger, as is the practice followed by some in order to reduce the scraping. Sometimes, although not often, small blow-holes would show in the boring. These were simply soldered before scraping. Both before and after the final boring, the bearings were tested by hammer blows. Any sound of hollowness was sufficient reason for rejection. In the initial stages of the practice, there were many rejections. After the men began to realize the importance of cleanliness and care, this trouble became infrequent.

* * *

A BABBITTING DEVICE

BY C. F. MEYER[*]

In Fig. 1 is shown a so-called "jack-comb" used for a certain kind of textile machinery. This comb consists of a number of punched sheet-iron plates *A*, which are held together by a babbitt base *B* and a babbitt connecting strip *C*, running along the rear side of *A*. This strip also serves as a stop for the swinging pieces *D*. The latter swing around a small shaft *E* running through the entire length of the comb section. Two holes *F* are provided to fasten these sections upon a long base, one beside the other, until the desired length of the complete comb is obtained.

It is rather difficult to cast base *B* and strip *C* in such a way that all the plates are held correctly, as the latter must be exactly at right-angles to the base, and parallel to and at the same distance from each other. Each comb plate must also be held rigidly in its position. These sections are made in large quantities and must be so babbitted that no additional finishing is required; hence, a special device is used for the work. It is the purpose of this article to describe this babbitting device.

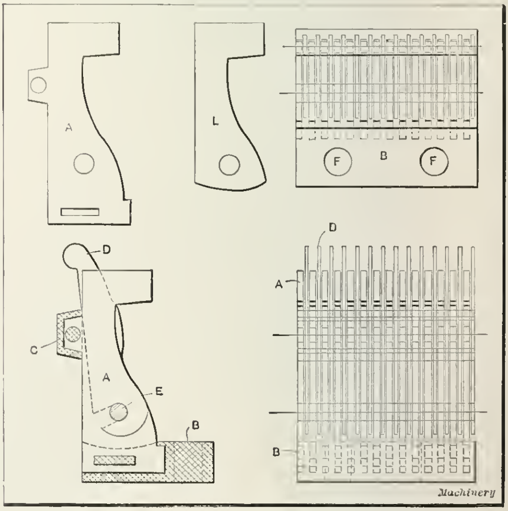


Fig. 1. "Jack-comb" for which Babbitting Device is used

As shown in Fig. 2 the device consists of a cast-iron base *X* having an extension or projection *G* cast in one piece with it. The right-hand end of extension *G* has a hinge *I* in which the eye-bolt *K* swings on a pin. The inner side of projection *G* is finished in such a way that the back sides of plates *A* fit against it when these are placed upon pin *H*. Between each of the plates *A* a distance piece *L* is placed, as shown in Fig. 1. This piece corresponds exactly, in shape, to piece *A*, except that it does not cover it at the base *B*, and at the rear extension *C*. When all the plates are in position, the top plate will be flush with the finished top surface of extension *G*. A swinging arm *M* then brings all the pieces into position. This swinging arm is clamped by the eye-bolt *K*. The steel part *U* fastened to the inside of arm *M* is shaped to suit the curved front part of the plates so as to force them into position. A crank is provided on the end of eye-bolt *K*, as shown in Figs. 3 and 4; hence, the operation is quicker than if a nut were used.

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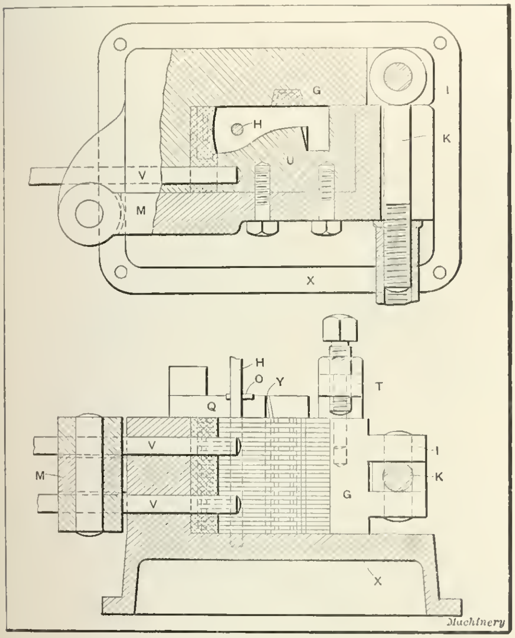


Fig. 2. Sectional Views of Babbitting Device

The rear side of extension *G* is provided with a bracket to which cover *Q* is attached. This cover is swung out of place while the plates are being inserted, and when the column of pieces is completed it is swung over the tops of the plates.

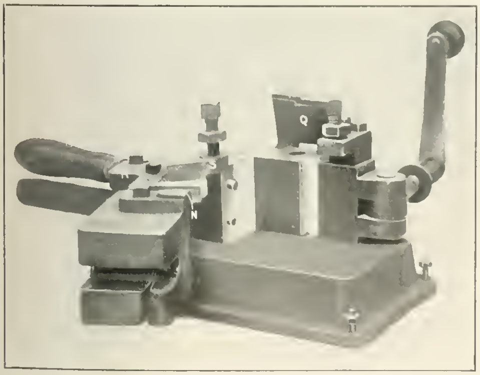


Fig. 3. The Babbitting Device shown Open

A second covering plate shown at *R*, Fig. 3, is fastened to the top of the swinging arm *M*. This plate is also provided with a projection *S* carrying a hardened set-screw which works against a small plate *O*, Fig. 2, riveted to cover *Q*, thus pressing the latter tightly against the column of punchings. Another bracket *T* is provided on casting *G*. This carries a set-screw which presses upon a second steel plate *X* fastened to swinging arm *M*. In this way, the covering plates *Q* and *R* are pressed tightly against the finished top of base *X*. At both sides of the hinge for arm *M*, Fig. 2, holes are drilled to correspond with the holes in the babbitt base *B*. Before the babbitt is poured in, two pins *V* are inserted through these holes far enough to be guided by two corresponding holes in piece *U*. These pins serve as cores for the holes in *A* and are provided with wooden handles so that they can be manipulated even though they may be heated by the babbitt.

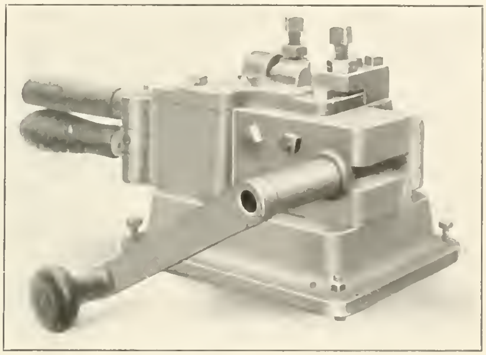


Fig. 4. The Device Closed, ready for Pouring

After the device is filled with the plates and closed, the babbitt is poured through an opening at the top. The air escapes through the small opening *Y*. The results obtained by the use of this fixture are excellent, and no further finishing is necessary after the section leaves the device. Fixtures based on this principle may be found useful for similar jobs that may confront machine designers.

* * *

In a paper read before the Society of Automobile Engineers, Mr. Frank Burgess, in speaking on worm-gearing, emphasized that the hardening process, for the Hindley worm especially, should be such as to cause the least amount of distortion. The object of this is that the teeth of the Hindley type, which it is impracticable to grind, can then be lapped, making them concentric with the hole, which is very essential in a worm drive of this type. The teeth should have a mirror-like polish. In this way, with hardened concentric polished tooth surfaces, the Hindley type presents a better surface for contact than the best form of straight worm, even though the latter is finished by grinding.

The worm gear should be made of a special mixture of hard bronze. The gear should be slightly polished after being cut to insure a perfectly smooth glazed surface to mesh with the hardened polished worm. This set of gears, properly housed, with ball bearings and the right lubricant used, will give an efficiency of at least 90 to 95 per cent. A simple method of testing the gears for efficiency without elaborate apparatus is to run them in their regular housing, containing a bath of oil, subjected to the load to be transmitted. If the worm and gear do not have a high temperature after running several hours, they show a high efficiency and suitability for the given purpose.

* * *

The department of education in Prussia is considering the use of the moving picture machine in certain courses in the higher educational institutions. During last summer several large manufacturers of moving picture films were given an opportunity to show to the educational authorities films adapted to such purposes. Two fully equipped moving picture machines have been donated by a private citizen to the schools of Berlin. One of these machines is to be used in the institute corresponding to our normal schools, and the other in the high-schools of Berlin. Moving picture films are now available on anatomical, biological and bacteriological courses. Ordinary stereopticons have been used for some time in connection with the courses in geography, mineralogy, zoology and art.

THE VAUCLAIN TWIST DRILL*

Speaking generally, there can be no better definition of economical drilling than "rapid drilling"—the saving of time. The fact that a drill will cut at some phenomenal speed and consume little power in so doing means very little, so far as productive capacity is concerned. The object in view is the removal of chips. The productive possibilities of any metal cutting tool are limited by its stress and heat resisting capacities. The temperature at which the tool will continue to work successfully depends upon the excellence of the material from which it is made and the perfection of the process used in its manufacture. The rapidity with which heat is generated from the friction of the cut, and the stress set up in the tool, depend upon the design and the selection of feeds and speeds. Other conditions being equal, the strength of a tool depends upon the area of its cross-section and the distribution of the metal composing it.

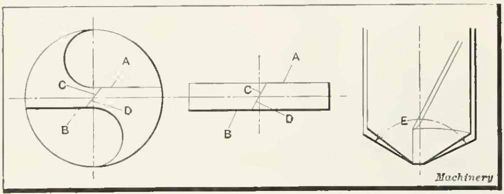
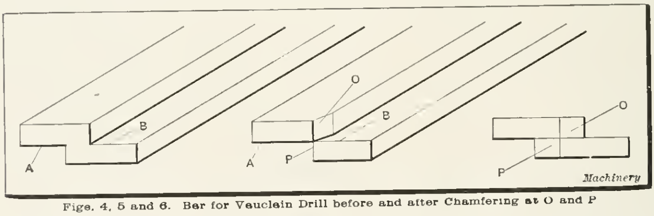


Fig. 1. Common Type of Twist Drill Fig. 2. Common Form of Flat Drill Fig. 3. Angle between Cutting Edges

In the case of drills, the size is necessarily limited by the size of the hole to be drilled, and the section of the drill must necessarily be less than the area of the hole in order to provide space for the discharge of the chips. In designing a drill, the object in view should be to produce a section which will give the maximum strength. The stress which a drill is called upon to resist is practically independent of the cutting speed, and with a given feed this stress is proportional to the lip angle of the cutting edge; the cutting stress does not increase in direct proportion to increases of feed. The rapidity with which cutting heat is generated depends upon the cutting speed, the depth of feed, and the lip angle of the cutting edge. Both the stress and heat generated are influenced by the keenness of the cutting edge; consequently it is desirable that the lip angle shall be as small as possible. It is necessary, however, that the lip shall be blunt enough to carry off the heat and to support the pressure, which falls more or less back of the actual cutting edge according to the depth of the feed.



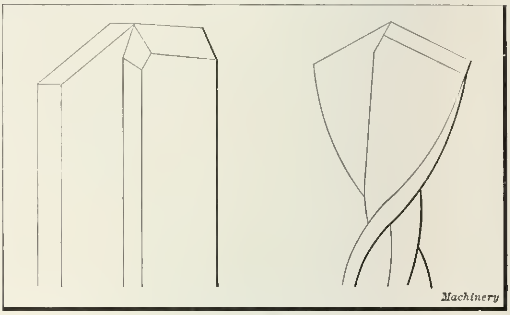
Figs. 4, 5 and 6. Bar for Vauclain Drill before and after Chamfering at O and P

Under ideal conditions, the torsional capacity of a drill would be its limit of cutting strength. This is not the case, however, in the types of drills which are commonly used, as experience shows that such drills break very considerably below their torsional strength. Under constant conditions of feed, the consumption of power in drilling operations will be proportional to the speed, and if the speed is maintained constant, the power consumed in cutting does not increase as rapidly as the feed. The power consumed by the machine remains constant for all feeds. It will be seen from the preceding, that the most economical method of drilling is that which gives preference to feeds rather than speeds; power, time and drills will be saved by such a method.

Commonly used Types of Drills

Figs. 1, 2 and 3 illustrate the section scheme of commonly used types of drills. This design has been modified in many directions, but the general principle is seen in the position of cutting edges *A* and *B* which pass to each side of the axis of the drill instead of intersecting it. This type of drill has four distinct cutting edges, *A*, *B*, *C* and *D*, and is generally known as a "two-lip" drill, although this name is incorrectly applied. The customary included angle *E* is 118 degrees, which is an unfavorable lip angle for the cutting edges *C* and *D*. These edges constitute what is commonly called the chisel point and their cutting resistance is excessive, thus producing a tendency toward longitudinal fracture of the drill. This tendency to split may be briefly explained by saying that the resistance of cutting edges *C* and *D* is far in excess of that of edges *A* and *B*, with the result that the drill splits close to the axis.

In the commonly used types of drills, there are two possibilities of reducing the chisel point: first, by thinning the drill at its center; second, by pointing the drill. By the former method, the resistance to longitudinal splitting is reduced, and by the latter method, the cutting edges lose their support near the center of the drill. These are the reasons for the limited feed possibilities of the ordinary types of drills, which cause them to break long before their torsional capacity is reached.



Figs. 7 and 8. Bar ground and twisted to form Drill

Description of Vauclain Drill

The Vauclain drill is especially adapted for heavy feeds, and is capable of working under the most economical conditions. Its design is shown diagrammatically in Figs. 4 to 9, where it will be seen that the strength of the drill is due to the arrangement of the metal in the section. The method by which this section is developed can best be explained by reference to the diagrams shown in Figs. 4 to 9 inclusive. Fig. 4 shows two flat bars overlapping, and integrally connected. By beveling the corners of these bars, as shown at *O* and *P*, in Fig. 5, the edges *A* and *B* are made to meet at the axis of the drill. Fig. 7 shows how the end of the bar appears when ground to form a drill, and Fig. 8 illustrates the same bar after it has been twisted. Fig. 9 shows the same end view of the bar at *a* which was previously illustrated. By introducing fillets into this section at *R* and *S*, the form shown at *b* is produced. The

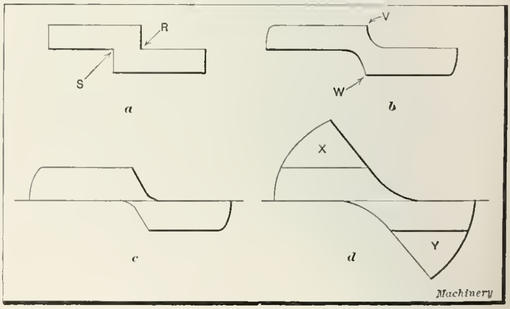


Fig. 9. Evolution of Cross-section of the Vauclain Drill

corners *W* and *V* are next removed with the result shown at *c*, and the final step in the evolution of the section is attained by adding the areas *X* and *Y*. The result is a drill section which is especially well suited to resist the torsional stresses encountered in the class of work for which the tool is intended.

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* Abstract of a paper by A. C. Vauclain and Henry V. Wille, published in the Journal of the A. S. M. E., October, 1912.

By examining the diagrams showing the section of the Vauclain drill, it will be seen that the chisel point is eliminated without thinning the central section of the drill, and without weakening the cutting edges. That the drill produced in this way has a considerably increased capacity, will be shown from the result of tests, in which the capacity of drills of this type was compared with that of other drills. These tests were made by drilling a tough grade of forging steel of about 0.45 carbon. In order to secure reliable results, it was necessary to compare Vauclain drills with other types of drills made from a similar grade of steel and subjected to similar heat-treatment and tempering. The size of drills used in all tests was 1 9/64 inch. The tests covered such an extensive field that lack of space prevents their being fully dealt with, but the advantages of the Vauclain drill which were demonstrated may be briefly outlined as follows: Under the same conditions of speed and feed 10.86 H. P. was required to drive the regular type of drill as compared with 4.73 H. P. for the Vauclain drill, while in a second case the regular type of drill required 10.30 H. P. to drive it as against 5.03 H. P. required for the Vauclain drill. The advantage of such a condition is not only in the saving of power which is effected, as it is evident that the Vauclain drill cuts so much more easily, that the maintenance cost would be reduced in something like the same proportion. The reduction in cutting resistance would also have a corresponding effect in reducing the tendency of the drill to break.

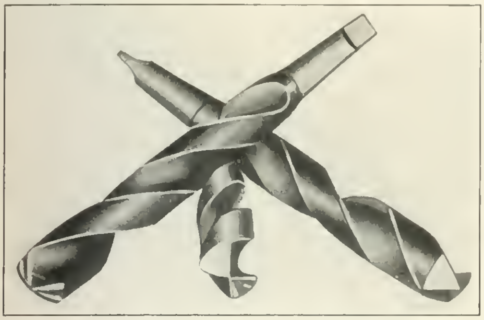

Fig. 10. The Vauclain Drill as finally developed

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AUTOMATIC SPRINKLERS AND INSURANCE RATES

Figures gathered by the Chicago Association of Commerce, showing average insurance rates per $100 in that city, may be partially tabulated as follows:

	Buildings	Contents
Mill constructed buildings, with sprinklers....	$0.23	$0.32
Mill constructed buildings, without sprinklers.	.57	1.04
Ordinary constructed buildings, with sprinklers	.31	.40
Ordinary constructed buildings, without sprinklers	.77	1.19

If the contents of the average manufacturing or storage building are assumed to be worth double the value of the building, a general index for comparing buildings protected with automatic sprinklers and those not so protected is available. Mill constructed buildings on this basis will show an index of 87 for the protected building, whereas that of the unprotected building is 265, or more than three times as great a rate. This means that the reduction in the rate is 67.2 per cent. On the same basis, buildings of so-called ordinary construction would show an index of 111 when protected by automatic sprinklers and 315 when not so protected. In this case the reduction in the rate is 64.8 per cent. The saving effected by the installation of automatic sprinklers will ordinarily pay for the entire sprinkler equipment within a period of five years.

NOTES ON THE EARLY HISTORY OF TAP MAKING

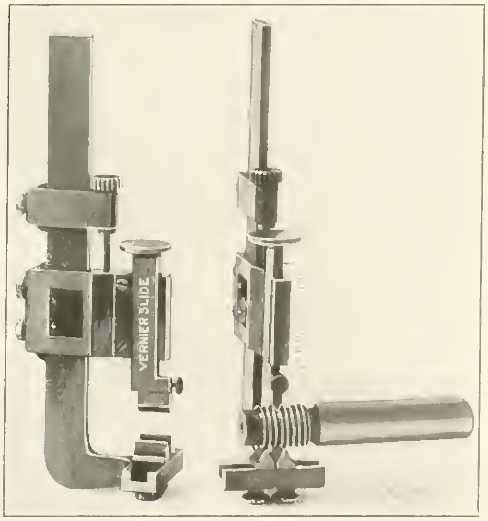
HISTORY OF RADIAL AND TAPER RELIEF—THE CARPENTER THREAD CALIPER—EARLY U. S. STANDARD GAGES

BY ERIK OBERG[*]

The following information relating to the early history of tap making in the United States has been obtained through the courtesy of the J. M. Carpenter Tap & Die Co., Pawtucket, R. I. A brief account is given of the development of the radial relief in tap making, which, at the present time, has been almost entirely superseded by the back taper relief which was first employed by Mr. J. M. Carpenter in the manufacture of taps as early as 1870. A vernier thread caliper designed by Mr. Carpenter for measuring the pitch or angle diameter of taps and screws, and which was the first of its kind, is shown, and also a set of U. S. standard thread gages, being one of the first sets of these gages ever made.

History of Radial Relief in Tap Making

In 1866, Benjamin Bee, of West Harwich, Cape Cod, a naval engineer, obtained a patent for tap threading machinery. He was successful in interesting outside capital and formed a company under the name of the New York Tap & Die Co., which commenced to manufacture taps on Cape Cod the following year. After some time, however, the factory burned, and due to the influence of outside capital, the business was moved to Bridgeport, Conn., where a new factory was built. The firm of Post & Goddard of New York acted as distributor of the product. Soon after the company had moved to Bridgeport, it became in need of more capital, and Mr. Manning, of Manning, Maxwell & Moore, became financially interested in the concern. Nevertheless, the company finally failed, and Mr. Manning sold the threading machinery, built under Benjamin Bee's patent, to the Morse Twist Drill & Machine Co., New Bedford, Mass., which at that time began to make taps. The machinery invented by Mr. Bee milled the threads in the taps, and also milled a radial relief at the same time, with a round or circular cutter.



Figs. 1 and 2. The Carpenter Vernier Thread Caliper

About this time, Alfred Goddard, who had been a mechanic in the employ of the New York Tap & Die Co., and who was a brother of Edward Goddard of the firm of Post & Goddard, the distributor of the taps made by the New York Tap & Die Co., brought out a machine similar to that of Benjamin Bee's which produced the same form of radial relief and differed only in that it did the work of threading and relieving with chasers set in a turret head, thus chasing out the thread, while Benjamin Bee milled the radial relief with a circular cutter, as mentioned, on his machine. The Goddards induced Mr. Henry Prentiss of New York to finance their venture in tap making and afterward also obtained a loan from a bank in Essex, Conn. They then began to manufacture taps with the Alfred Goddard thread chasing machinery at Essex. The business, however, proved unsuccessful, and the machinery fell into the hands of the bank at Essex that had loaned money to the Goddard Brothers.

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[*] Associate Editor of MACHINERY.

The bank attempted to run the business through its president, Mr. J. E. Redfield—as the charter of the bank did not allow it to enter into manufacturing—but as later the business was not successful, the Essex bank sold the threading machinery to the Wiley & Russell Mfg. Co., of Greenfield, Mass., which company still continues to manufacture taps with the radial form of relief.

The Essex bank mentioned, before selling the threading machinery to Wiley & Russell, made an effort to interest Mr. Amos C. Barstow, of Providence, R. I., in the purchase of the Goddard Brothers' machines for the threading of taps with radial relief, and Mr. Barstow's son-in-law, Mr. Cutler, approached Mr. J. M. Carpenter of Pawtucket, R. I., with the proposition of buying this machinery and consolidating the business with that of Mr. Carpenter, who was at that time already engaged in the making of the Carpenter tap. Mr. Carpenter investigated the matter and, basing his opinion upon his mechanical experience, concluded that this method of threading taps was impractical and inferior to the taper relief of his own invention, declined all offers, and continued to put the Carpenter tap with its original taper relief on the market. After forty-three years of successful manufacturing, this form of taper relief has been indorsed by practically all the leading tap makers and users of taps, in that nearly all makers have adopted this method of relief, which was long looked upon as a valuable trade secret. The Wiley & Russell Mfg. Co., however, continued to furnish taps with the radial relief first used by Benjamin Bee of the New York Tap & Die Co., from which it may be inferred that there is still a difference of opinion among tap buyers as to the value of the radial relief.

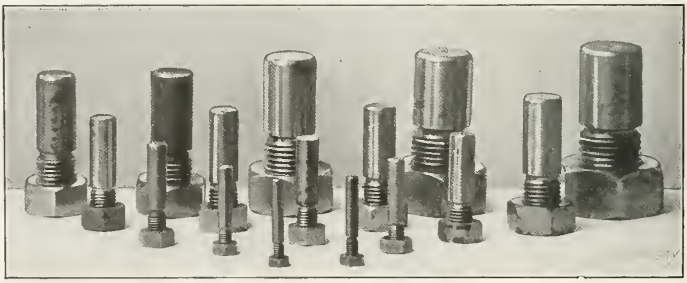

Fig. 3. One of the First Sets of U. S. Standard Plug and Ring Gages made

The First Thread Caliper

The accompanying illustrations, Figs. 1 and 2, show a vernier thread caliper designed by Mr. J. M. Carpenter about 1875. It is without doubt the first thread micrometer ever devised for measuring the angle or pitch diameter of taps and screws, and embodies the principles later developed in the Brown & Sharpe thread micrometer. Fig. 1 shows a side view of the device indicating the provisions for adjustment, while Fig. 2 shows the device in use, the pitch diameter of a thread plug being measured. Up to the time that Mr. Carpenter began to measure taps in this manner, little or no attention had been paid to the angle diameter, all measurements having been taken on the outside diameter of the taps. This, particularly in the case of the sharp V-thread, evidently furnished a very unreliable means of comparison, and the invention of this device for measuring threads in the angle was, therefore, a very decided step towards the standardization of tap dimensions. As is well known, few of the early manufacturers of V-thread taps had any actual standard for the small flat that had to be introduced on the top of the sharp V-thread. Mr. Carpenter, however, at an early date, decided upon rigid limits for the dimensions of this class of taps, and by means of this device for measuring the angle diameter, he was able to maintain his sizes within the limits he had adopted.

Early U. S. Standard Thread Gages

In Fig. 3 is shown an illustration of one of the first sets of U. S. plug and ring gages ever made. In 1868, the Sellers or U. S. standard system of screw threads was authorized for use in the naval service by the Secretary of the Navy, and shortly after, fifteen sets of plug and ring gages ranging from ¼ inch up to 3 inches in diameter were ordered by the government from Mr. George Fox, of Boston, maker of a chasing lathe known as the Fox lathe. When making these sets, Mr. Fox also made up a number of extra sets, of which Mr. Carpenter bought the last two complete sets, and part of a third one which he himself afterward completed. The illustration shows one of these original sets made by Mr. Fox, which are still in the possession of the J. M. Carpenter Tap & Die Co.

* * *

HIRING HELP

BY ABAN SAW

"It surely is a tough proposition," remarked the master mechanic to me a few days ago, "to pick up a good mechanic nowadays when you are most in need of him. Why, I could put on ten more men in this very department right off, if the right ones were available. That 'dub' who just called me out to the time office and said he ''eard as 'ow I was looking for an electrician'—well I am looking for one still. Of course I asked him if he was an electrician and he said 'Yes.' "

" 'What can you do?' "

" 'Anything from making a dry battery to running a dynamo,' was the reply of Johnnie Bull."

" 'Well,' said I to test him, 'what is necessary to be done in order to run a dynamo in the opposite direction of rotation?' "

" 'Same as on a steam engine.' "

" 'What's that?' "

" 'You shift the lever the other way!' "

"Well that capped the climax and I soon sized him up as a first-class bluff—a good one, say, to edit articles for some kid's paper. I thought, just for the fun of it, I would try him on his first occupation—making dry batteries—so I said: 'How many ammeters in an ordinary dry battery?' "

" 'Two,' was the prompt reply."

" 'A dry cell that contains less than four is considered worthless,' I informed him. 'All dry batteries are worthless,' he replied. 'Yes, and so are you,' said I, giving him a wave towards the open door.' "

"The next fellow who came along stated that he was a 'blueprint machinist.' I asked him where he got the title and he said that he saw my 'ad' for a first-class machinist who could read complicated blueprints. Well, I thought I might possibly use him in the snagging room, so I put him to work. Well, sir, in the three hours that he was in there he did more fool tricks than a green apprentice boy trying to harden a scriber made of coil solder. The first job, he was told to take off the emery disk and put on the rag wheel to buff up those valve handles. He got the disk off all right, but couldn't for the life of him put the rag wheel on. First he tried to screw it on right-handed, then to pound it on, and finally he brought it to Jim, the other polisher, and asked him for one with a larger hole. He even put paraffine on one of those twelve-inch bastard files to stop the chattering when he was taking the burr off of a piece of sheet steel."

"Oh well, I wish some of the trade schools would send out some more first-class machinist improvers. They are worth twice as much as any two of these pieces of humanity traveling from place to place trying to hold a job."

IMPROVING THE EFFICIENCY OF A CHECK-ROOM

BY R. H. WADSWORTH*

Efficiency in a shop involves a study of all the conditions, methods, and appliances related to maintenance and production, and an intelligent effort to perfect each detail. This study should not be confined to jigs and tools, but should also be extended to a large number of conditions which, at first thought, seem to be too remote to prove fruitful fields of investigation. The following account deals with a shop once under the writer's jurisdiction, showing conditions that formerly existed and the increase in efficiency that was secured in the check-room system for tools and blueprints.

For an entire day, notations were made concerning each man who came to the check-room window, and how long he waited. It was found that a total of twenty-three hours was spent in this way, three check-room attendants being kept busy. The number of men who had occasion to call was about 150. The length of time they waited was from half a minute to nine minutes, and two calls were still longer.

The original arrangement of the check-room is shown in Fig. 1 and the improved arrangement in Fig. 2. It will be observed that there was originally no partition between the check-room and the tool-room. All persons desiring to enter the tool-room came through the door leading from the machine shop to the check-room. This feature was annoying to the attendants, and made it impossible for them to be accurate in their work. The evidences of trouble were seen in lost checks, misplaced checks, and tools gone without checks in exchange. Every time such matters were brought to the attention of the head attendant, he excused himself on the grounds that the trouble was beyond his control: that both the shop men going through the tool-room and the nearby toolmakers frequently helped themselves to anything they wanted when the attendants were busy, and that these men could not be depended upon to leave their checks. Blueprints were kept in the shallow drawers of a cabinet, and pieces of sheet iron nearly as large as the drawers were laid on top of the blueprints to keep them from curling up. Occasionally a blueprint would slip out at the back of the drawer and get lost.

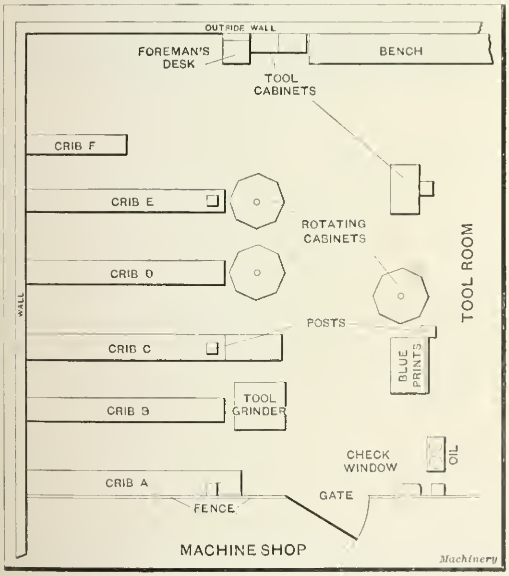

Fig. 1. Original Arrangement of the Check-room

The check-room window was about 24 inches wide and 12 inches high, and at such an elevation that shop men could not see the attendant without stooping. There were three octagonal, revolving cabinets having bins in which such small tools as taps and dies were kept. To find any article, the attendant would rotate the cabinet two or three times before getting what he sought. Poor lighting, together with the further loss of light because of the size and location of these large revolving cabinets, made the work of the attendants still more difficult.

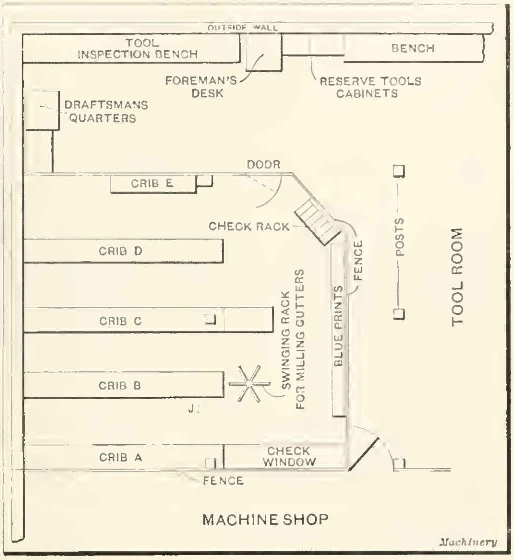

Fig. 2. Improved Arrangement of the Check-room

The first step taken to improve matters was to build a fence of woven wire separating the check-room from the tool-room, as shown in Fig. 2. The entrance to the tool-room from the machine shop was placed to the right of its former location, so that it was outside the check-room. The only door entering the check-room was located near the desk of the tool-room foreman. This door was kept shut by a spring, and secured by a snap latch on the inside. Anyone desiring to enter the

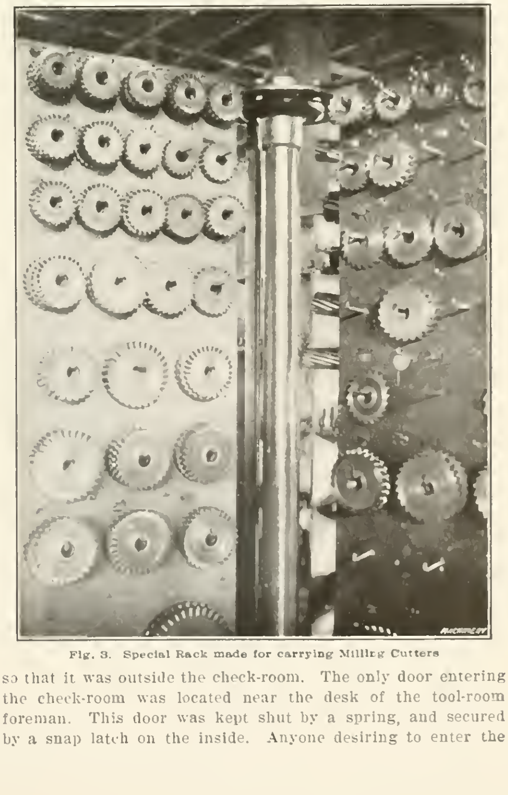

Fig. 3. Special Rack made for carrying Milling Cutters

check-room was thus unable to do so until he had satisfied the attendant as to the necessity for so doing. The window opening to the machine shop was made 10 feet long and 2 feet high. The door which closed this window out of work hours served as a big counter when open, and the men of the shop were served with tools and prints over it. A small window in the side fence accommodated the toolmakers. A large cabinet was set up under the big counter in which the small tools were deposited. Under the old system, tool cribs *A*, *B*, *C*, and *D* were mostly filled with obsolete tools and machine parts. About three tons of this stuff was scrapped, and the remainder moved to the rear. The new tools, formerly stored in cribs *E* and *F*, were brought forward to *A* and *B*. The tool grinder was not in service; consequently it was removed to make room for useful tools.

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* Address: 68 Clinton St., Seneca Falls, N. Y.

One of the revolving cabinets was dismantled, and a pair of flanges about 10 inches in diameter were mounted on its spindle, one at the top and the other near the bottom. Eight boards were cut about 6 feet long and 20 inches wide. Straps of soft steel 1 by ⅜ inch were secured to each end of these boards, about five inches of the straps extending beyond the edges of the board. These boards were then mounted upon the spindle of the former revolving cabinet, the straps resting upon the flanges and being secured by one bolt through each strap and flange. This permitted the boards to swing upon the flanges like the leaves of a book; in addition to this movement, the spindle and flanges could be rotated about the supporting spindle. Fig. 3 shows the upper part of this stand, which was placed near the check-room window so that shop men could see to select from the array of milling cutters on it, and ask the attendant for what they required, without entering the check-room. A board about 14 inches wide and 36 inches long was hung from the side of a tool crib, as shown at *J* in Fig. 2; the board itself is shown in detail in Fig. 4. Strips of sheet steel, bent as shown in Fig. 5, were attached to this board, and small cards, each bearing the number of a jig or fixture and its location, were inserted in the manner shown. The flexibility of this arrangement made it possible for new cards to be inserted, or the location of tools to be altered in the cribs and still allow the numbers of jigs and fixtures to be kept in numerical order on the board.

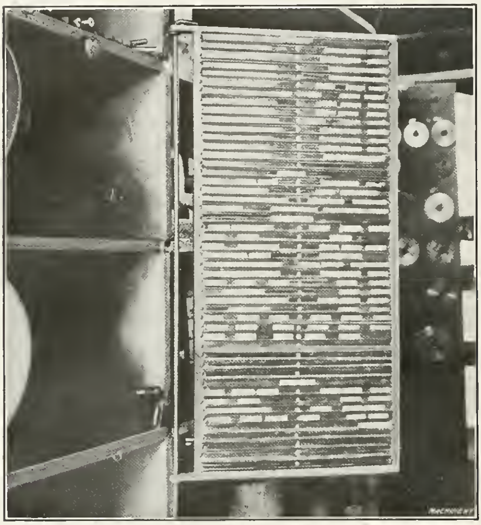


Fig. 4. Rack for carrying the Flexible Card Index of Jigs and Fixtures

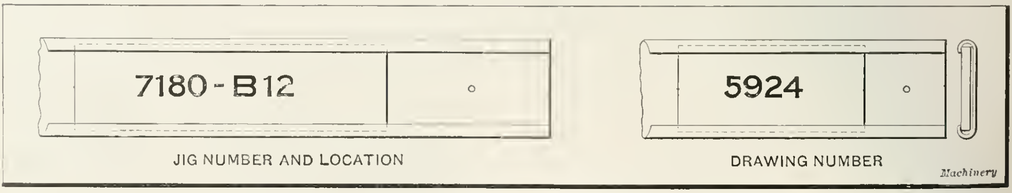


Fig. 5. Method of attaching Card to Rack shown in Figs. 4 and 6

Fig. 6 shows the new arrangement of the blueprints on racks; these racks were made of sheet steel, as shown in Fig. 7, and secured to 2 by 4 timbers. The numbers of the blueprints were written on stickers and pasted on the steel racks. Several prints of each number were carried on a single rack, and the length of the rack was varied in different rows to suit the dimensions of the prints. As will be seen from the illustration, there were three rows of racks; each row was ten feet long, and there was a total of 1350 racks. A small card index was provided, giving the size of the sheet for each drawing number. Checks were taken in exchange for blueprints, and these checks were hung on hooks on the racks shown in Fig. 8. The drawing number of every blueprint in stock was marked on a piece of cardboard and inserted in numerical order in the steel strips above the hooks; these strips were of the same design as those on the index board for jigs and tools, shown in Fig. 5. The hooks were arranged nine in a row, and there were sixteen rows on each side of seven boards, making a total of 2016 hooks. The total number of different drawings in use was less than a thousand, but their numbers ranged from 125 to 6000. This range of numbers required an arrangement of great flexibility or great space to accommodate the checks. This device gave the required flexibility in small space, as the cardboards could be rearranged at will, to insert new numbers or remove those not in use and still retain the numerical order.

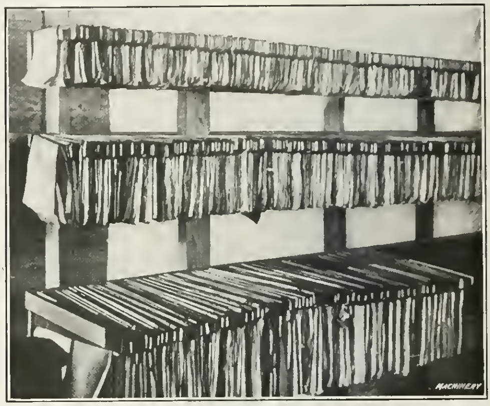


Fig. 6. Method used for filing Blueprints

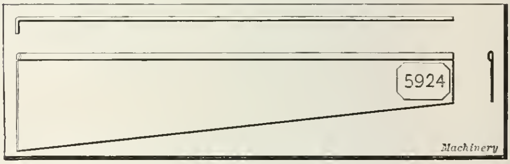


Fig. 7. Detail of Blueprint Rack and Method of mounting

The number of both standard and special tools that are required with drill jigs is frequently greater than the number of checks allowed to an operator. This formerly required him to borrow checks or get tools on memorandum. Both methods have their defects. To assist in the solution of this problem, we placed a brass plate on each fixture on which was stamped the number of the fixture, its location in the tool crib, the name of the piece for which it was made, its part in the production of that piece, and the number and description of the special tools which were required for use with the fixture. For the fixture and tools mentioned on the plate, only one check was required. The information on the plate was of service to both the operator and the check-room attendant, and was of great assistance in accounting for tools in the shop. One of these brass plates is shown in Fig. 9.

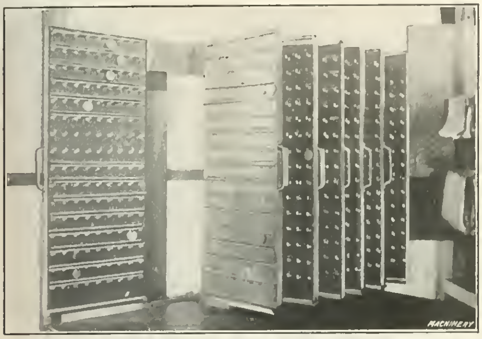
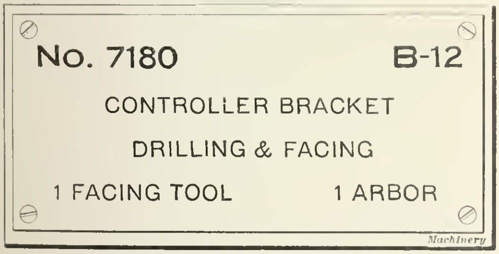


Fig. 8. Rack for filing Checks taken in exchange for Blueprints

When these changes in our tool-room method were put into effect, it was found necessary to keep only two attendants in the check-room, where three were formerly employed, and these men were not always busy. A study of the time employed by men waiting at the window was again made, and it was found that but fourteen hours was thus employed instead of twenty-three as at first. Taking the average rate of all men calling at the check-room window at 25 cents per hour, we find a saving of $2.25 in a nine-hour day. The rate of the attendant who was dispensed with was 15 cents, or $1.35 per day. This makes the total saving $3.60 per day.



No. 7180 B-12

CONTROLLER BRACKET

DRILLING & FACING

1 FACING TOOL 1 ARBOR

Fig. 9. Name-plate used on Jigs and Fixtures

For 300 working days per year, the annual saving would be $1080, without including the larger production of the machine operators that has been made possible. The change was accomplished at a cost of less than $100.

For his efficient cooperation in bringing about these improvements, the writer desires to acknowledge the services of Mr. G. W. Linn, then in charge of the tool-room and check-room.

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GERMAN MACHINE TOOL IMPORTS AND EXPORTS

During the first six months in 1912 the exports of machine tools from Germany amounted to 36,624 metric tons, as compared with 27,061 metric tons during the first six months in 1911, and 26,871 tons during the first six months in 1910. The largest percentage of exports was shipped to Austria-Hungary, with France, Russia and Italy coming next as the best customers of German machine tools.

The imports of machine tools into Germany amounted to 4459 tons, as compared with 3396 tons during the first six months in 1911, and 3224 tons during the first six months in 1910. Of the imports the United States supplied more than 60 per cent, the imports from the United States increasing from 2100 metric tons during the first six months in 1911 to 2819 tons during the first six months in 1912.

ANNEALING HIGH-SPEED STEEL

BY A

The method which seems to be most generally used for annealing high-speed steel is as follows: The high-speed steel tools or pieces to be annealed are packed in air-slacked lime in iron boxes of suitable size. Care is taken not to let any of the tools come in contact with each other, and to see that they are well surrounded by the lime. The boxes are covered by iron covers and the openings between these covers and the boxes are smeared over with fireclay so as to prevent any air from reaching the contents of the boxes. The boxes are then put into the annealing oven and the latter is heated, with the boxes in place, to from 1900 to 1950 degrees F. for not less than nine or ten hours. The heat is then shut off and the boxes left in the oven to cool off with the furnace, and are taken out first when the furnace is cold.

This method invariably produces good results, the tools being soft and evenly annealed, but it is very expensive. In the first place, considerable time is taken in packing the tools, and the man employed on this work must be a man that uses considerable judgment and care in his work. Then there is the cost of the fuel for maintaining this high heat for the length of time mentioned, and, in addition, the cost of the iron boxes which seldom can be used more than once on account of the high heat to which they are subjected. For these reasons the new method described in the following will be found advantageous. This method is much quicker, and if the instructions are conscientiously carried out, it will be found to be as effective as the one just outlined. The new method is as follows:

Pack the tools to be annealed directly in the oven, one on top of the other, the furnace being entirely filled if necessary. Then heat the furnace to a temperature not exceeding 1700 or 1750 degrees F. It should not require more than three hours for the furnace to reach this heat, which is then maintained for about two hours more, or, until the temperature of all the tools has been raised to that of the furnace itself. (When smaller pieces are to be annealed, it is therefore, sufficient to maintain the heat for only one hour.) Then shut off the heat and at the same time close all holes, such as burner and draft holes, as carefully as possible, and let the tools cool off in the furnace. This cooling takes place very much quicker than when the first mentioned method is used, because the tools are not packed, and, hence, there is a saving in time not only in the heating but also in the cooling. The greater part of the expense of annealing is thus saved on account of the saving in fuel, and the elimination of the packing, packing materials and the boxes.

* * *

RELATION BETWEEN HARDNESS AND WEAR OF STEEL

In a paper presented before the International Association for Testing Materials, at its congress in New York, September, 1912, Mr. E. H. Saniter stated, as the results of experiments made, that there is no definite relation between hardness, as measured by the Brinell hardness testing method, and wear. While, in general, a high Brinell hardness number may be expected to indicate a metal which will give better wear, there are so many exceptions that this test for indicating wearing properties would be unreliable. As an example, it was mentioned that Hadfield's manganese steel, which has a low Brinell hardness number, proved the best steel as far as wear is concerned in the wear tests undertaken. However, the relation of either Brinell tests or ordinary wear tests to wear in actual practice is a subject which requires further investigation, and it is not certain that the ordinary type of wear test is a fully reliable indication of the wear a certain material may give when in use under certain conditions. It would seem, from opinions expressed at the congress for testing materials, that wear tests should be made along different lines according to the actual uses to which the metal is to be put.

* * *

A fair day's work well done, good habits and a good name usually keep pretty close company.

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DECEMBER, 1912

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UNPROFITABLE REPAIRING OF TOOLS

Machines and tools are often repaired and kept in use when it would be more economical to buy new ones. Some men even pride themselves on what they call the savings resulting from this patching up of old tools. A story that illustrates the extremes to which this habit of repairing old tools rather than buying new ones can be carried was recently told can be carried was recently told by the mechanical engineer of a plant making machinists' tools.

A complaint was made to the sales department by a toolmaker, who stated that nippers of the firm's make did not stand up well. He mentioned in particular that when he worked at the Jones & Smith Co. one of these nippers was sent over to the toolroom for repairs at least twice a year. The tool in question did not cost more than $2, and had apparently been used for something like five or six years. When asked how long it took him to repair the nippers, the man making the complaint said: "Well, I should say about half a day." He was asked what wages he received, and promptly replied that he was a first-class toolmaker receiving forty-three cents an hour!

It requires no elaborate cost system to point out this moral; yet similar instances are not of unusual occurrence, particularly in the case of the smaller tools used around a machine shop, and the loss on such wasteful repairs may amount to a considerable sum during the year. Often this is caused by a mistaken theory of economy on the part of a foreman, but quite as often the general policy of the management of a shop is at fault. The foreman of the department or the superintendent of the plant has so often been cautioned by his manager against "unnecessary" expenditures, that he tries to avoid sending in requisitions for new tools, and prefers to put one or more of his men to repairing old ones, because this work will not show up directly in the expense account, but will be charged to general repairs. Many a foreman remembers well how he has been requested to explain in detail the reason for buying a new device or tool costing but a few dollars, while at the same time wasteful methods of doing work which absorbed daily several times the cost of a new appliance, might be passed by unnoticed. What is needed is closer cooperation between the heads of concerns and the men in charge of the various departments. In many instances considerable economies could be effected if foremen and superintendents were encouraged to follow their own judgment with regard to the buying of new tools and the repairing of old ones; or, if this policy in some cases would not be advisable, they should at least be encouraged to state their opinions freely, as it is likely that by their cooperation a great many false economies could be eliminated.

* * *

THE NEED OF POWER

The steam engine is such a common and necessary part of our civilization that few stop to think what a debt we owe to it. The need of man in his struggle with the crudeness and rawness of natural resources has been, is, and always will be for power. He is a comparatively weak creature, barely able to supply his physical needs by unremitting toil if unassisted. The first upward step from savagery was made when a cave man of splendid courage conquered the wild horse and trained him to carry burdens. The harnessing of horses and cattle to the plow was another great step forward that reduced manual labor and increased food production. Removed from the fear of immediate starvation, the needs of the mind as well as the body were ministered to and the march upward toward the civilized state was well begun.

But unhappily the opportunity to live on a higher plane was for only a few. The great mass was still submerged in poverty and in a state of actual or practical slavery. The ancient Greeks believed that civilization without slaves was impossible, and it was true of the conditions then existing. Without power other than that of animals, men must be employed to serve their masters to those comforts and luxuries that the higher life demands, but which the servers could not hope to enjoy themselves.

The invention of the steam engine and the great improvements made by Watt marked a new era which has had no parallel, and, therefore, is not comparable with any recorded epoch of the world's history. While elemental human nature does not change, the environment of man has so changed that predictions of the future based on the past are futile, if not foolish. But we know that human servitude has not yet been abolished; it has taken on new forms less galling physically, but still intolerable to sensitive minds. How can liberty be attained? Only by acquiring the means of developing more power.

The growth of a great modern city is consonant with the development of power stations to supply its railways, lights, elevators, manufactories and other urban activities. The energy developed in one comparatively small unit is greater than all the available working force of some of the proudest ancient empires. The great Curtis turbine of the New York Edison Co., developing 30,000 H. P., is the physical equal of over a million men working in three equal shifts throughout the twenty-four-hour day. What a tremendous multiplication of the dynamic energy of the comparatively few men required to attend it and the boilers generating the steam needed to supply it! It is this great multiplier of human force, applicable in one way or another throughout the world, which is required to realize the ideals of the advanced engineer. To make the world small, to bring the produce of the uttermost parts to its markets and distribute the products of manufacturers to those who have furnished the food and crude materials, is the great problem of the age. It is the problem of distribution that the engineer must solve as well as that of production; and power in all its many manifestations is the one great necessity for its accomplishment.

GAS ENGINE CAMS

It is a curious feature of gas engine design that the simple, primitive form of valve lifter cam, that is, the form in which the contour is made up of arcs and tangents, is less noisy than the more refined shapes which have often been proposed and but little used. To one familiar with the laws of mechanics and the general requirement to overcome the inertia of matter gradually and progressively to prevent shock, it is natural to conclude that an accelerated motion cam would work more smoothly and create less noise than that shape commonly used in which the lifter is practically a V-shaped boss on the side of a semicircular hub.

The article begun by Mr. Terry in the November number, and concluded in this number, exhaustively analyzes the conditions of gas engine cam action and shows why the primitive form is after all best. The article is lengthy, and so far as the conclusions are concerned it can be summed up in a comparatively few words, but we believe, nevertheless, that the space required for the elaboration of the analysis will be profitably used. It should settle once for all this question, which has caused no little discussion and perplexity among automobile engine designers. The case is one in which rule-of-thumb designing seems to have the best of it and theory to be at fault, but this is only apparent. When all the theoretical considerations are given their due weight, we can clearly see why the supposed refinement of cam design is not an improvement but actually a detriment.

* * *

REFORMING THE PUBLIC SCHOOL SYSTEM

As the defects of our public school system are brought out more and more by the educational deficiencies of the boys entering shops and factories at an early age, the more apparent it becomes that steps should be taken to correct them. Under the present system the public schools are open five days a week, from thirty-nine to forty weeks a year. The pupils go to school considerably less than two hundred days in the year; taking out the holidays, the average is about 190 days.

When it is considered that the children of the working classes have to leave school at fifteen or sixteen in order to contribute to the family support, the question is: "Why not try to improve the years when they can go to school"? Continuation schools are merely to make up for lost time. The average boy and girl in the towns and cities would be better off going to school six days a week fifty weeks in the year than loafing around, as many must, during the vacation period. This schedule would give them fifty per cent more hours of school work in a year, and that would be equivalent to two years extra schooling between the twelfth and sixteenth years. The boy who has to leave school at sixteen under this schedule should be as far advanced as he is at eighteen under the present system.

The arguments against the continuous school term are the strain on teachers, objections of parents, hot weather in July and August, and the need of pupils for long seasons of rest. As to the teachers, it is hardly necessary to point out that employes in stores, mills and factories work longer hours every day in the week and in many cases every week in the year. The parents' objections would become inconsequential when the benefits of the plan became apparent. School buildings can be made cool in summer, and will be made comfortable when the continuous school term becomes general. Pupils advance relatively faster when the school work is continuous. Several days or weeks are lost every opening term in the process of getting back into harness and regaining the receptive frame of mind largely lost during the vacations.

The continuous school term is being tried in several cities and towns with satisfaction. A feature of no little importance is that the better utilization of school buildings has lessened the need of new structures, meaning a saving of thousands of dollars annually in a large city. But the chief advantage is that the general adoption of the continuous school term will raise the educational standard of the workers' children to a plane that will better fit them for their duties not only as efficient industrial workers, but also as citizens.

LOCATING BALANCE WEIGHT CHAINS ON HORIZONTAL BORING MACHINES

BY W. G. DUNKLEY*

The most frequent problem met with in determining the correct location for the balance weight chains for the spindle slides of horizontal boring machines, is that in which the slide is under-balanced. In this case the difference in weight between the spindle slide and the balance weight is carried by the vertical screw. Consequently, there is a reaction on the slide, equal in value to the load on the screw, which acts along the axis of the screw. If the presence of this reaction is ignored, it will give rise to a turning moment on the slide which will cause the latter to bind on the upright. Such a binding action between the slide and upright would have been avoided if the proper means had been taken to locate the balance weight chains correctly. It will be readily understood from the preceding that the location of the balance weight chains is a matter of considerable importance in the design of horizontal boring mills.

In order to enter into this subject in detail, a case will be considered in which the spindle slide weighs eight tons and the balance weight only four tons. In this case, the reaction of the screw on the slide is equal to the difference between the weight of the slide and counterweight, or four tons. The load on each chain is two tons, as illustrated in Fig. 1, and, as a result, the vertical downward force of eight tons is balanced by the vertical upward forces, which have a total value of eight tons as shown. The slide is not in equilibrium, however, unless the moment of all the forces about any point is zero. If the moment of the vertical forces on the slide about any point is not zero, this moment must be balanced by a moment due to the reactions Q of the slide on the vees, because the slide is in equilibrium. In this problem, the friction between the slide and the face of the column is neglected. The center of gravity of the slide is located on the line CC which is ten inches from the screw. With this data at hand, the problem consists in determining the correct location for the chains. Bearing in mind that the reaction of the screw is four tons, the chains should be placed as indicated by the full line arrows, and with such an arrangement, the vertical forces are depended upon to keep the slide in equilibrium. There may still be a tendency for the slide to turn in a plane at right angles to the face of the upright.

Neglecting the reaction of the screw, the chains will naturally be placed at equal distances on either side of the center of gravity of the slide, as indicated by the dotted lines in Fig. 1. With such an arrangement, the turning moment of the vertical forces about an axis at the center of gravity will equal $4 \times 10 = 40$ ton-inches. This moment has to be neutralized by the moment of the forces Q which are determined as follows:

$$Q \times 60 = 4 \times 10 \times 2000 \text{ pound-inches.}$$

$$Q = \frac{4 \times 10 \times 2000}{60} = 1335 \text{ pounds}$$

This twisting action on the slide may attain a still greater value for increased inaccuracy in the location of the counterweight chains, but where these chains are properly placed, the presence of any twisting forces Q on the slide will be entirely avoided.

In some cases an additional chain is provided at the outer end of the slide, as shown at E in Fig. 2. Where such a design is adopted, it is necessary to provide an auxiliary standard to carry the balance weight. Where this practice is followed, it is necessary to be particularly accurate in designing; otherwise the arrangement is open to question, so far as the turning moment on the slide is concerned, but in any case the result secured will depend largely upon the location of the center of gravity of the slide. For example, if the slide shown in Fig. 1 were balanced according to the design shown in Fig. 2, the turning moment due to the vertical forces on the slide would be 130 ton-inches, 120 ton-inches of which would be due entirely to the force at E. In such a case, the amount of the moment Q due to the reaction of the vees would be considerable, with the result that there would be excessive binding of the slide on the upright.

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Let us next consider a case in which the center of gravity of the slide lies on the line DD shown in Fig. 2. The twisting moment due to the vertical forces would then be zero, and in such a case the action of the slide will be free from any tendency toward binding. There is one point about the arrangement shown in Fig. 2 that is particularly worthy of attention. Any alteration of the load at E will give a corresponding alteration of the reaction of the screw on the slide, which will result in a considerable variation in the twisting moment on the slide. This makes it possible to vary the load at E until the slide is properly balanced and binding action eliminated; in this way, any inaccuracy in the calculation of the position of the center of gravity may be compensated for.

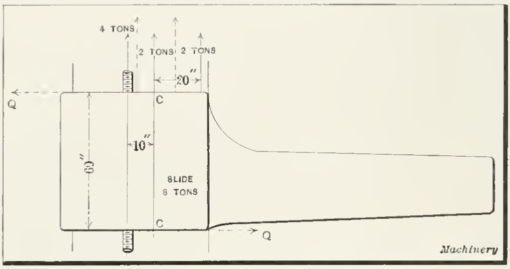

Fig. 1. Correct and Incorrect Methods of balancing Slide with Two Chains

The calculation of the center of gravity of a heavy slide is not a simple matter, and as a result, it is apt to be avoided. This is obviously poor practice, as the proper action of the slide on the upright has been shown to be dependent upon having the counterweight chains correctly located in regard to the center of gravity of the slide. For example, the vertical hand adjustment of the slide is sometimes difficult to accomplish, and is made even more difficult if there is an excessive binding action between the slide and upright. In the preceding discussion, the balance of the slide has been treated for cases where the slide is stationary. Since there is binding action between the slide and upright, due to the resistance of the cut when working, it is obviously desirable that the binding action should be reduced to a minimum when the slide is stationary. In some cases an attempt is made to put the screw under the center of gravity of the slide, but a consideration of the conditions shown in Fig. 1 will make it evident that there is no necessity for so doing in order to obtain a proper balance. For example, let us consider a case where the slide is engaged on a milling operation. In such a case, the force of the cut introduces an additional force between the screw and the slide, with the result that the turning moment on the slide, due to the force of the cut, is equal to this force multiplied by the distance between the screw and the line of the cut. It is thus evident that the screw should be as near the cutting face as possible, in order to reduce this turning moment to a minimum. If the screw is made to coincide with the position of the center of gravity of the slide, the distance to the face of the cut is increased; consequently it is not advisable to do this in order to obtain the desired balance of the slide, on account of the increased twisting moment that is introduced. The width of the guiding surface does not enter into the calculations in any way.

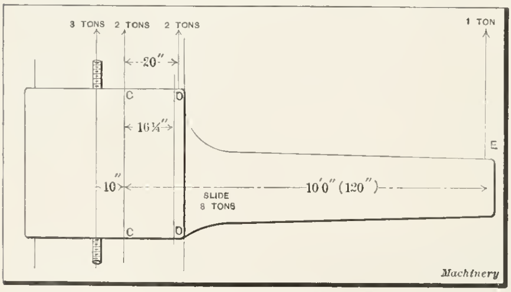

Fig. 2. Correct and Incorrect Methods of balancing Slide with Three Chains

* * *

THE PYROMETER AND TIME STUDY IN STEEL TREATMENT

The general experience of a maker of lathe and planer cutters for tool-holders, outlined briefly in the following, shows how necessary are exact scientific methods to insure the production of uniformly satisfactory high-speed steel tools:

"Investigations in machine shops and tool-rooms indicate that the fault of most importance to the managers, is the lack of uniformity in results obtained from high-speed cutting tools. Many places were found where attempts were made to treat steel by faulty methods or with inadequate facilities. The lack of pyrometers, failure to use pyrometers when provided, hardening in charcoal furnaces insufficiently heated and treating without preheating, were a few of the practices noted that produced ununiform results—a few good pieces and many almost worthless.

"It seems to be the general opinion among those not getting results, that pyrometers are not of much use, that they do not give correct readings, and that better results can be gotten by depending on a man's experience than on any mechanical device. Now in the treatment of cutters we have had failures with pyrometers, but at the same time have found the cure for it, and that is frequent calibration. There is no question but what a man's eye is a better judge of the heat in a furnace than an incorrectly calibrated pyrometer.

"In the treatment of our cutters we have probably employed no more skilled men than are used in many large plants for treating high-speed steel, but the methods that they use and depend on are scientifically correct. Since the adoption of the improved Taylor-White treatment of high-speed steel we have sent out thousands of cutters and have received practically no complaints. Our experience has shown that a cutter treated today is the same as one treated six months ago and will be the same as one treated six months from now. We have tested all makes of high-speed steel, and have proved that with proper heat treatment any one of four or five of the real high-grade high-speed steels is entirely satisfactory and, in fact, cutters made from all of them cannot be told apart in use.

"All our cutters are preheated in a low-heated furnace at a temperature of 1350 degrees F. This heating takes out all strains in the metal and puts it in the best possible condition for bringing quickly to the high heat necessary to get the best results from high-speed steel. Every cutter from the smallest to the largest is treated in accordance with its sectional area and size. It goes from the low heat into the high heat furnace and stays there for a time that has been determined for each size by tests. We use pyrometers constantly on both furnaces, which are tested twice a week, having found that this is as long as they can safely go without being checked. The heat-treating room is provided with a specially made clock which starts on the pull of a lever by the man running the furnace, who knowing the proper length of time required for the cutter being treated, sets the clock accordingly. At the end of the predetermined time the clock rings a bell and stops, and the operator takes out a cutter and puts it into the proper medium.

"Our experience shows that it is necessary to bring the high-heat furnace to a temperature above the melting point of high-speed steel to get satisfactory results. This, of course, requires positive accuracy of the time chart as a fraction of a minute too much in the furnace would ruin the cutter, and too short a time would not give sufficient heat. Another reason for this is that to get the best results from high-speed steel, it is necessary to quickly raise the heat from 1350 F. to the highest heat required.

"We believe that the essentials for proper treatment of high-speed steel are: a first-class quality of high-speed steel, preheating, quickly raising the temperature of the steel to the proper quenching heat in a high-heat furnace, the use of accurately calibrated pyrometers and a correct time chart."

* * *

The Harvard engineering school has recently instituted all-the-year-round courses. The course for master's degree in engineering now can be taken in two years, there being no summer vacation. The students work from eight to ten hours per day, and the total vacations in the year amount to only about four weeks. The University of Chicago has also for some years maintained a summer term having equal weight with the other three-quarters of the year. This is a movement in the right direction. The inefficiency and waste of time due to the time-honored system of long summer vacations is out of place especially in engineering schools.

SPECIAL KNURLING OPERATIONS*

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON†

The knurling operations dealt with in the previous articles by the writer are what might be called "standard," and are met with frequently in automatic screw machine practice. The following examples are more of a special nature, and illustrate unusual applications of knurls. The data which follows should be of suggestive value to the designer of screw machine tools, inasmuch as it presents commendable methods of applying knurls to the work under varying conditions.

Bevel Knurling Tools Operated from the Turret

The simple bevel knurling tool shown in Fig. 2 is provided with a tapered shank and is held in a standard floating holder in the turret. The piece to be knurled, *A*, is a small German silver button which has a convex face, but as the curvature is slight, a straightface diamond knurl can be used. In applying the knurl to the work, the center line *BC* of the knurl should be at right angles to that portion of the work it is required to knurl. This particular holder was used in a No. 00 Brown & Sharpe automatic screw machine, which was operated at a spindle speed of 1492 R. P. M., and with a feed to the knurl of 0.0023 inch per revolution of the work.

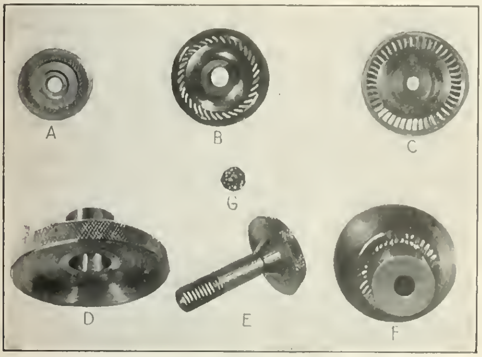

Fig. 1. Examples of Work requiring Special Knurls and Knurl-holder Applications

Another example of end-knurling from the turret is shown in Fig. 3. The piece to be knurled is shown at *A*, and also at *F* in Fig. 1. The knurl is presented from the turret under the body of the work, and produces a single spiral knurl, the teeth of which are at an angle of 25 degrees with the axis of the work. The holder is held in a No. 2 Brown & Sharpe automatic screw machine, and the work is rotated at 1200 R. P. M., with a feed to the knurl of 0.0024 inch per revolution.

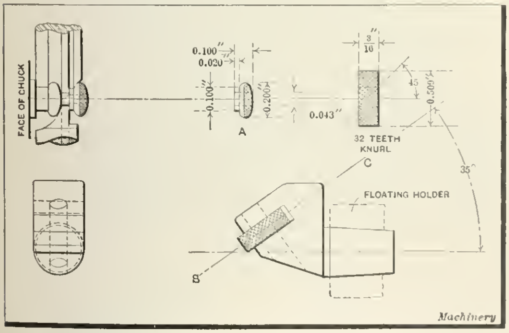

Fig. 2. End-knurling Tool held in Floating Holder

The knurl holder consists of a shank *B* which fits the hole in the turret, and a holder *C* held to the body *B* by a screw, and located by a tongue and groove. The hole for screw *D* in holder *C* is larger than the body diameter of the screw, to provide for adjustment. The knurl which is shown detailed at *E* is provided with a shank which is a running fit in the hole in holder *C*. It is retained by a washer *F* and screw *G* and rotates on a hardened washer *H*. The distance *I* on the knurl shank is slightly greater than the width of the holder, so as to allow the knurl and washer *G* to rotate freely.

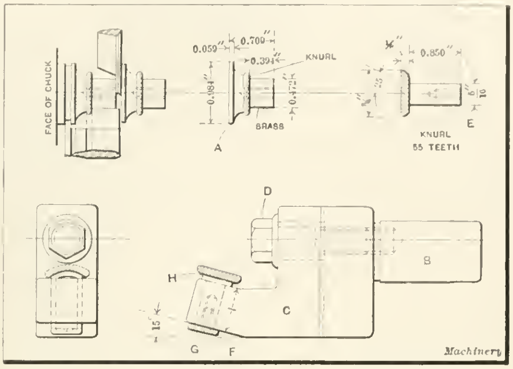

Fig. 3. End-knurling Tool held in Turret and operated at an Angle

The knurl *B* and the knurl holder *D*, shown in Fig. 4, are used to produce a ratchet form of radial teeth in the shoulder of the piece shown at *A*, and also at *C* in Fig. 1. The teeth in the knurl are cut at an angle of 60 degrees and are radial with the center line. The work is rotated at 1216 R. P. M., and a feed of 0.0008 inch is given to the knurl per revolution of the work.

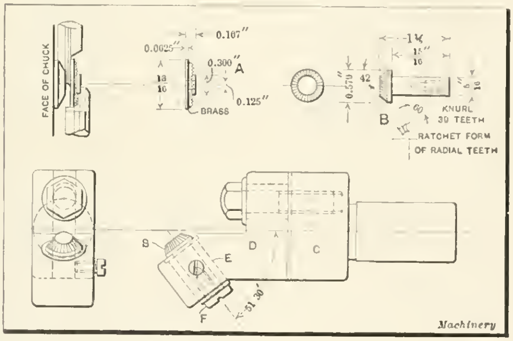

Fig. 4 Knurl and Knurling Tool-holder for producing Ratchet Form of Radial Teeth

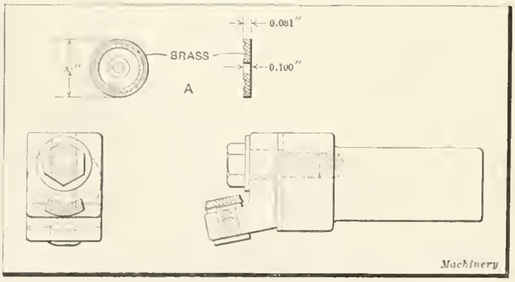

Fig. 5. Knurl and Holder for producing "Tangential" Form of Knurl

This holder is held in the turret of a No. 2 Brown & Sharpe automatic screw machine, and consists of a body and shank *C* to which the holder *D* is held by a screw. The knurl *B* rotates in a phosphor-bronze bushing *E* which is prevented from turning by a screw. The knurl is retained in the bushing by a large-headed screw *F* provided with a shoulder. There is sufficient end play to allow the knurl to rotate freely. It should be noted that in presenting the knurl to the work, the bottom of the teeth should be at right angles to the center line of the work holder.

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* See MACHINERY, June and July, 1909, "Knurls and Knurling Operations."

† Associate Editor of MACHINERY.

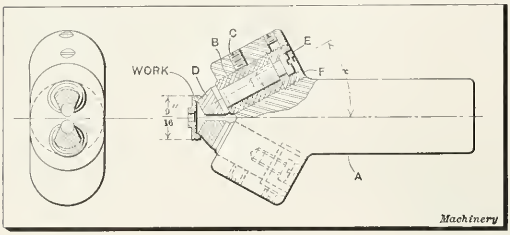


Fig. 6. Special Knurle and Holder for Internal Bevel Knurling

A knurl holder having a marked similarity to that shown in Fig. 4 is illustrated in Fig. 5. In this case, however, the knurl is used for producing "tangential" teeth, as shown on the piece *B*, Fig. 1, and consequently it is provided with spiral teeth. It is not inclined at so small an angle with the center line of the holder, and approaches, when in operation on the work, as closely as conditions will permit, the action of a helical gear in mesh.

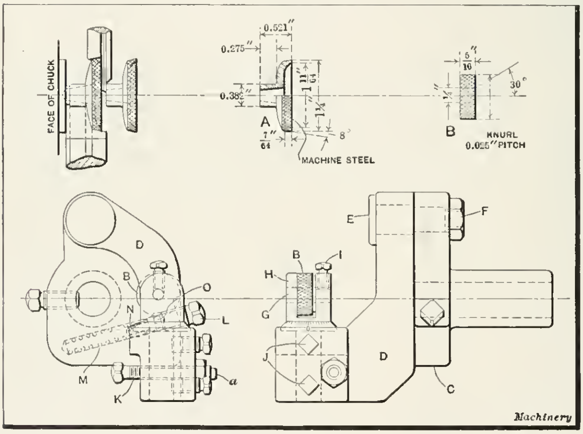


Fig. 7. Swing Type of Turret Knurl-holder for knurling at Various Angles

Internal Turret Knurl Holder

A special application of two bevel spiral knurls to the work is shown in Fig. 6. Here the portion of the work to be knurled is beveled at an included angle of approximately 90 degrees, and as shown at *A* in Fig. 1, a diamond-shaped knurl is to be produced. This operation can be more easily accomplished in this case with two spiral knurls than would be possible with one diamond knurl. Under these conditions it is advisable to have the angle *a* slightly less than half the angle on the work, so that it will be possible to use a bevel knurl, as a straight knurl would not work freely when operated from either the turret or cross-slide.

The holder *A*, Fig. 6, which is held in the turret, is made from a machine-steel forging and has two lugs, bored to receive the phosphor-bronze bushings *B*, these being retained in the holder by screws *C*. The knurls *D* are provided with shanks and are retained in bushings *B* by screws *E*, which rotate with the knurls. The end thrust of the knurls in this holder is considerable, so that it is necessary to back up the bushings *B* with screws *F*.

Special Swing Knurl Holder

A special knurl holder which is held in the turret and operated from the cross-slide by a rising block under the front tool-post, is shown in Fig. 7. The work is shown at *A*, and also at *D* in Fig. 1. It will be noticed that the work is considerably greater in diameter than that suited to the ordinary capacity of the No. 2 Brown & Sharpe automatic screw machine, thus requiring the use of a special outside feeding attachment, the ordinary feed tube being removed. The work is revolved at 240 R. P. M., and the knurl holder advanced at the rate of 0.00077 inch per revolution of the work. This is the speed at which the swinging arm *D* is moved, so that the actual feed of the knurl will be somewhat less than this amount.

The main body of holder *C* is provided with a shank held in the turret, and the swinging member *D* is held to its front face by a bolt *E* and nut *F*. The knurl *B* is held on pin *G* retained in the swivel holder *H* by screw *I*. The holder *H* is provided with angular graduations reading to degrees, so that the knurl can be set to the desired angle with the work. In the illustration the knurl is set straight, but in actual operation it is set around at an angle of 8 degrees. The shank of holder *H* is retained in the swinging member *D* by two set-screws *J*, which operate on bronze shoes to prevent marring the shank.

In operation, the rising block on the cross-slide comes in contact with the point *a* of the adjusting screw *K*, forcing the knurl into the work. The swinging member is returned to adjustable stop-screw *L* by a spring *M*, plunger *N* and pin *O*, the latter being driven into the swinging member and operating in an elongated hole in the holder *C*.

Special Opening Knurl Holder

An opening type of knurl holder is shown in Fig. 8. Two bevel knurls *B* are held in the swinging arms *C* and *D* in the manner shown in the sectional view. These arms are provided with offset lugs bored to receive the phosphor-bronze bushings *E*, which are prevented from turning by set-screws *F*. The knurls *B* are provided with shanks and are retained in the bronze bushings by screws *G*. The type of holder shown gives better results on the piece shown at *A*, and also at *E* in Fig. 1, than would a holder held on the cross-slide which would force the knurl straight into the work. The reason for this is that in operating a bevel knurl from the cross-slide on a tapered piece of work, the knurl has a tendency to glide off and produce an imperfect form of knurl. The opening type of holder obviates this difficulty to a considerable extent, as the power can be applied, so to speak, at right angles to the surface knurled. The knurls are brought into position by the turret, and then fed into the work by the rising block on the cross-slide.

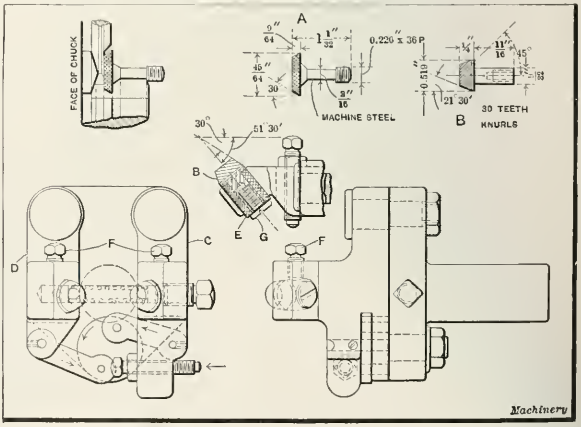


Fig. 8. Opening Type of Turret Knurl-holder for Bevel Knurling

SPIRAL GEAR DESIGN[*][†]—1

TO CALCULATE THE ELEMENTS OF FORTY-FIVE DEGREE COMBINATIONS

BY JAMES H. CARVER[‡]

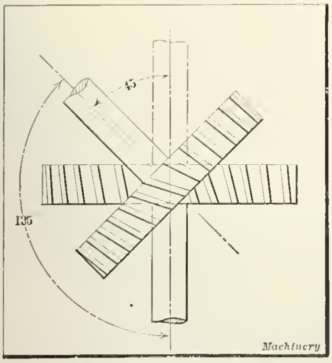
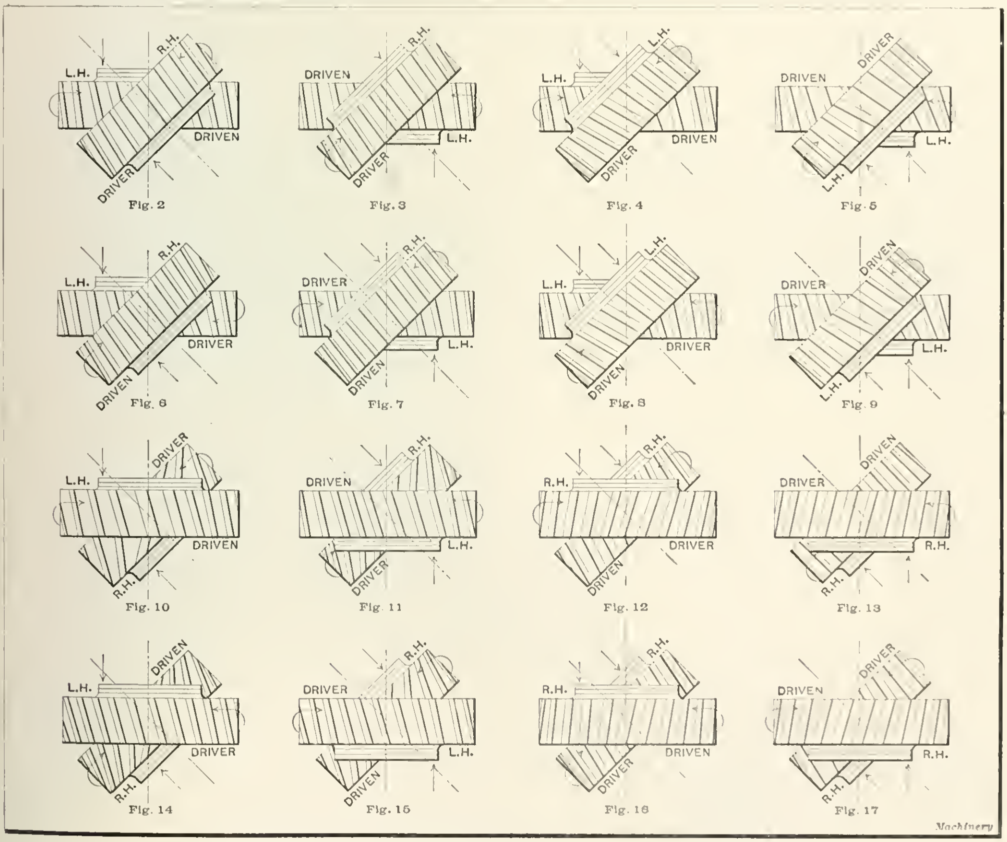


Fig. 1. Diagrammatical View showing General Arrangement of Spiral Gearing with Shafts at 45-degrees Angle

In the September, 1911, number of MACHINERY, the design of spiral gears with parallel shafts was dealt with, and in the October, 1911, number, spiral gears with shafts at right angles were treated. In the present article and in the accompanying Data Sheet Supplement, formulas will be given for calculating spiral gears with a shaft angle of 45 degrees. As seen in Fig. 1, the treatment, as far as the design is concerned, will be the same for a 135-degree shaft angle as for an angle of 45 degrees. Thrust diagrams Figs. 2 to 17 are given, the same as in the previous articles referred to, as an aid in determining the directions of thrust and rotation, and the direction of spiral, whether right- or left-hand. The arrows shown indicate the direction of the reaction against the thrust caused by the tooth pressure.

The relation between the direction of rotation, direction of spiral and spiral angle may be studied in Figs. 18 and 19. In Fig. 18 two spiral gears are shown, one in front of the other, with shafts at an angle of 45 degrees to each other. Line *AB* represents a right-hand spiral tooth on the front side of gear *C*. Assume gear *C* to rotate in the direction shown; then when the tooth *AB* reaches the rear side, it will be represented by line *EF*, which also represents the tooth direction on the front side of gear *G*. Angle *BOH* equals angle *EOH*, and it will be seen directly that the spiral angle of either gear equals 45 degrees minus the spiral angle of the other, both gears being right-hand. In Fig. 19 the spiral angles are shown to be of opposite hand, and one spiral angle is 45 degrees plus the other angle. From these illustrations we may draw the following conclusions relative to gears with a shaft angle of 45 degrees:

When the spiral angle of either gear is less than 45 degrees, then the spiral angles are the same hand, and one spiral angle is 45 degrees minus the other. When the spiral angle of either gear is greater than 45 degrees, then the spiral angles are of opposite hand, and the spiral angle of one gear is 45 degrees plus the spiral angle of the other.



Figs. 2 to 17. Thrust Diagrams for Spiral Gears with Shafts at 45-degrees Angle

The four cases which are dealt with in the accompanying Data Sheet Supplement are:

1. Shafts at 45-degrees angle, ratio equal and center distance approximate. 2. Shafts at 45-degrees angle, ratio equal

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[*] With Data Sheet Supplement.

[†] See "Spiral Gear Design", MACHINERY, September, 1911, engineering edition, and the articles there referred to. See also MACHINERY'S Reference Book, No. 20, "Spiral Gearing", and MACHINERY'S Data Sheet Book, No. 6, "Bevel, Spiral and Worm Gearing".

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and center distance exact. 3. Shafts at 45-degrees angle, ratio unequal and center distance approximate. 4. Shafts at 45-degrees angle, ratio unequal and center distance exact.

The Data Sheet Supplement gives the required formulas for calculating gears for each of these cases. In the following the derivation of some of these formulas is explained.

1. Shafts at 45-degrees Angle, Ratio Equal, and Center Distance Approximate

As already stated, the spiral angle of one gear must equal 45 degrees plus or minus the spiral angle of the other. The formulas in the Supplement in Part (*a*) are to be used when the spiral angles of both gears are 22½ degrees, which will often be the case. The pitch diameter of both gears will be equal, and are found by the formula (see Data Sheet Supplement for notation):

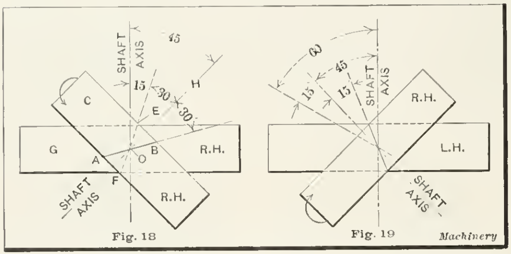
$$D = \frac{N}{P_n \cos 22\tfrac{1}{2}^\circ} = \frac{N}{0.92388\ P_n}$$

Further

$$T = \frac{N}{\cos^3 22\tfrac{1}{2}} = \frac{N}{0\ 788}$$

$$L = \pi\ D \cot 22\tfrac{1}{2}^\circ = 7.584\ D$$

The other formulas are the same as those given in the articles referred to at the beginning of this article. Part (*b*) is used for unequal spiral angles.



Figs. 18 and 19. Relation between the Spiral Angles of Teeth in Two Gears

2. Shafts at 45-degrees Angle, Ratio Equal, and Center Distance Exact

Following the same method of reasoning as in Case (6), "Spiral Gear Design", MACHINERY, October, 1911, the approximate number of teeth in each gear is found from the equation:

$$\frac{N}{P_n \cos \alpha_a} + \frac{N}{P_n \cos \beta_a} = 2\ C$$

from which, multiplying by $P_n \cos \alpha_a \cos \beta_a$,

$$N \cos \beta_a + N \cos \alpha_a = 2\ C\ P_n \cos \alpha_a \cos \beta_a, \text{ or}$$

$$N = \frac{2\ C\ P_n \cos \alpha_a \cos \beta_a}{\cos \beta_a + \cos \alpha_a}$$

After the exact number of teeth to be used in each gear is found from the last equation, the spiral angles are found from the same equation used in finding the approximate number of teeth.

Let $\dfrac{N}{P_n \cos \alpha} + \dfrac{N}{P_n \cos \beta} = 2\ C$, where α and β are now the exact spiral angles. The secant being the reciprocal of the cosine,

$$\frac{N}{P_n} \sec \alpha + \frac{N}{P_n} \sec \beta = 2\ C, \text{ or } \sec \alpha + \sec \beta = \frac{2\ C\ P_n}{N}$$

By using a table of secants, reading to minutes, angles can be found to satisfy this equation, after very few trials.

3. Shafts at 45-degrees Angle, Ratio Unequal and Center Distance Approximate

A formula for finding the number of teeth in the small gear is found from the equation:

$$\frac{N}{P_n \cos \alpha} + \frac{n}{P_n \cos \beta} = 2\ C$$

by solving for the value of n, the relation of N to n being:

$$R = \frac{N}{n}, \text{ or } N = Rn$$

Then multiplying by $P_n \cos \alpha \cos \beta$, we have:

$$N \cos \beta + n \cos \alpha = 2\ CP_n \cos \alpha \cos \beta$$

and substituting Rn for N:

$$n = \frac{2\ C\ P_n \cos \alpha \cos \beta}{R \cos \beta + \cos \alpha}$$

After finding the number of teeth N from the relation $Rn = N$, the pitch diameters are found in the manner previously described. In Part (*a*) are given the formulas to be used when both spiral angles are 22½ degrees. The constants were found from the numerical values of the functions in the formulas of Part (*b*), which latter formulas are used for unequal spiral angles in the two gears.

4. Shafts at 45-degrees Angle, Ratio Unequal, and Center Distance Exact

This case could be used under the same conditions spoken of in Case (8), "Spiral Gear Design", MACHINERY, October, 1911. The number of teeth is found exactly as in Case (3) of the present article, after which the exact spiral angles are found by trial from the equation:

$$R \sec \alpha + \sec \beta = \frac{2\ C\ P_n}{n}$$

which is found from the equations

$$\frac{N}{P_n \cos \alpha} + \frac{n}{P_n \cos \beta} = 2\ C, \text{ and } N = Rn$$

in the same manner as before. When using these equations for finding spiral angles, the table used must give values to minutes in order to insure accuracy.

* * *

HOW TO PATCH A CONCRETE FLOOR

When a cement floor surface becomes worn, it is often necessary to patch it. Mr. Leonard C. Wason, president of the Aberthaw Construction Co., Boston, in a recent paper describes the common, or wrong way, and the right way, as follows:

Commonly a sand and cement mortar is made, some cutting is done and the mortar is put in and scrubbed with a steel trowel until smooth. It is then covered up for a while. If the concrete under the patch is left dry, it soaks up the water of the mortar. As a result, the mortar does not set. If the room is dry or hot the surface of the patch dries out and for the same reason it does not set. If the concrete under the patch is dusty the patch does not adhere to the concrete. If the materials in the mortar are not suitable, naturally the patch wears badly, particularly as it is obviously located at a point of severe wear.

To proceed in the right way, cut down the worn place at least one-and-a-half inch. This cutting should be carried into the strong unbroken concrete and the edges should be cleanly undercut. The bottom of the cut should then be swept out, clean-blown out with compressed air or a pair of bellows, if available, then thoroughly wet and scrubbed with a broom. In this way, small loose particles of broken material which the chisel has driven into the surface are removed. A grout made of pure cement and water, about the consistency of thin cream, should be scrubbed into the pores with a broom or brush, both at the bottom and sides of the cut. Following this a stiffer grout, about the consistency of soft putty, should be thoroughly compressed and worked into the surface, which has already been spread with grout. Finally, before the grout is set a mortar made of one part cement to one part crushed stone or gravel, consisting of graded sizes from one-half inch down to the smallest, excluding dust, should be thoroughly mixed and put in place, then floated to a proper surface. Cover with wet bagging, wet sand, sawdust or other available material. All trucking should be kept off and the surface kept thoroughly wet for at least one week or ten days.

If a particularly hard surface is required, six-penny nails are sometimes mixed with the mortar and other nails stuck into the surface when the patch is finished. This will produce a surface which is extremely hard and durable.

* * *

When a man thinks that he is too old to learn, it simply means that he is getting either too self-satisfied or too stubborn and contrary, for there is no age limit to learning.

MAKING ANNULAR BEARINGS*

SOME OF THE MACHINERY AND METHODS EMPLOYED IN THE MANUFACTURE

BY ROBERT H. ORANT†

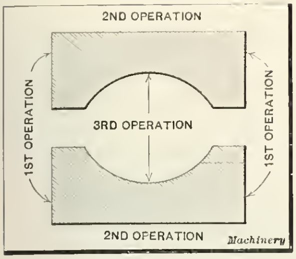


Fig. 1. Order of Grinding Operations on Races

The rapid increase in the use of annular ball bearings has led to many improvements in their design. Such improvements have required a corresponding development in the methods used in the manufacture of these bearings, until they have now reached a very complete stage. The inner and outer races were formerly made from separate pieces of bar stock and this method was responsible for a waste of at least eighty per cent of the raw material. This operation was improved by the writer so that both races were produced from the same bar, as described in a previous article in Machinery.

Use of Drawn Tubing

The next development in the production of the races came in the form of the tubing made by the Becker Steel Co., New York City. The smaller sized races can now be made very rapidly from this stock, using an automatic screw machine. The larger sizes are produced on Fay automatic lathes of the type made by the Jones & Lamson Machine Co., Springfield, Vt. In making the larger sized races, tubing or forgings of suitable size and material are used. The Fay automatic lathe shown in Fig. 2 has a worm-driven head which gives ample power for driving several tools at a time. The turning and facing tools are worked together, and the rounding of the corners is done by the same facing tools. The bar used for boring the races has two sets of tools inserted in it, the finishing tool starting right after the roughing tool has gone through the ring. Owing to the semi-automatic action of the machine, it is possible for one man to run four machines, thereby reducing the cost of machining to a minimum.

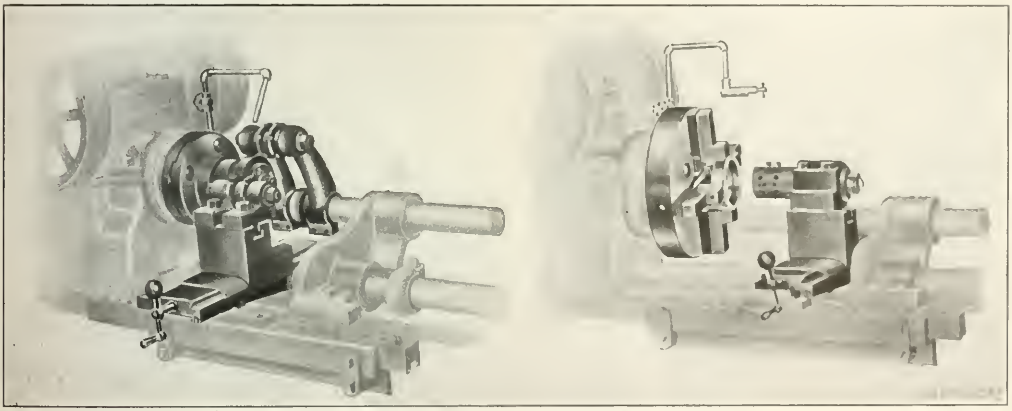


Fig. 2. Fay Automatic Lathe used for forming Blanks for Races

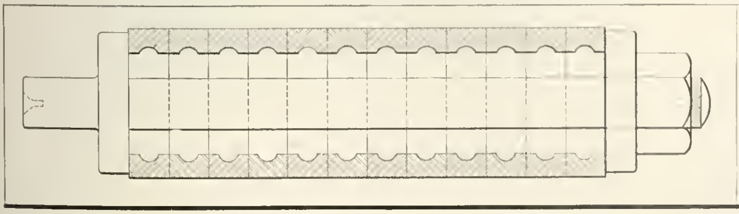


Fig. 3. Arbor used for grinding Outer Races in Multiple

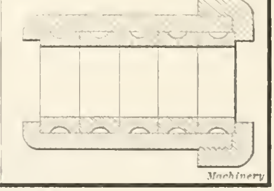


Fig. 4. Gang Fixture for grinding Inner Races

Hardening and Grinding

The extreme thinness of the bearing races makes it difficult for them to hold their shape. Consequently they must be very carefully treated in the hardening department. The method of procedure followed in the hardening operation was fully dealt with in a previous article in Machinery. After being hardened, the work is ready for grinding, the order of the operations being shown diagrammatically in Fig. 1. The first grinding operation, which consists of roughing out the blanks, has the effect of relieving the strains in the work. This important operation is performed on a Pratt & Whitney or a Blanchard face grinder. The work is held in a magnetic chuck so that a number of races can be ground at a time and still maintain the required degree of accuracy. The outer races are next mounted on a gang-arbor, as shown in Fig. 3; this arbor is considerably smaller than the hole in the work, the size being indicated in the illustration. A simple method of loading the arbor consists of having a V-block to support the work, and adjustable V-blocks that support the arbor at each end. These blocks are set in such a position that the work is centrally located on the arbor when the clamping nut is tightened. The work is now ready to be ground on the outside. The outside of the inner races is ground in the same way. The hole in the inner races is also ground in a gang fixture, as shown in Fig. 4. This will be seen to consist of a sleeve of the proper size to hold the work, which is secured between the shoulder at one end and a threaded cap at the other. When the sleeve has been loaded with work, it is held in a universal chuck. This method of grinding has effected a considerable reduction in the cost of manufacturing. The grooves in both the inner and outer races are rough-ground with a form wheel. After grinding, the work is allowed to

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* For additional information on the manufacture of ball bearings, see article entitled "The Manufacture of Steel Balls" published in Machinery for February, March and April, 1912; also article entitled "Ball and Roller Thrust Bearings" published in August, 1912, and other articles there referred to.

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"rest" for two or three weeks, after which time it is ready for finishing. The high finish which is produced on the ball bearings of foreign manufacture has made it necessary for the American product to be brought to corresponding perfection in order to compete in the open market.

The grinding of the grooves in the races is, of course, one of the most important steps in manufacturing ball bearings.

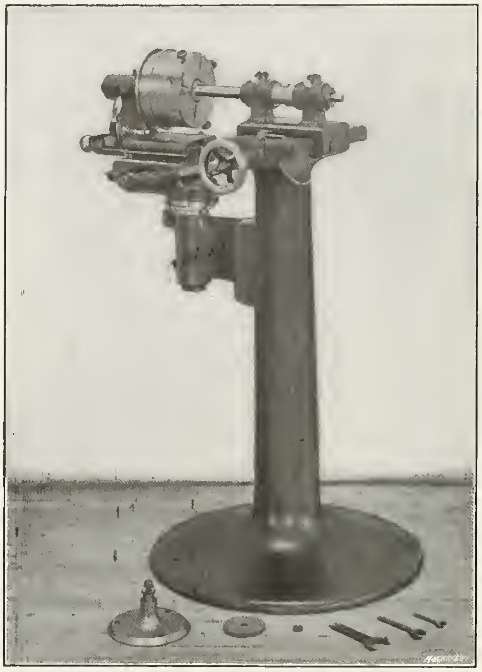


Fig. 5. Simple Form of Machine for grinding Grooves in Races

The machinery for doing this grinding has seen a great many improvements, and has now been brought to a stage where it is well nigh perfect. Fig. 5 shows the original type of grinder made for the trade by the Brown & Sharpe Mfg. Co., Providence, R. I. This was a very simple head that was mounted on one of the bases of the B. & S. No. 2 cutter grinder; the machine had a special head so that it could be used for radius grinding on both the inner and outer races. The column of the machine has a bracket attached to it, which is provided with a vertical adjustment and bored out to receive the grinder head that is equipped with two slides, thus providing for adjustment in two directions. The lower slide has a scale graduated on it, and a pointer is screwed to the bracket; this provides for setting the head over so that any radius can be ground, as the center of the wheel and the center of the bracket are kept in a direct line. The upper slide carries the work spindle and has a rack and pinion arrangement which provides for moving the head back from the wheel, so that the work can be measured at any time without disturbing the adjustment. This slide is also provided with an adjusting screw; in case the work which is carried in the spindle gets out of line with the wheel, it can be adjusted very easily. The work head has a pulley attached to it and is driven from the countershaft at constant speed. The slide which carries the wheel head is fastened to the base, and is equipped with stop pins that control the length of movement. The spindle runs in phosphor-bronze bearings, which are arranged with the usual form of take-ups so that they always fit closely. The drive is provided by two-step cones, to which a belt runs direct from the countershaft.

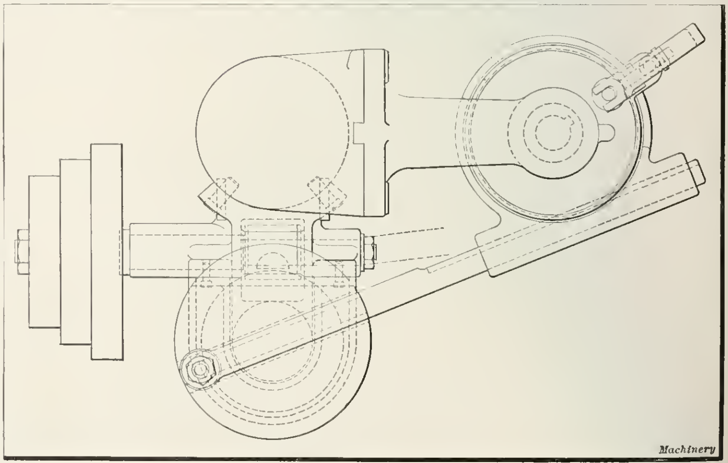


Fig. 6. Mechanism of Power Drive for oscillating Grinder Head

At the time of receiving our order, the Brown & Sharpe Mfg. Co. was so busy that it was unable to make us more than five of these machines, but the company lent us the patterns and sold us all the standard parts so that we were able to build these grinders in our own factory. The oscillatory motion of the head on this type of grinder was produced by hand and made it necessary to assign one man to operate each machine. This suggested the possibility of improvement by providing means for securing the oscillatory movement by power. The method by which this was finally accomplished, is shown in Figs. 6 and 7, where it will be seen that a bracket is attached to the column of the machine about 18 inches from the floor. This bracket carries a worm and worm-wheel, which are driven by a three-step cone pulley. A plate is mounted at the top of the worm-wheel spindle; this plate has a T-slot cut through its face so that the driving rod, which connects with the grinder head and produces the oscillatory motion, can be set at different distances off center. This provides for giving the work head any amount of throw which is necessary to grind the grooves in the races. The transmission of power from the plate on the worm-shaft to the grinder head is effected by a rack which is cut in the end of the connecting-rod. The teeth of this rack drive a suitable spur gear which is a loose fit on a shaft that is part of the lower work head slide. A plate is keyed to the shaft above this gear and carries a plunger that can be raised or lowered by a lever. When it is required to throw in the drive, this lever brings the plunger down into a hole in the spur gear and starts the head oscillating. Fig. 7 shows a machine of this type, and by referring to this illustration, together with the line drawing, the method by which the head is oscillated will be readily understood.

Holding the Races for Grinding

The next important advance which was made in the design of machinery for grinding the races of annular bearings consisted of an improvement in the method of holding the work. Formerly, the work was held in the head by means of a split ring and adjusting screws. These screws were manipulated to locate the work in the desired position; this was a very tiresome job, as it frequently took from five to eight minutes to get the races in a central position. Fig. 8 shows the improved method, which consists of taking the same head and inserting a hardened steel ring that is tapered on the inside. A master chuck was made to fit this taper and pads were then made to fit any race, the construction being similar to that used in an ordinary screw machine. A hole was drilled through the spindle to carry the drawback bar, which is fitted with a knob at the outer end that is turned to open or close the chuck by hand. The chuck is prevented from turning, while the work is being put in or taken out, by means of a pin which is carried in the grinder head. As it was not necessary to grind the races to one diameter on the outside, the variation allowed the center of the work to come out of center with the emery wheel. To avoid this trouble, three stop-pins were arranged on the inside of the chuck, the pins being fastened to the head. This allowed the race to come against the pins while the chuck was being closed, thereby holding it central with the emery wheel.

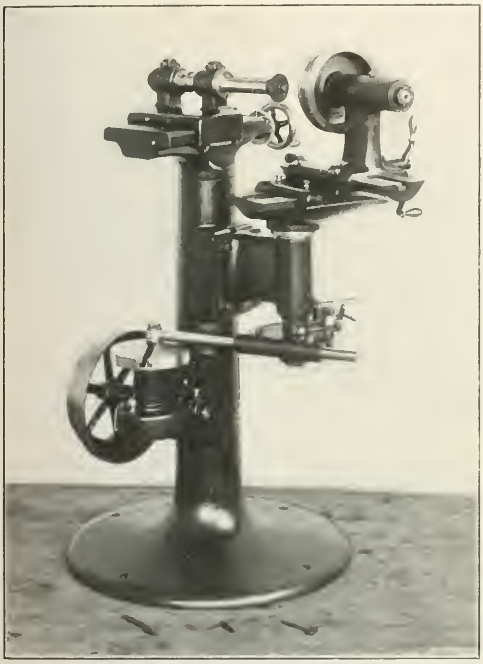


Fig. 7. Type of Machine with Head oscillated by Power

Wet Grinding the Ball Races

Up to this time we had been using a dry wheel, which of course made the work very slow. In order to increase production, the problem of equipping the machines to use a wet wheel was next undertaken, and a solution was finally found in equipping the machines with water guards. It will be readily understood that this was not an easy matter, as the oscillation of the head caused the water to be thrown in all directions. Fig. 9 illustrates a machine equipped with water guards of the type that was finally devised. The application of wet grinding created a material increase in the amount of work produced. Further increase in this direction arose from equipping the machine with a power feed for the wheel head; this made it possible for one man to run four machines and still produce a very fine grade of work. The power feed for the wheel head was accomplished by means of a regular ratchet wheel and a friction disk which allowed the emery wheel to be fed into the work to a certain point and then stop at any place at which the stop on the friction disk had been set.

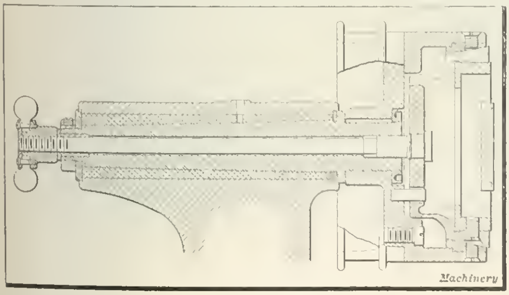


Fig. 8. Improved Type of Grinder Head Chuck

The process of grinding the intake groove that is used for assembling the balls in the races requires a great deal of care. This groove must not be too deep or it will permit the balls to jump and catch; if it is too shallow, it will cause the races to be sprung out of shape during the assembling process. The emery wheel used for grinding this groove is slightly larger than the diameter of the balls used in the size of annular bearing race being ground. The depth of the groove is determined by the use of a ball-point micrometer caliper, with which the distance between the bottom of the groove and the outside diameter of the race is measured.

The final operation before assembling consists of polishing or lapping the work. American manufacturers have been considerably behind their European competitors in regard to their polishing methods; it has been the custom to polish only the grooves of bearings made in America, whereas the foreign manufacturer laps the entire surface of the bearing. The finishing operation is conducted by remounting the work in the grinder and using a hard wood wheel covered with crocus, going through the same operation as was formerly followed in grinding the bearing from the rough.

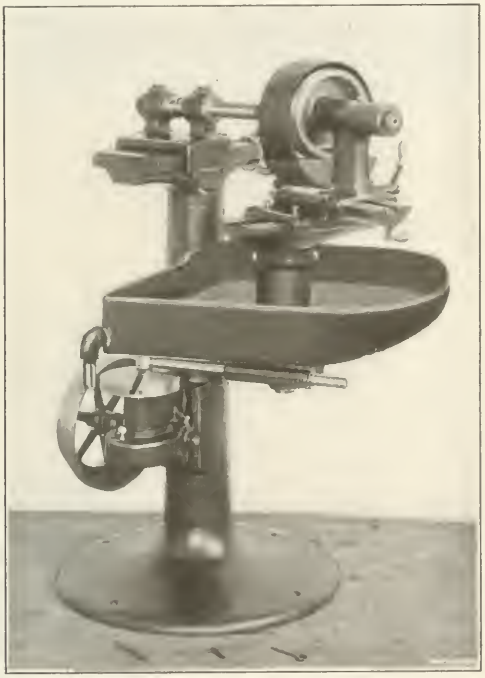


Fig. 9. Type of Water Guards used for Wet Grinding

Assembling Bearings

The method of assembling this type of annular ball bearings is a very simple matter. Fig. 10 shows a view in the assembling room which is equipped with tables upon which cast-iron surface plates are mounted. These plates are provided with auxiliary plates of tool steel, which are first hardened and then carefully ground to a perfect surface. Five boxes are located at the rear of each assembling table and each of these boxes contains balls of different sizes. These sizes are as follows: O. K., 0.0005 inch large, 0.0005 inch small, 0.001 inch large, and 0.001 inch small. In assembling a bearing, the assembler takes three balls from one of these boxes and forces them into the bearing by means of the arbor press which is fastened to the table. He then distributes these balls around the bearing and tests it for the closeness of fit. If the bearing is either too loose or too tight, he forces the balls out and replaces them with the next larger or smaller size, according to the fit that was produced with the first balls tried. This process is repeated if necessary, until the proper size has been secured; the bearing is then filled with balls if it is of the full type, or with one less than the number required to fill the races if a cage is to be used. The foreign manufacturers grind all their bearings to one size and consequently they only require an O. K. ball. This is a more expensive process, and to reduce the cost of production American manufacturers have adopted the method previously described. After the assembling process is complete, the assembled bearing is subjected to a final grinding process in order to make the outside of the outer race concentric with the center. As the inner races are a trifle thinner than the outer races, the bearings can be assembled on a gang arbor in the same manner as shown in Fig. 3. In this case, the arbor is of the proper size to fit accurately in the hole in the inner races, and the side faces of the outer races bear against each other. The work is accurately located in this way, and when the grinding operation is finished, the outside of the races is concentric with the center, provided the assembling has been properly done. The finished bearings are tested and then marked to indicate their eccentricity and the degree of side motion that the outer race has when revolved on the inner race. The degree of accuracy required runs from 0.0005 inch to 0.0015 inch according to the diameter of the bearing.

Fig. 10. Equipment of Room where Annular Bearings are assembled

* * *

Steel hardened in oil has not so hard a surface as when hardened in water. This is due to the fact that when water is used for quenching, the cooling of the heated steel takes place at a much more rapid rate than when the cooling is in oil. Experiments show that a piece of steel will cool from 700 to 600 degrees C. (from 1292 to 1112 degrees F.) in five seconds when quenched in pure water, while, when quenched in oil, forty-three seconds was required to cool off the same amount.

* * *

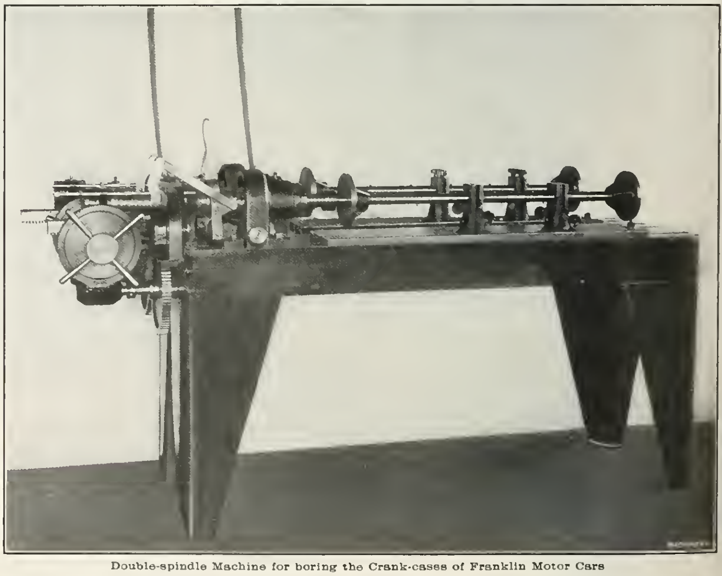
The motor boat *Baby Reliance III* is probably the fastest in the world, having a speed record of 53.8 miles per hour. She is driven by a twelve-cylinder Van Blerck engine fitted with Bosch magnetos.

A DOUBLE-SPINDLE CRANK-CASE BORING MACHINE

A double-spindle horizontal boring machine which will bore a crank-case in two and one-half minutes, when it formerly took fifteen minutes, has just been completed by the tool construction department of the H. H. Franklin Mfg. Co., Syracuse, N. Y. The machine bores two crank-cases at a time; each case has five crankshaft bearings, so that ten bearing holes can be bored at one setting. The operator adjusts one crankcase on the machine and starts boring. While the first crankcase is being bored he adjusts the second, and by the time it is ready, the first crank-case is finished. In this way, continuous operation is obtained.

It will be seen from the illustration that there is an auxiliary table for the different sizes of crank-cases. The work is clamped to the auxiliary table, and two pedestals steady the boring-bars in the center. There are heads at each end of the boring-bars which fit in the ends of the crank-cases, holding them in their true position and practically making each case its own aligning jig. Each boring-bar has five pairs of cutters, which reduce the size of the chips on each cut. These cutters can be adjusted to bore different sized bearings for the different sizes of crank-cases. They bore holes from 1½ inch to 2 inches in diameter.

The boring-bars are driven by a semi-universal joint from the main spindle of the machine. Each spindle is independent and has an independent control. The feed drive is similar to that on any other horizontal boring machine; both heads are driven by worm-wheels from one shaft which runs at 1100 revolutions per minute, and drives the boring-bars at 200 revolutions per minute with a feed of 0.005 inch per revolution. There is a clutch for each main drive and one for each feed; these clutches have an automatic knockout for stopping the spindle and feed. The feed on this machine is obtained by a rack and pinion operating through a train of gearing from the main spindles.


Double-spindle Machine for boring the Crank-cases of Franklin Motor Cars

The machine is designed for one speed and one feed. All bearings have solid bushings to prevent changes in the feed and speed, and to prevent the operator from needlessly adjusting the bearings and getting anything out of order. A safety device on the clutch keeps the spindle from starting unintentionally, thereby protecting the operator from injury while setting the bars or crank-case.

* * *

Good lockers for the men should be a part of the equipment of every modern shop and factory.

FORMS OF BABBITTING FIXTURES

BY JOHN A. H. PHILLIPS*

The work of babbitting bearings offers considerable opportunity for the use of different forms of fixtures that are capable of making a material increase in the efficiency with which this operation can be carried on. During the writer's experience, he has had occasion to babbitt a variety of bearings, and in the following article a description is given of the different types of fixtures which he has used.

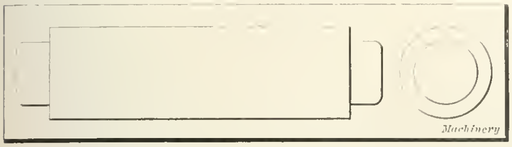


Fig. 1. A Simple Form of Babbitting Mandrel

Fig. 1 shows the most common of all forms of babbitting mandrels. This is merely a piece of shafting of the required size, which is turned down at the ends to fit into the corresponding hole in the supporting plate *A*, shown in Fig. 7. This plate is a piece of cast iron with a number of different sized holes bored in it to fit various sizes of mandrels. The body of the mandrel is turned with a taper of 0.0025 inch per foot of length in order to make it easy for the operator to remove it from the finished bearing. The mandrel is painted with a coat of thin white lead each time it is used.

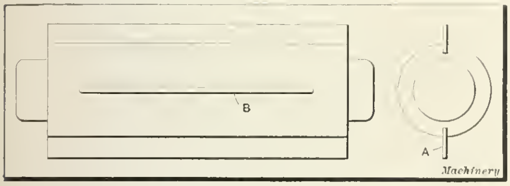


Fig. 2. Mandrel for babbitting Plain Bearing Caps

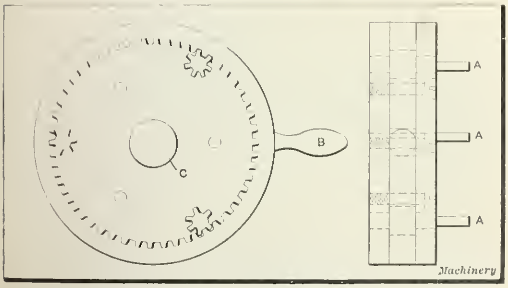


Fig. 3. Fixture used for locating Bearing at Center of Wheel

Fig. 2 shows an arbor for babbitting the cap of a plain bearing. Two thin pieces of steel *A* are inserted in this mandrel, and the space occupied by these strips while babbitting is replaced by liners in the finished bearing. *B* is a projection on the mandrel which forms the oil groove in the bearing, obviating the necessity of cutting it after the babbitting operation has been completed. The fixture shown in Fig. 7 is used for clamping the bearing to the mandrel.

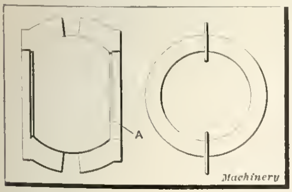


Fig. 4. Fixture for babbitting Spherical Bearings

Fig. 6 shows a rather more complicated form of babbitting mandrel which is used for ring oiling bearings. The two rings *A* are attached to the mandrel and serve to give clearance for the oil rings in the cap. The two small rings *B* are not fastened to the mandrel but are placed in the bearing to prevent the babbitt from running out; the space around these rings is carefully plugged up with putty before the babbitt is poured. Bearings of this type must be babbitted in a horizontal position, the six notches cut in the sheet-steel feathers being used to provide space through which the babbitt is poured.

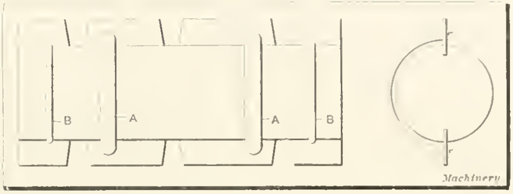


Fig. 6. Mandrel for babbitting Ring Oiling Bearings

Fig. 4 shows a fixture used for babbitting spherical bearings. In this case, the shoulders *A* are made to fit the castings as closely as possible, and any remaining cracks are carefully plugged with putty in order to prevent the escape of the babbitt. This type of bearing is babbitted in halves similarly to the ring oiling bearings, the babbitt being poured through the notches in the thin steel plates, as in the preceding case.

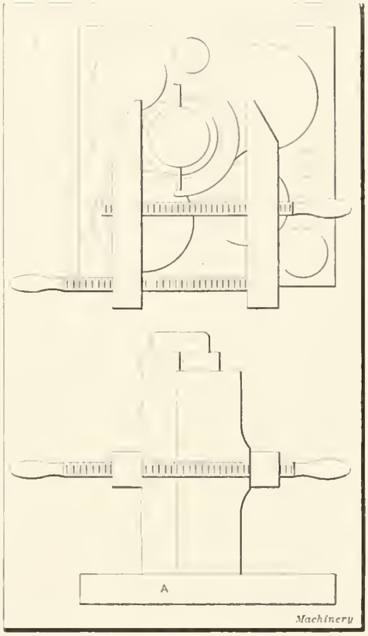


Fig. 7. Fixture for supporting Babbitting Mandrels

The mandrel shown at *A* in Fig. 5 is used for babbitting the bearing *B*, which is a type that is extensively used on belt conveyors used for handling a variety of loose materials. The four notches *C* are used as sight holes for centering the mandrel in the bearing; one of these notches is cut larger than the others and is used for pouring the babbitt into the bearing. The jig shown at the right-hand side of the illustration is used for removing the bearing from the mandrel. The

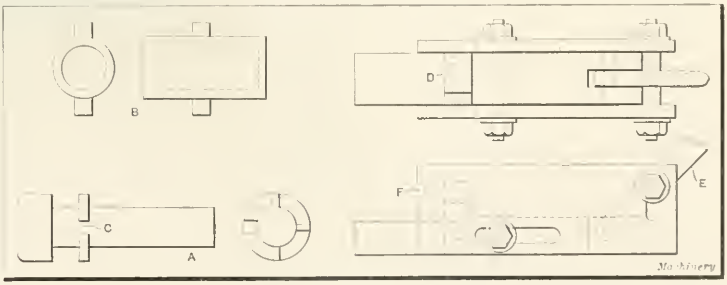


Fig. 5. Mandrel and Fixture used for babbitting Bearing B

mandrel is placed in the slot *D* with the bearing projecting, and when the lever *E* is brought forward, the notches *F* come into contact with the lugs on the bearing and force it off the mandrel.

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Fig. 3 shows a fixture for babbitting cast-iron rollers and wheels. This fixture was designed to provide a means of locating the bearing in the exact center of a wheel; it is made in two halves with teeth cut on the inside of the ring as shown. The three pins *A* are turned eccentric with the pinions of which they are a part, and by swinging the handle *B*, the wheel is accurately centered. A mandrel of the type shown in Fig. 1 is used in connection with this fixture, the mandrel being placed in the central hole *C*.

* * *

HOW TO FORGE AND HARDEN A COLD CHISEL

BY C. C. SEMPLE[*]

Some blacksmiths advocate hammering a cold chisel at a black heat to refine and toughen it. After taking the pains to do this, they will replace the tool in the fire and heat it hotter than it was when they began to refine it, after completing the heavy forging. In such cases, the temperature is often still further increased to secure heat enough to draw the temper. When the required temperature has been reached, the tool is taken from the fire and the cutting end is immersed in the bath, part way up the length of the heat. It is then withdrawn and the blade is next polished with a stick covered with emery or with emery cloth. The blacksmith then waits for the temper to run down from the red hot part above the blade, and when the desired temper shows by color, the whole chisel is immersed in the bath. When sufficiently cool, it is given to the man who is to use it.

By this treatment, the blacksmith has undoubtedly undone a part of the mischief and all of the good—if any—that was produced by his cold hammering. In nine cases out of ten, he has heated the vital part of the tool too hot for good refining in order to make the heavy part hot enough to draw the temper. Any steel that will not stand this treatment and make a good chisel is condemned by him.

Now let us see how a blacksmith who keeps the tools in order for a gang of more than 100 men does such work. He takes a piece of steel of the right length for a chisel, heats it to a bright red heat for one-third of its length, and draws the cutting end down on his steam-hammer to about twice its finishing thickness. This being done, he returns the tool to the fire and reheats it to about the same temperature as before. The work is next taken to the anvil, and by means of a hand-hammer and light sledge in the hands of the helper, the chisel is quickly shaped, with the blade still red-hot, or nearly so, when finished. Instead of resorting to cold hammering to refine the steel, the chisel is again returned to the fire, and a second piece that has been getting warmed up on the side of the fire is also moved to the center at this time. The chisel just forged, when heated to a low red heat, is thrust into the annealing box and left to cool. All the subsequent chisels are treated in the same manner, and if any of them are required for immediate use, the ones that were forged first are selected; if not entirely cold, they are plunged into water to make them so.

The hardening process used for chisels cooled by either of the preceding methods is as follows: A piece of iron is laid across the fire and partially buried. The thin edge of the chisel is laid on this iron and the heat allowed to take hold some distance back and run up to the edge. The blade is then dipped and hardened well up, so that in most cases there is not enough heat left to draw the temper. In hardening chisels by this method, the temper is drawn at a light blue. Chisels hardened and tempered in the manner described are put aside for future use, and it is claimed that if they are allowed to remain several days they are better than when used at once.

It may seem that this is quite a rigmarole for forging and hardening so simple a tool as a cold chisel. The question arises, does the end justify the means? The fact that this blacksmith keeps the tools in shape for more than 100 men, and that every one of these men will swear that the tools are the best he ever used in any shop where he has worked, leads to the supposition that there is something in it.

This same method of treatment may be safely applied to all forged tools, so far as omitting the cold hammering and heating of the larger parts to draw the temper is concerned. It is an established fact that many of the high-carbon and alloy steels require reheating to relieve the forging strains and that they are improved by being reheated and allowed to cool slowly after forging. It is also an established fact that these steels are ruined if they are hammered at any temperature much below a red heat. The inference is plain that the steel made nowadays does not require the old time blister-steel treatment, and that it will not stand it and yield the best results. The most economical steels to use are now made in such a way that they need no refining on the part of the blacksmith. You will get less hardening cracks by hardening in saturated brine than by hardening in water, but in any case the piece must be kept moving in the hardening fluid. These notes were supplied to the writer by the manufacturer of a well known and extensively used brand of Swedish steel (Fagersta), but the method is equally applicable to all high-grade steels.

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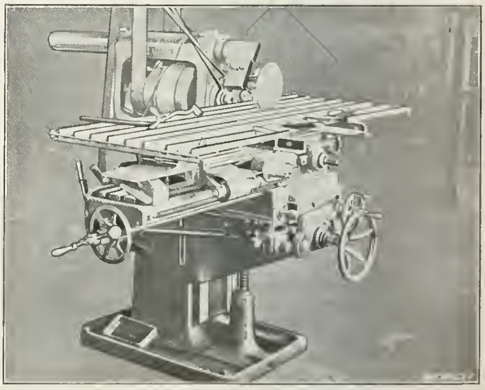
* * *

A COMBINATION OF GRINDER AND MILLING MACHINE

BY S. A. MCDONALD[*]

The accompanying illustration shows a way of combining two machines to perform an operation on a piece of work which could not be handled otherwise with the average small shop equipment. The work done consisted of a special machine table 5 feet long and 2 feet 2 inches wide, to which were fastened a series of rows of $\frac{1}{2}$ by $\frac{3}{4}$-inch cold-rolled steel bars. Five of these guide bars were to be parallel within a variation of less than 0.005 inch for their full length; hence, it was considered necessary to grind them. This was a job for a large plain grinder, but, as such a machine was not available, the following method was resorted to:



A Combination of Grinder and Milling Machine

The platen and grinder bed of a No. 2 Walker grinder were placed on the table of a No. 14A Garvin milling machine, the grinder bed being clamped to the table of the milling machine, and the table to be machined bolted to the grinder platen. By this arrangement the combined travel of the grinder and milling machine tables was sufficient to cover the work. A lathe grinding attachment was fastened to the overhanging arm of the milling machine. This attachment was belted to a pulley on the lineshaft. By shifting the arm in or out, the emery wheel was set to approximately the right position, and the arm clamped. The final adjustment was then made by the transverse feed of the milling machine. The grinding was done with the side of the wheel and a very smooth finish was obtained, well within the limits of accuracy required.

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DYNAMICS OF GAS ENGINE CAMS—2

AN INVESTIGATION INTO THE RELATIVE MERITS OF DIFFERENT TYPES OF CAMS

BY M. TERRY*

In the previous installment of this article an analysis was made of a tangential cam, such as is commonly used in gas engine design for automobile engines. In the present installment, it is proposed to make a similar investigation with relation to a uniformly accelerated and retarded motion cam, in order to definitely determine if the latter possesses advantages over the tangential cam.

In comparing different types of cams, or even cams of the same type, we must make them alike in all respects but the one we wish to investigate. It is evidently impossible to draw any conclusions by comparing cams of different lifts and base circles and driven at different speeds, or having followers of different diameters, possessing different clearances and producing different timing of valves.

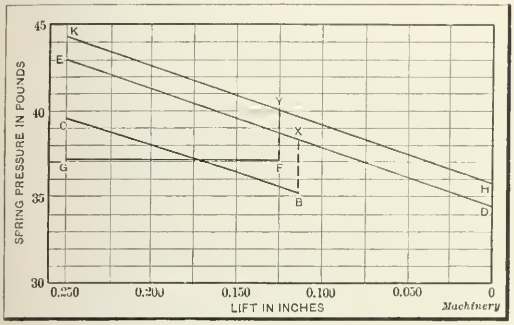

Fig. 14. Spring Pressure Diagram for Tangential and Uniformly Accelerated Motion Cams

Since the object of our investigation is to find out which shape of the two cams is more suitable in a dynamic respect, we shall make our uniformly accelerated aand retarded motion cam identical with the tangential cam discussed in the first installment. In other words, our new cam must comply with the following requirements:

Base circle = 1.000 inch in diameter.
Roller circle = 1.000 inch in diameter.
Lift = ¼ inch. Full lift must be attained in the same length of time, *i. e.*, in 53 degrees of the angular motion of the cam.
Weight of reciprocating parts = 1.6 pound.
The same rotary speed, *i. e.*, the camshaft turns through 1 degree in 1/5000 second.
The same timing, which, so far as individual cams are concerned, means that the exhaust and inlet valves should stay open 110 degrees and 100 degrees, respectively.
The same amount of clearance between the valve lifter and the valve stem.

The last item, it will be noted, does not call for the 5 degrees clearance angle assumed with the tangential cam, and the reason for this will be shown presently.

Clearance and Clearance Angle

In the early part of the first installment reasons were given for the necessity of clearance whenever the poppet type of valve is used. The amount of clearance given is, in general, arbitrary, and with different manufacturers it varies from 0.004 to 0.010 inch. With the valve gear arrangement shown in Fig. 15 a backlash of, say 0.006 inch is obtained by inserting a steel gage 0.006 inch thick between A and B; the timing gears are then adjusted so as to secure the timing originally intended for that motor. When this last object is attained with a reasonable degree of accuracy the screw B is locked securely in place, and only a slight pull should be sufficient to remove the gage.

It is clear, then, that the valve lift is equal to the cam lift less the clearance, and that the follower would rise the amount of backlash before the valve proper is started on its upward journey. This loss in valve lift is generally neglected, but its effect on valve timing is universally recognized.

In Fig. 16, O is the center of the tangential exhaust cam which turns counter-clockwise. The cam and its follower are shown in the position where the latter starts on its upward motion. As before, assume that the cam is stationary and that the roller moves to the right; its center C will describe a straight line CC_2, and in doing so the distance between O and C will increase. When such a point, C_1, is reached that $OC_1 - OC$ equals the backlash, the valve will begin to open. The angle COC_1 is known as the clearance angle or the angle of backlash.

$$\cos COC_1 = \frac{OC}{OC_1} = \frac{OC}{OC + \text{backlash}}$$

In general, the amount of backlash is assumed first and the angle of clearance is determined afterwards. Since, however, in the case analyzed in the previous installment of this article we have assumed the angle of backlash to be 5 degrees, our first problem is to determine the amount of clearance corresponding to 5 degrees.

$$\cos 5 \text{ deg.} = \frac{1}{1+x}, \text{ or } x = 0.00382 \text{ in.}$$

Our next problem is to determine the clearance angle of the uniformly accelerated and retarded motion cam corresponding to this amount of backlash, *i. e.*, 0.00382 inch.

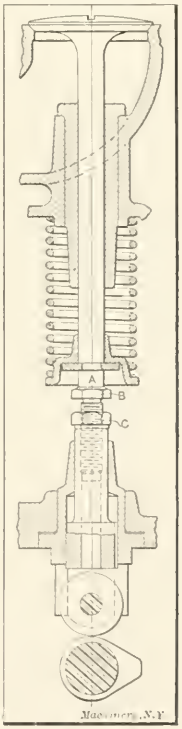

Fig. 15. Valve Mechanism

Uniformly Accelerated and Retarded Motion Cam

Almost every text-book on mechanisms mentions the uniformly accelerated motion type of cam. In our case it would be a cam so shaped as to impart to the roller center a uniformly accelerated motion during the first half of the lift, and a uniformly retarded motion during the second half.

If A = acceleration per second, in feet per second (constant),
t = time in seconds,
v = velocity in feet per second,
S = lift in feet,

Then

$$v = A \times t \quad (1)$$
$$S = \tfrac{1}{2}At^2 \quad (2)$$

These equations can be applied only within the limits of one-half the lift. A is unknown for the present, but its value can be readily determined from the last equation. In the present case:

S = 1/8 inch, or 1/96 foot,
$t = 26\tfrac{1}{2} \times 1/5000 = 0.0053$ second,
$A = \dfrac{2S}{t^2} = 741\tfrac{2}{3}$ feet per second per second.

To find the clearance angle x corresponding to a backlash of 0.00382 inch:

$$t^2 = \frac{2S}{A} = \frac{2 \times 0.00382 \times 1/12}{741\tfrac{2}{3}}$$

from which we find $t = 0.000926$ second. But

$$t = x \times \frac{1}{5000},$$

from which $x = 5000 \times t = 5000 \times 0.000926 = 4.63$ degrees, or 4 degrees 38 minutes.

The clearance angle of the uniformly accelerated and retarded motion cam being equal to 4 degrees 38 minutes, the total angle of the exhaust cam = 110 deg. + 2 × (4 deg. 38 min.) = 110 deg. + 9 deg. 16 min. = 119 degrees 16 minutes (see Fig. 17), and the total angle of the inlet cam = 109 degrees 16 minutes.

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The cam shown in Fig. 17 is what may be termed the equivalent of the tangential cam, Figs. 9 and 10, previous installment.

In order to plot an accurate lift curve (Fig. 18), as well as to draw the contour of our new cam (Fig. 17) we shall make a table of lifts for each degree of the cam.

TABLE IV. ANALYSIS OF UNIFORMLY ACCELERATED MOTION CAM

a	a	L	a	a	L
1	0.000356	0.000178	15	0.000356	0.040050
2	0.000356	0.000712	16	0.000356	0.045568
3	0.000356	0.001602	17	0.000356	0.051442
4	0.000356	0.002848	18	0.000356	0.057672
5	0.000356	0.004450	19	0.000356	0.064258
6	0.000356	0 006408	20	0.000356	0.071200
7	0.000356	0.008722	21	0.000356	0.078498
8	0.000356	0.011392	22	0.000356	0.086152
9	0.000356	0.014418	23	0.000356	0.094162
10	0.000356	0.017800	24	0.000356	0.102528
11	0.000356	0.021538	25	0.000356	0.111250
12	0.000356	0.025632	26	0.000356	0.120328
13	0.000356	0.030082	26.5	0.000356	0.125000
14	0.000356	0.034888	..	....	....

Equation (2) may he put in the form:

$$L = \tfrac{1}{2}aa^2$$

where L is the lift of the cam follower in inches, a is the cam angle in degrees, and a the acceleration per degree, in inches per degree; this acceleration is, of course, constant and can be readily determined:

$$a = \frac{2L}{a^2} = \frac{2 \times 0.125}{(26.5)^2} = 0.000356 \text{ inch.}$$

(Since full lift is attained in 53 degrees, a lift of 0.125 inch corresponds to an angular motion of 26½ degrees.)

Knowing now the value of a, and by assigning various values to a in the equation just given, we can determine the lift or position of the roller center for every degree of the cam. This is done and the results are compiled as shown in Table IV. With the help of this table we can now plot a complete lift curve, since the latter is symmetrical both with respect to XX and YY, Fig. 18.

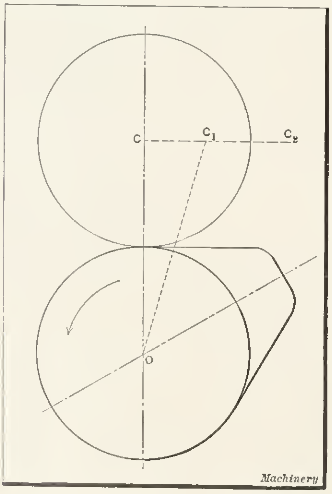

Fig. 16. Relation between Clearance and Clearance Angle

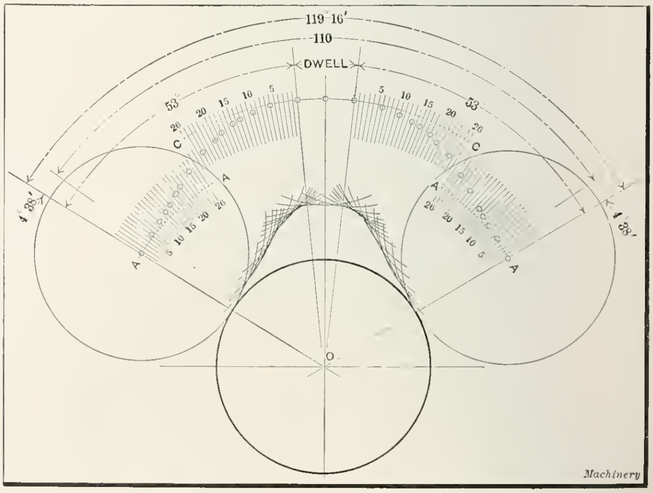

Fig. 17. Lay-out of a Uniformly Accelerated and Retarded Motion Cam

Again, with O as the center of our cam (Fig. 17) strike two arcs AA of 1 inch radius and CC of 1¼ inch radius, and from intersections of these arcs with the radial lines of the cam lay off proper lengths as indicated in the third column, Table IV. A line through the points thus obtained represents the path of the roller center; if from these points as centers we strike a number of arcs the radii of which are equal to the radius of the roller, the curve drawn tangent to these arcs will give us the contour of the cam.

The Valve Spring

In the previous installment we have fully discussed the functions of the cam and of the valve spring, and the conclusions there arrived at hold good for the uniformly accelerated and retarded motion cam. It remains now to select a suitable valve spring. If

T = spring pressure in pounds,
A = acceleration per second in feet per second required by the cam,
m = total mass of the reciprocating parts of the valve gear plus one-half the mass of the spring proper, we have:

$$T = m \times A = \frac{A \times 1.6}{32} = \frac{742 \times 1.6}{32} = 37.1 \text{ pounds.}$$

Since A is constant, 37.1 pounds of pressure is all that is required of the spring at any point from one-half to full lift of the cam. In other words, the ideal spring for a uniform motion cam is the one whose stress-strain curve is a horizontal line. This, of course, is an impossibility, for within its elastic limit any spring will exert pressure directly proportional to its distortion.

In Fig. 14 (reproduced from the previous installment) the line FG represents the spring pressure required by the uniformly accelerated and retarded motion cam. If we wish to use the same spring that we have designed for the tangential cam, and give it the same excess of pressure at F as it has anywhere between the lines BC and DE, we shall obtain HK for our actual spring pressure line. This would give us a spring, the initial and final pressures of which are 35.8 pounds and 44.4 pounds, respectively. In other words, a greater spring pressure is required for the uniformly accelerated and retarded cam.

Our conclusions in regard to the relative stiffness of springs required for the two cams are substantiated by an actual test of two engines identical in every respect but for the shape of their timing cams. The two engines were originally equipped with identical valve springs. The follower of the uniformly accelerated motion cam developed a tendency to "jump" the cam at from about 2100 to 2200 R. P. M. of the engine; the follower of the tangential cam showed signs of the same tendency when the engine speed exceeded 2400 R. P. M. The "jumping speed" of the first follower was raised to about 2500 R. P. M. by equipping its motor with additional valve springs.

The two motors were built for racing purposes, and if the writer remembers correctly, the valve lift was 7/16 inch (unusually high for automobile engines); the weight of reciprocating parts of the valve gear was 2.7 pounds, and the spring pressures were 175 pounds for the tangential and about 200 pounds for the uniformly accelerated motion cam. The experiment referred to took place over two years ago, and its results were contrary to the expectations of all concerned, for the prevailing opinion among designers is that of the two cams it is the tangential one that requires the stronger spring. To quote Mr. P. M. Heldt (*Horseless Age*, July 5, 1911, pages 4 and 5): "* * * this computation is based on supposition that acceleration and deceleration of the valve are uniform. With a tangential cam this is not the case, and the spring should then be made slightly stronger."

The author takes exception to this opinion. A glance at Fig. 14 will suffice to convince anyone who is even slightly familiar with mechanics. Assume a multiple cylinder engine equipped with cams of both types; the valve springs are all alike, their pressure line being represented by *DE*. As the speed of the engine rises above the assumed maximum, the lines *BC* and *FG* would rise parallel to themselves; *DE* would, of course, remain stationary, for the spring pressure is independent of the engine speed. It is clear, then, that *FG* would be the first line to cross *DE*, or to put it in other words, the uniformly accelerated motion cam would be the first one to exceed the capacity of the spring.

It would not be out of place here to mention the fact that if one is very anxious to prove the contention that a tangential cam requires more spring pressure than one with a uniformly accelerated motion outline, he can easily do so by "juggling" with the former. For instance, he can take the cam described in the first installment and give it a fillet of 1/16 inch radius instead of ⅛ inch. This will put a heavier duty on the spring, requiring it to perform the work of retardation and of acceleration in less time; but in this respect our comparison of the two types of cams has been absolutely fair, for not only was the total time required to lift the valve to its full height the same in both cases, but in each case the time was equally divided between acceleration and retardation, and that is as far as one can go in making the two cams alike. The only difference between them lies in the nature of their accelerations: it is constant in one and variable in the other; and, as has already been proved, in the case of the tangential cam it varies in such a manner as to favor the spring.

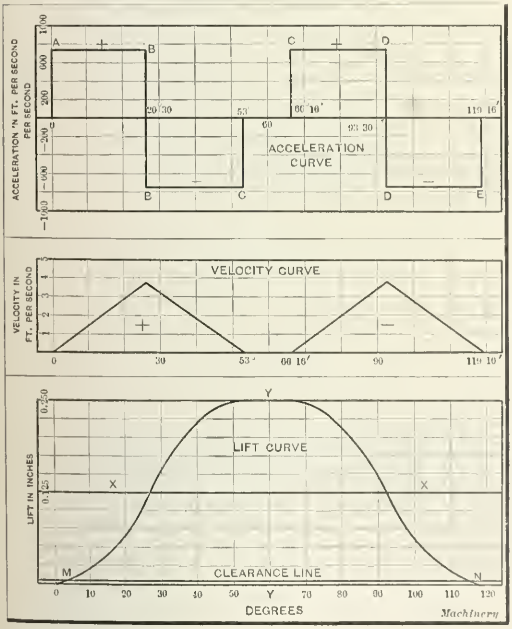

Fig. 18. Acceleration, Velocity and Lift Curves for a Uniformly Accelerated and Retarded Motion Cam

Origin of Noise

In a lecture delivered before the automobile class of the West Side Y. M. C. A., New York, Mr. C. E. Reddig, engineer of the United States Motor Co., speaking on the Silent-Knight motor, said, in part:

"The Knight engine is not different from standard engines, except in its valves; the cycles are performed in the usual manner, the gas is drawn from the carbureter, is compressed, combustion takes place, and it exhausts, in the same manner as in any of the four-stroke cycle engines.

"The changes which in the Knight engine constitute the great improvement over ordinary types of engines are the silent, tremorless, sliding sleeves working away perfectly without care or attention. They make no noise, for they strike nothing. They cause no vibration."

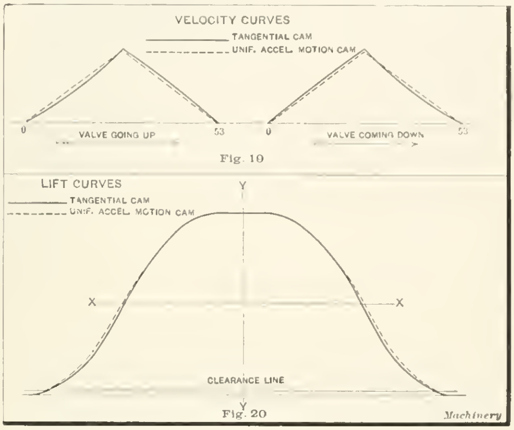

Fig. 19. Comparison of Velocity Curves. Fig. 20. Comparison of Lift Curves

Indeed, they make no noise, for they strike nothing. Not so with the poppet valve. In what follows we shall limit our discussion to the type of mechanism shown in Fig. 15. The complete lift curves, Figs. 12 and 18, represent the motion of the follower and of all the parts rigidly connected to it. The motion of the valve proper, while following along the same curve, does not commence until after the cam follower rises the amount of the backlash. In other words, the valve motion begins at *M*, the point of intersection of the lift curve with the clearance line; likewise it ceases at *N*.

If at *M* and *N* we erect ordinates until they intersect the velocity curve, the cause of noise will become apparent: 1. The cam follower possesses a definite velocity at the instant it comes in contact with the valve stem. 2. The valve possesses the same velocity when its head comes in contact with the valve seat. Whenever two bodies possessing different velocities come in contact, impact takes place; and in the case of poppet valve engines, there are two impacts per cycle for each valve in the engine.

The impact due to the valve striking its seat can be most readily analyzed. Owing to the rigidity of construction of both the valve head and the cylinder casting, practically no deformation of either can take place after the impact, and, consequently the velocity of the valve must vanish almost instantly. At the instant the valve strikes its seat, the former, owing to its velocity, possesses a definite amount of kinetic energy, the value of which is $\frac{1}{2} mV^2$, where m is the combined mass of the valve, and of all the parts attached to it, plus one-half the mass of the valve spring, and V is the velocity of the valve at the instant it strikes the seat. Since, after the impact, V vanishes almost instantly, the kinetic energy of the valve must also completely disappear. However, energy cannot be created nor destroyed, and the kinetic energy of the valve merely undergoes a transformation and reappears in other forms of energy, namely: heat and sound.

In just what proportion the kinetic energy resolves itself into the above two forms is, of course, impossible to tell. Simple observation seems to indicate that the pounding noise increases very rapidly with the speed of the engine, and we are justified in making the assumption that, at all ordinary engine speeds, noise constitutes a constant percentage of the kinetic energy of the valve at the moment of impact. We can write then:

$$\text{Noise} = c \times \tfrac{1}{2} m V^2 = K V^2$$

where K is a constant.

This assumption is very useful for the purpose of comparing the pounding action of valves due to different cams.

Tangential vs. Uniformly Accelerated Motion Cams

Sub-figures ($_1$) refer to uniformly accelerated motion cam, and sub-figures ($_2$) to the tangential cam.

Let S_1 = backlash in feet,

A_1 = acceleration per second, in feet per second,

V_1 = velocity of the valve in feet per second at the moment of impact,

β_1 = angle of backlash = 4 deg. 38 min., or 4.63 degrees,

t_1 = time in seconds required for the cam to turn through the angle of backlash = $\beta_1 \times 1/5000$.

S_2 = backlash in feet,

A_2 = average acceleration per second, in feet per second during the angle of backlash,

V_2 = velocity of the valve in feet per second at the moment of impact,

β_2 = angle of backlash = 5 degrees (see previous installment),

t_2 = time in seconds required for the cam to turn through the angle of backlash = $\beta_2 \times 1/5000$.

Then

$$V_1 = A_1 t_1 \qquad (3)$$

$$V_2 = A_2 t_2 \qquad (4)$$

$$S_1 = \tfrac{1}{2} A_1 t_1^2 \qquad (5)$$

$$S_2 = \tfrac{1}{2} A_2 t_2^2 \qquad (6)$$

Substituting (3) and (4) in (5) and (6), respectively, we obtain:

$$S_1 = \tfrac{1}{2} V_1 t_1 \qquad (7)$$

$$S_2 = \tfrac{1}{2} V_2 t_2 \qquad (8)$$

But $S_1 = S_2$, since the amount of backlash allowed was the same in both cases. Hence $\tfrac{1}{2} V_1 t_1 = \tfrac{1}{2} V_2 t_2$ (9)

and

$$\frac{V_1}{V_2} = \frac{t_2}{t_1} \qquad (10)$$

Now since $t_1 = \beta_1 \times 1/5000$ and $t_2 = \beta_2 \times 1/5000$,

$$\frac{t_2}{t_1} = \frac{\beta_2}{\beta_1} \qquad (11)$$

Substituting (11) in (10):

$$\frac{V_1}{V_2} = \frac{\beta_2}{\beta_1} = \frac{5}{4.63} \qquad (12)$$

Now, then everything else being equal, we can write:

$$\frac{\text{Noise due to the uniformly accelerated motion cam}}{\text{Noise due to the tangential cam}} = \frac{V_1^2}{V_2^2} = \frac{\beta_2^2}{\beta_1^2} = \frac{5^2}{4.63^2} = 1.16,$$

or 16 per cent greater.

The fact that in the early stages of opening and the late stages of closing, the valve velocity due to the uniformly accelerated motion cam is greater than that due to the tangential cam can be shown graphically by superimposing the velocity curves of the two cams. (See Fig. 19.)

Lift Curves Compared

Our study of the two cams would remain incomplete if we failed to compare their lift curves. As a matter of fact, these are the only curves that the majority of designers ever take pains to construct and to compare. The object of their comparison, however, has nothing to do with the dynamics of the cams themselves.

In Fig. 21 is shown what is known as a flat-seated valve. The effective area for the passage of gases is that of a cylindrical surface whose diameter is D and whose height is Y. This area is equal to $\pi D Y$, where π and D are constants, and Y at any instant is the actual rise of the valve. When a cone-seated valve is used, the relation between the effective area-opening and the valve lift is somewhat more complicated.

It is the aim of every designer to provide as large gas passages as possible in order to increase the volumetric efficiency, and—along with it—the output of his engine. At any instant, then, the lift regulates the amount of charge admitted, and, thus, the former can graphically represent the latter. The total charge taken in during the suction stroke of the engine, and consequently, the output of the latter can be represented by the lift-integral, *i. e.*, by the area bounded by the lift curve and the clearance line.

It is clear, then, that the output of the two identical engines equipped with different cams would be approximately proportional to their lift-integrals, and it is for the sake of comparison that we have superimposed the lift curves of our two cams, as shown in Fig. 20. The advantage is in favor of the uniformly accelerated motion cam, but the amount of this advantage is very slight, as anyone can see at a glance.

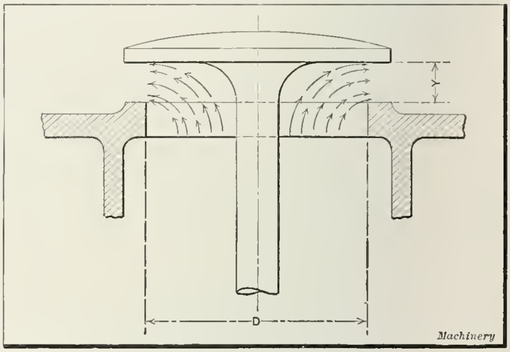

Fig. 21. Relation between Lift and Discharge Area

To sum up our results:

1. A tangential cam requires less spring pressure than a uniformly accelerated and retarded motion cam.
2. It produces less noise.
3. It can be manufactured more cheaply and accurately.
4. The indicated horsepower of the engine would, in all probability, be the same, no matter which type of cam were employed.

* * *

OIL-MIXED PORTLAND CEMENT CONCRETE

A serious drawback to the general use of concrete for tanks, cisterns, house walls, cellars, etc., is its permeability to moisture. A concrete cistern, unless specially treated, is likely to be leaky, and even if leakage is not serious, it is usually objectionable on account of the dampness resulting from it. Concrete block houses are often damp and unhealthful. Several formulas for making concrete waterproof have been successfully used but some of them are too expensive for general application. One of the simplest, cheapest and most effective yet found is that developed by the U. S. Geological Survey in the office of public roads by Mr. L. W. Page. Mr. Page found that a heavy residual mineral oil of 0.93 specific gravity, mixed with Portland cement, makes it waterproof and does not weaken when the concrete consists of, say, cement, one part, sand, three parts, and oil not more than ten per cent by weight of the cement. Concrete mixed with oil requires about fifty per cent longer time to set hard, and the compressive strength is slightly decreased, but not seriously. The bond or grip of oil concrete on steel is much decreased when plain bars are used, but formed bars, wire mesh or expanded metal act as effectively in it as in ordinary concrete.

* * *

It has hitherto been believed that pitchblende, the mineral containing the largest amount of radium of any mineral known, was principally to be found in Austria. It is now stated, however, that this mineral is found in even greater quantities in one of the northern provinces of Sweden, and that it is only a question of time when these deposits will be worked for obtaining the radium contained in them.

MODERN METHODS OF A PRESS WORKING PLANT

DESCRIBING WORK DONE BY THE WORCESTER PRESSED STEEL CO.

BY CHESTER L. LUCAS*

Nestling under a hillside at Greendale, one of the pretty suburbs of Worcester, Mass., are the works of the Worcester Pressed Steel Co., an "aviator's view" of part of which is presented in Fig. 1. The buildings of the plant embrace the main press working factory; the foundry for making special tool castings for dies, die beds, etc.; a new building for pickling, with ventilated roof 45 feet high; the rolling mill for cold-rolling strip steel; the acetylene gas generating house; the annealing and casehardening building; the storage and shipping building; the office building and the power house. The business was established in 1883 under the name of the Worcester Ferrule & Mfg. Co., at which time it occupied 7000 square feet of floor space and employed 20 hands. At the present time the plant covers 70,000 square feet of floor space and gives employment to 250 men.

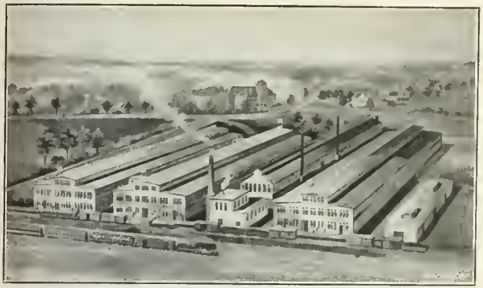
Fig. 1. Aviator's View of Worcester Pressed Steel Co.'s Plant

This manufactory specializes in cold drawing, pressing, forming and stamping shapes to order from steel, brass, aluminum and other sheet metals.

Rolling the Metal

On account of the accuracy and various thicknesses of steel required for pressed and seamless drawn metal products, as well as the necessity for having sheet metal with highly finished surfaces, this company maintains a pickling and rolling department of its own, for cold-rolling the steel to its finished gage. A section of this department is shown in Fig. 2. On the two machines shown, the steel rolls themselves are 12 inches in diameter. During the rolling operation, the rolls are kept flooded with oil. To furnish adequate facilities for this work, a new building 70 feet by 110 feet has just been completed and equipped with most modern vats, cranes and appliances. Work has also been started on another new cold-rolling mill, 150 feet by 100 feet in size and of steel and glass construction. A fireproof addition to the main press shop, 90 feet by 100 feet in size, is now being erected.

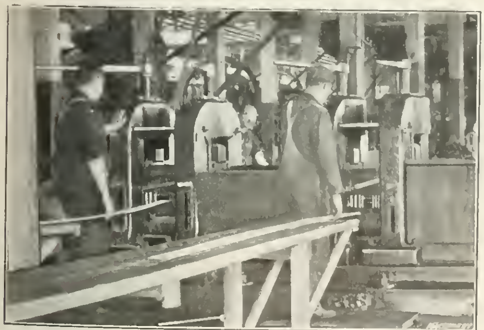
Fig. 2. A Corner of the Sheet Metal Rolling Department

Making Radiator Fans

One of the interesting jobs of press work done in these works is the making of a one-piece steel fan for an automobile radiator. These fans are 14 and 16 inches in diameter, made of cold-rolled sheet steel 0.035 inch thick, and reinforced at the edge by an enclosed wire ring which stiffens the entire fan. The different stages in making the fan may be seen by referring to Fig. 3. Commencing with the blank at the left-hand upper corner, these pieces represent the work done: blanking; flanging edge; closing in preparatory to wiring; closing the wire in position; piercing between the blades; shaping the blades; electrically welding the spider and hub; and piercing the rivet holes in the hub.

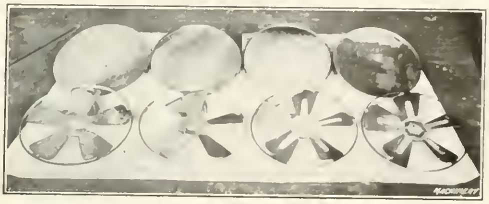
Fig. 3. Evolution of a Radiator Fan

The blanking, flanging and closing-in operations are ordinary jobs of press working. The welding operation which connects the spider with the blades of the fan is performed upon a National electric welding machine, known as a spot welder. This operation is shown in Fig. 4. A helper clamps a spider upon the fan with a simple fixture, which centers the hole in the spider with the opening in the fan and holds both parts securely in place. This being done, the welding machine operator spot-welds an arm of the spider to a corresponding blade on the fan, hands it back to the helper, who has, in the meantime, prepared another fan and spider for welding. The helper now removes the fixture from the fan and the welder completes the work on the other blades, while another fan is being placed in the fixture. There are three welds to each blade and fifteen welds to a fan. A welder and a helper will

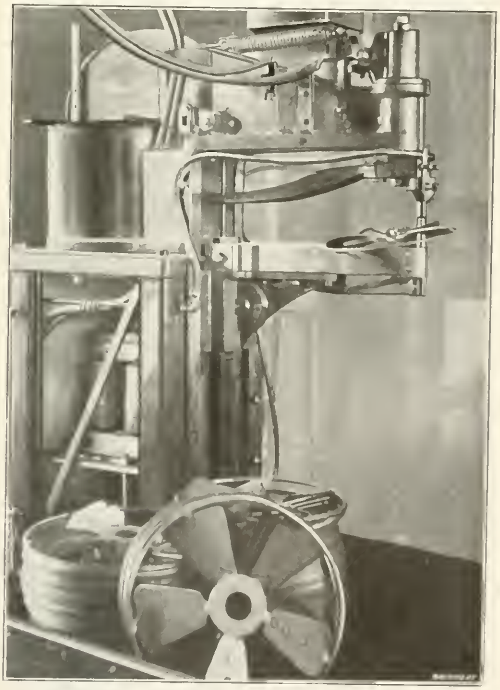
Fig. 4. Welding Fan Blades on a National Spot Welder

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* Associate Editor of MACHINERY.

turn out about 400 fans per day of ten hours, which makes a total of about 6000 welds per day. There are four of these machines in this department.

Cold Forging

A somewhat unusual branch of press work was developed and is followed to a considerable extent in this shop, *viz:* cold forging. Cold forging is the name commonly applied to the process of producing sheet metal shapes or pieces having raised bosses or projections upon their surfaces. Some typical examples of this class of work, as well as the steps followed in making them, are shown in Fig. 5. Such work requires powerful presses, the samples shown being made in a heavy, 1000 ton capacity knuckle-joint, Toledo press, which is shown in Fig. 6. Needless to say, such work requires dies that will stand this heavy pressure, and Vulcan steel is one of the steels which has proved very satisfactory for these dies. In the making of pieces of this nature, blanks are used which are oftentimes waste punchings from the production of other pieces. These pieces are struck between the dies, which, except for the depressions for forming the bosses or panels, are flat. Such being the case, the result of this cold forging operation leaves the work in the condition shown by the central pieces of each of the groups in Fig. 5. In each case, the blanks are shown to the left. All that now remains for the completion of the pieces is to run them through blanking operations to trim off the surplus metal. While there is nothing especially difficult about doing this class of work after the tools and methods are designed, it requires presses which are extremely powerful, and above all, dies which will withstand the severe work they must do.

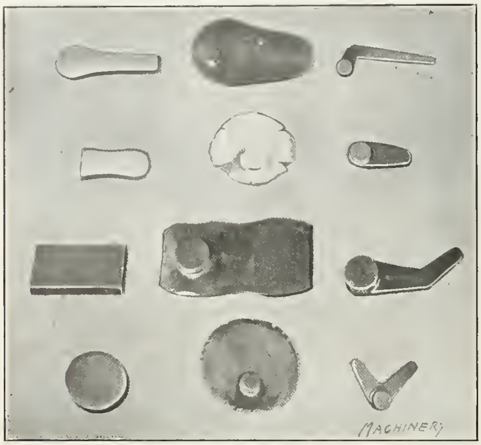


Fig. 5. Steps in making Cold-forgings

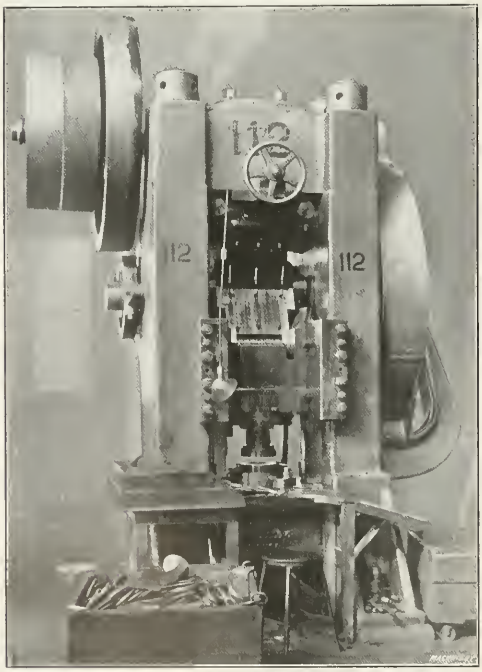


Fig. 6. Heavy Knuckle-joint Press used for Cold-forging

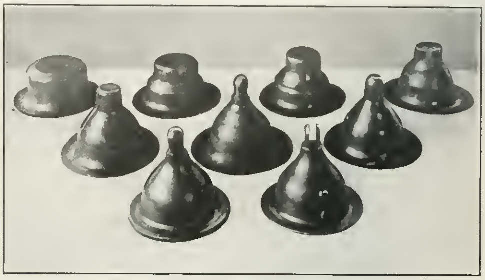


Fig. 7. Making a Difficult Stamping

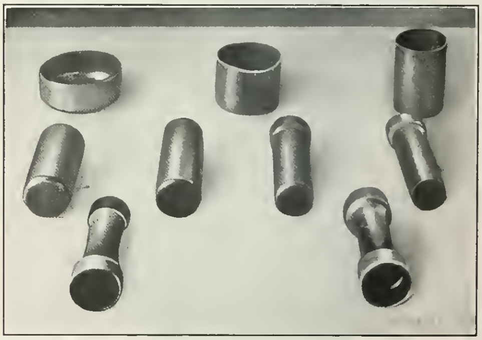


Fig. 8. An Unusual Stamping and its Evolution

Successive Steps in Forming Typical Stampings

Three sets of stampings showing the steps taken in making the respective pieces are shown in Figs. 7, 8 and 9. In Fig. 7, the piece shown is very difficult to produce, mainly on account of the small diameter of the small end. In producing this piece, the first step consists of cupping the blank, as shown at the extreme upper left-hand corner. From this blank, the stock is gradually worked toward the point to get enough metal into position to form the narrow thimble-shaped end, without enough strain being exerted upon the metal to tear it. The pierced end is, of course, the result of the final operation. The metal is kept a uniform thickness throughout.

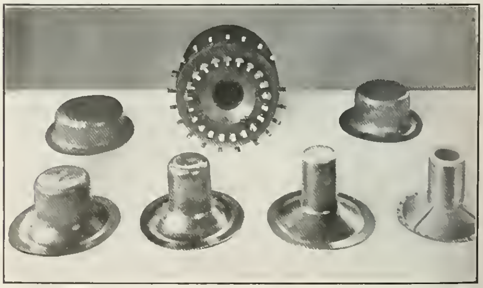


Fig. 9. Steps in Drawing a Flanged Cup and the Last Operation Punch

In Fig. 8, an unusual piece of work is shown in the making of a special steel ferrule. The difficulty in producing this ferrule lies in the fact that it must be opened out from the small end after being drawn. It takes nine operations to complete this piece, the first operation consisting in drawing the shell in the usual way, leaving a shoulder at the mouth, and the final operations consists of punching out the bottom, expanding the small end and shaping the finished piece.

In Fig. 9, six steps in making the special stamping at the right-hand lower corner are shown, together with the piercing punch used in the final operation. Up to this final operation, the work consists of plain drawing, but the last operation embraces the cutting of the central hole, the formation of the ribs on the beveled section, and the piercing of the small cuts around the edge. It will be noticed that these cuts are not round holes, but are made by a combined shearing and forming operation effected by the special punch shown in the center of the illustration. The individual punches on this tool are held in position by set-screws so that they are easily renewable if broken.

Perforating Tools

Except by those directly connected with the manufacture of telephone mouth-pieces, it is not generally known that the best type of these pieces is made with a steel core beneath a hard rubber covering. It is, of course, apparent that the strength of such a mouth-piece exceeds the solid rubber article, and, moreover, more durable threads are secured when cut in the steel core than is the case when the threads are cut directly in the rubber. For the purpose of making the rubber adhere firmly to the steel core, it is necessary that perforations be made in the metal, through which the rubber can run. Two sets of tools for this operation are shown in Figs. 10 and 11. Fig. 10 shows the simpler set in which the die is mounted within the arbor, which is shown just behind the operator's left hand. This arbor is, in turn, supported by a base which is clamped to the press bed. The punch is shown directly over the arbor which, of course, holds the die. For indexing, a spring finger, the rear end of which is shown in contact with the operator's finger, is supported by a suitable bracket from the base of the fixture. Pressure upon the end of this finger causes the gaging end to extend, and the slot previously cut in the core is turned against the end of this finger while the next slot is being punched. This operation is repeated until all six of the slots have been perforated, when the finger is released and springs back out of the way. After the completed piece has been taken from the arbor, the six pieces of scrap drop through the arbor.

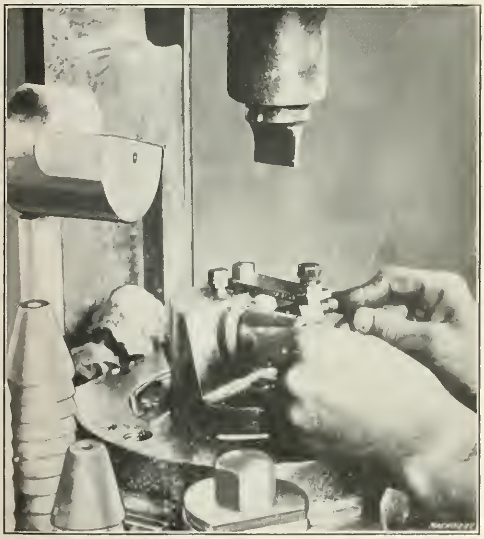


Fig. 10. A Simple Set of Perforating Tools

A second set of perforating tools is shown in Fig. 11. These tools are a little more complicated in design, but they are also more efficient and more interesting. They consist essentially of the bedplate upon which the base block of the fixture is mounted, supporting the work on the arbor, which may be seen at the center of the illustration. The punch is fitted with a spring stripper. The die, of course, is mounted in the arbor. Rotation of the work upon the arbor is secured by means of the automatic indexing mechanism, which is operated through a bracket that extends downward from the ram of the press. This bracket is fitted with adjustable button head "pushers" which reciprocate the end of the lever, one end of which appears between the pushers. This lever communicates with the indexing plate by means of a pin at its opposite end. A handwheel operates a friction disk which acts against the end of the work. When the lever is depressed, the index plate turns the work by means of a ratchet, just ⅛ of a revolution; therefore, after the press has operated continuously for eight revolutions, a new piece is put on the arbor. The latch at the extreme lower right is used to facilitate the removal of the work.

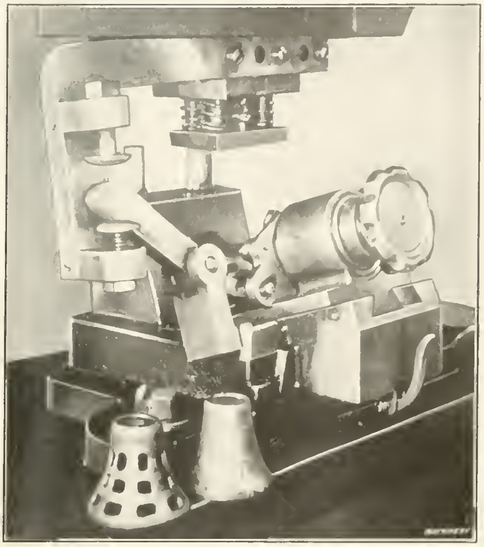


Fig. 11. Perforating Tools with Provision for automatically rotating the Work

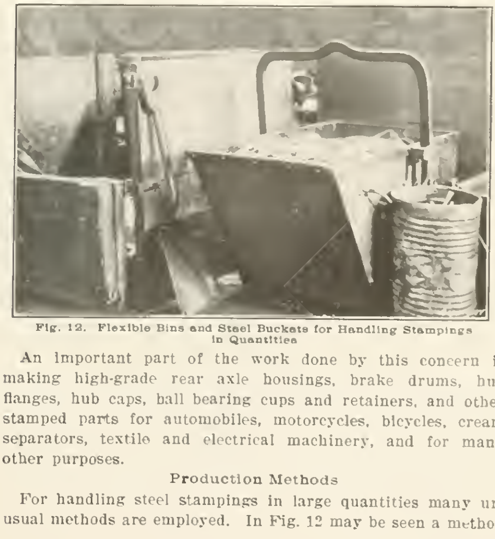


Fig. 12. Flexible Bins and Steel Buckets for Handling Stampings in Quantities

An important part of the work done by this concern is making high-grade rear axle housings, brake drums, hub flanges, hub caps, ball bearing cups and retainers, and other stamped parts for automobiles, motorcycles, bicycles, cream separators, textile and electrical machinery, and for many other purposes.

Production Methods

For handling steel stampings in large quantities many unusual methods are employed. In Fig. 12 may be seen a method of bin construction which is used for handling heavy stampings in large lots. These bins consist of sections which may be fastened together, forming a semi-flexible arrangement that may be moved to any position on the floor and expanded or contracted at will, as there is no bottom. A method of transporting work about the factory, is by means of sheet steel buckets handled by an electric traveling crane. Punchings and stampings except those which are light and easily bent, are thus treated like so much building material, being shoveled into the bucket and dumped from it in the same manner. Small cans like that shown at the right, are common to all shops for holding small quantities of work.

Power is derived from a hydro-electric plant, situated on the Connecticut River, sixty miles away. This power is carried to the factory at a tension of 23,000 volts, at about half the cost of steam power if produced by coal at the plant. All the presses are driven by individual electric motors.

Credit is due Mr. F. C. Cutler, sales manager of the above company, for cooperation with the writer in preparing this article.

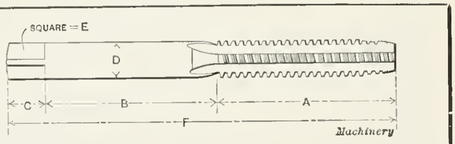
* * *

STOVE-BOLT TAPS

BY A

In the March, 1909, number of MACHINERY, an article accompanied with tables was published giving data for the making of stove-bolt taps. As is well known, there is no standard for this class of taps that has been accepted by all the different makers, and the diameters of taps made by different manufacturers vary to a great extent. The dimensions given in the upper part of the table below represent the practice of two of the more prominent tap manufacturers, the dimensions of whose stove-bolt taps agree with slight (and practically unimportant) differences. The dimensions for the pitch diameters have been obtained by measuring the taps with the ordinary type of screw thread micrometers for the standard number of threads per inch within the range of each micrometer. As the thread, however, is not a regular U. S. standard thread, but is provided with a wider flat at the bottom of the thread than that corresponding to the number of threads per inch in the taps, care had to be taken when measuring these angle diameters so that the spindle would not bear upon the flat in the bottom of the thread; in other words, the point of the spindle at *A*, in the accompanying illustration, had to be flattened sufficiently so as to clear the bottom of the threads.

TABLE OF STOVE-BOLT TAPS



Nominal Size	Actual Outside Diameter	Pitch Diameter	Root Diameter	Flat in Bottom of Thread Corresp'ding to	Flat on Top of Thread, Inches	Number of Threads Per Inch
5/32	0.166	0.1500	0.134	20 U. S.	0.0110	28
3/16	0.197	0.1745	0.152	20 U. S.	0.0094	24
7/32	0.223	0.1965	0.170	18 U. S.	0.0079	22
1/4	0.257	0.2285	0.200	11 U. S.	0.0112	18
5/16	0.317	0.2855	0.254	10 U. S.	0.0067	18
3/8	0.354	0.3165	0.279	10 U. S.	0.0067	16

Nominal Size	A	B	C	D	E	F
5/32	7/8	1 5/32	7/32	0.166	1/8	2 1/4
3/16	15/16	1 3/16	1/4	0.197	9/64	2 3/8
7/32	15/16	1 1/4	1/4	0.223	11/64	2 7/16
1/4	1	1 7/32	9/32	0.257	3/16	2 1/2
5/16	1 1/8	1 5/16	5/16	0.317	15/64	2 3/4
3/8	1 1/4	1 5/16	3/8	0.354	9/32	2 15/16

It will be seen that some of the dimensions differ from those given in the March, 1909, number. It would, of course, be desirable to the trade if all the tap manufacturers could agree upon one standard, and it is believed that the table given herewith represents the practice to which probably the largest proportion of this class of taps conform. The thread has an angle of 60 degrees, with an arbitrary flat on the top, and a flat at the bottom corresponding to that of the standard U. S. thread for pitches coarser than the actual number of threads per inch in the tap. Hence the taps can be cut with regular U. S. standard thread tools selected for a coarser pitch than that of the thread to be cut. For example, when cutting the thread in a 3/16 inch stove-bolt tap, the lathe is geared to cut 24 threads per inch, but a threading tool for 20 U. S. standard threads per inch is used. It is of considerable advantage to settle upon a width at the bottom of the thread that corresponds to certain U. S. standard threads, because the expense and trouble connected with making special thread tools for these taps is thus avoided. As was mentioned in the previous article referred to, stove-bolt taps are made considerably larger in diameter than is the diameter of the screw, so that the nuts have a loose fit—a fit, in fact, that would not be tolerated for regular U. S. standard bolts and nuts. All taps of this kind have four flutes.

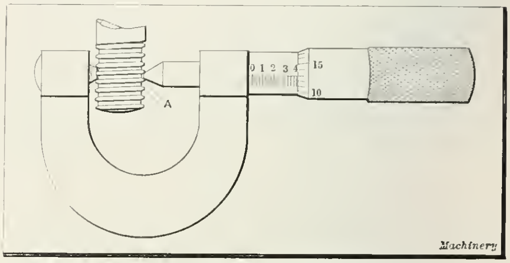


Illustration showing Modification of Point of Measuring Screw of Thread Micrometer for measuring Threads with Very Wide Flat at Bottom

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THERMO-ELECTRIC METHOD FOR TESTING THE STRENGTH OF MATERIALS

An interesting development in the testing of the strength of materials is that known as the thermo-electric method. It has been found that a bar of a given material, upon being subjected to a tensile stress, will absorb heat as long as the stress does not exceed the elastic limit of the material, but that beyond this limit heat will be generated by the friction of the particles sliding over each other. The observations are made by thermo-electric couples, the terminals of which are connected to a sensitive galvanometer. The elastic limit of the material is recognized by the reversal in the temperature curves, presuming, of course, that the temperature indication does not lag behind the stress to which the material is subjected. The extended experiments undertaken by Messrs. T. R. Lawson and J. A. Capp of Schenectady, N. Y., as recorded in a paper before the International Association for Testing Materials, at its congress, September, 1912, indicate, however, that the break in the thermo curve invariably occurs at a higher stress than the elastic limit, as shown by the extensometer.

* * *

FOURTH DIMENSION SPACE ANALYSIS

In a paper on the "fourth dimension" published in the *Polytechnic Engineer* for 1912, William J. Berry mentions a practical use for the mathematical analysis developed to prove the existence of four-dimensional space as follows: "The problem of motion in three-space is stated in terms of four variables—three for space and one for time. Now it is a well-known fact that the analogous problem in two-space may frequently be simplified by regarding it as a geometrical problem in three-space. The suggestion of a geometry of four dimensions to perform a like service for the problem of motion in three is inevitable. This is what makes four-dimension space analysis important, and is, in a large measure, the justification for its study."

THE MECHANICAL TESTING OF FILES[*]

THE DEMAND FOR STANDARD MECHANICAL TESTS AND TEST METHODS

BY GEORGE W. BURLEY[†]

The association of standard test specifications with the purchase of engineering materials and tools is a distinctly modern condition, though in certain outstanding cases, engineering materials have been purchased subject to their satisfactorily passing prescribed tests (more or less standard) for a considerable time. At present, however, it is an almost universal practice to demand standard tests on materials and tools where variations can exist in composition, design, construction, or manufacture. Practically nothing is left to chance, and any material or tool which does not excel, or at least equal the test standard, is rejected; if such material or tool represents a sample of any given quantity, the entire quantity is likewise condemned and rejected. The matter of a standard test is a most important one when viewed in connection with large contracts, as the acceptance of large quantities of materials or tools, which are not of the best quality obtainable at the purchasing price, is a source of loss that every progressive management seeks to eliminate. For this reason, the requirements of some commercial engineering departments are very stringent, though considering modern demands and needs, it cannot be said that they are anything but fair.

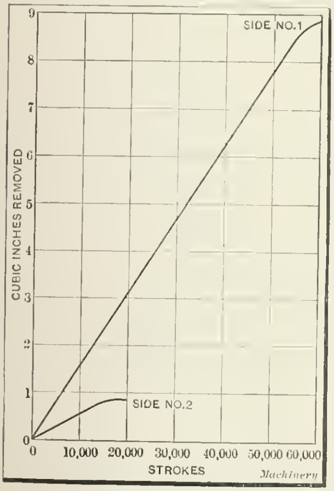

Fig. 1. Difference of 11 : 1 between Durability of the Two Sides of a File

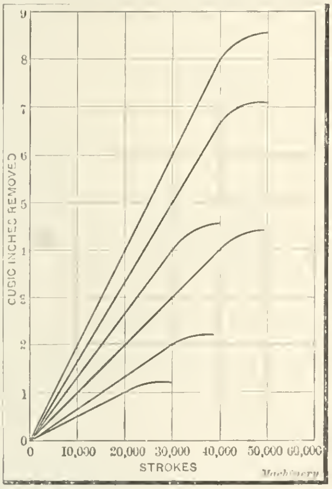

Fig 2. Typical Curves obtained from File Testing Machine Recorder

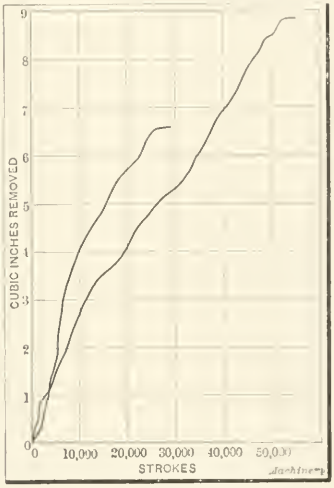

Fig. 3. Abnormal Curves showing no Dependence upon an Operating Law

Of the latest engineering materials and tools to come within the scope of standard commercial tests, one of the most important is the ordinary file, of which it is no exaggeration to say that tens of thousands are made, used, and worn out every year. Now in every file-manufacturing works, it has been the practice to test each file for sharpness by means of a "prover" before it is passed. A prover is nothing more nor less than a short piece of comparatively soft steel which is drawn over the face of the file by hand. If the prover drags as it is being drawn over the face of the file, the latter is passed; whilst if it slips too easily, it shows that the file is not cutting properly, and such files are rejected. This method of testing files, which in the hands of an experienced operator may produce fairly reliable results, is not entirely satisfactory because it depends too much upon the judgment of the workman for its results. Everyone knows that personal judgment is a variable quantity, and likely, therefore, to lead to variable results. In engineering works where files are used, the old-fashioned method of testing files—and one still in vogue in quite a large number of such establishments—consists of distributing files of the brands that are to be compared among a number of reliable workmen, with the order to try them on the materials ordinarily worked on in the shops and report as to the order of merit of the different brands. These reports express each man's judgment and form the basis of the decision of the purchasing department as to the brand to be finally selected when issuing orders for the files. This is not, however, a very reliable method of testing files, as it is a notorious fact that workmen can become so accustomed to the use of one brand of file, that even when called upon to choose between two or more brands, they will select the brand that they are used to—which they discover in some subtle manner—whether, in their honest opinion, that brand is better than the others or not. This is, of course, evidence of the conservatism of man.

Early History of Mechanical File Testing

Until the advent of the mechanical method of testing files embodied in the Herbert file-testing machine some five or six years ago, the above methods—each in its own sphere—were regarded as being the only two methods of testing files which were available—though a mechanical file tester has existed in a very crude form for something like twenty years. Mechanical file-testing can be adopted by both file manufacturers and file users—the former for the purpose of improving the cutting and wearing qualities of their products: the latter for the purpose of comparing files of different brands and also files of any one brand against the standard, in their effort to get the best that are available at the price.

The history of the mechanical testing of files, although so brief, is one in which conservatism and opposing interests have played a very large part. It is certain, however, that every manufacturer of high-grade files is now quite prepared to allow his products to be submitted to a mechanical test, provided the conditions of the test command his complete confidence. On the other hand, it is quite as certain that he will not willingly submit his products to a test in which he believes there is a considerable element of doubt as to the fairness and accuracy of the results. Consequently, it is of the utmost importance that the file test imposed should be one which commands the confidence of every one concerned—whether file manufacturer or file user. Care should be taken in applying the test to see that uniform conditions are maintained, and that the truth respecting any file is not masked by outside influences brought to bear on the machine or test. The Herbert file-testing machine was described in detail in the

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[*] For further information on file making and file testing, see "Manufacturing The Vixen File," September, 1912, and other articles there referred to.

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December, 1907, issue of MACHINERY. The results of tests made with this machine have been subjected to a tremendous amount of both favorable and adverse comment, on the part of file manufacturers and file users alike, though more especially the former. The reason why file manufacturers were and in many cases are still opposed to the use of the Herbert file-testing machine, for the purpose of determining the cutting qualities of their files and comparing them with a standard, has been because many of the results forthcoming were inexplicable and appeared to be contradictory. Thus, files which both manufacturers and users have regarded as being of the very best quality have given extremely poor results in the Herbert file-testing machine. In many cases, great differences in cutting power and durability are reported to have been discovered, by means of this machine, between the two sides of one and the same file. Similarly, files of the same grade and make have shown great variation, even when the utmost care has been taken in the process of manufacture to eliminate differences and to produce files similar in every respect. According to tests made on this machine, differences between the two sides of a file as great as 30:1 have been reported, while a difference of from 4:1 to 10:1 is by no means uncommon, even amongst the very best brands of files. Fig. 1 shows a difference of 11:1. Under ordinary circumstances of manufacture, it is not feasible to suppose that such huge differences can possibly exist, and it is these extraordinary results that have shaken the confidence of file manufacturers in the reliability of the results produced by file-testing machines.

There is, however, a real demand for a mechanical file test, notwithstanding the opposition of file manufacturers and others. The file-testing machine, in one form or another, has come to stay, and it will sooner or later be recognized as a necessity in the domain of engineering testing, where it will be used in connection with all large contracts for files. With this idea in mind, the subject of mechanical file-testing has been investigated during the past three or four years by Dr. W. Ripper and the writer in the laboratories of the Applied Science Department of the University of Sheffield, where a Herbert file-testing machine has been installed and thoroughly examined, together with the results which have been obtained from it. The method of procedure followed with this machine is briefly given: The file to be tested is held rigidly between two headstocks, which are carried on a reciprocating table. The test bar is supported on grooved rollers, in a horizontal position normal to the direction of motion of the table and file, and is pressed against the face of the file by means of a rope and weight. The movement of the file over the end of the bar causes a portion of the metal to be removed at each cutting stroke, the amount depending upon the composition of the material of the bar and the cutting power of the file under test. The file cuts on the forward stroke only. At the end of this stroke, the bar is drawn a short distance from the file by means of a clutch mechanism. This condition is maintained throughout the backward stroke, at the end of which the bar is released and allowed to come again into contact with the face of the file. The pressure of contact is 30 pounds per square inch, since the cross-sectional area of the bar is one square inch and the weight is one of 30 pounds. This pressure is maintained throughout the cutting stroke, the length of which can be varied to suit the conditions. To prevent chattering and jarring, and undue deflection of the file, heavy weights are supported on a rest which is carried by one of the reciprocating headstocks, these weights pressing on the back of the file. A recording apparatus is attached to the machine, the number of cutting strokes made and the number of cubic inches of the bar filed away, up to any time after the beginning of the test, being instantly obtainable from the curve which is automatically produced.

Cause of Errors in Mechanical File Tests

The early experiences of Dr. Ripper and the writer led them to believe that this machine possessed one or two defects, to determine the exact character of which, repeated and extended experiments were made. In the first series of experiments, only the best files of well-known makers were tested, the object being to eliminate, as far as possible, all outside influences upon the results of the tests. The results of the tests were quite normal in some cases, but in the majority of the cases, extraordinary and unaccountable differences of effectiveness or cutting power appeared to exist, both between files of the same batch and between the two sides of the same file. On examining the diagrams obtained from the machine during the tests, and also diagrams obtained from other machines, it was impossible to fail to notice at least two points in regard to their unusual character. The first point to be observed was the peculiar shape of each curve, this giving no evidence of the existence of an operating law. Two general forms of diagram or curve were discovered. The first, examples of which are shown in Fig. 2, is the more usual; the lower section is practically a straight inclined line, with a very slight curve at its upper end turning it into the horizontal. The other form is a zigzag line, examples of which are represented in Fig. 3; these diagrams show no signs of regularity and appear to contradict every mechanical law likely to operate in such a case as this. The second point to be observed was the great apparent difference in cutting capacities, which were found by means of this machine to exist between files belonging to the same batch, and between the two sides of the same file. In regard to the first point, we shall have to consider the nature of the file, and

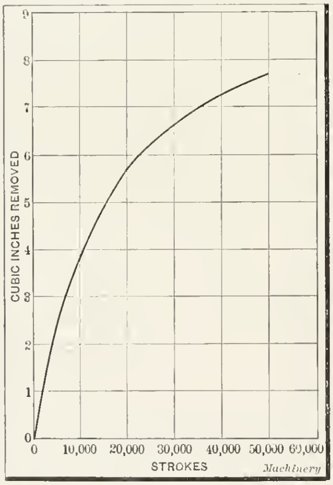


Fig. 4. Diagram showing Gradual Blunting of Files

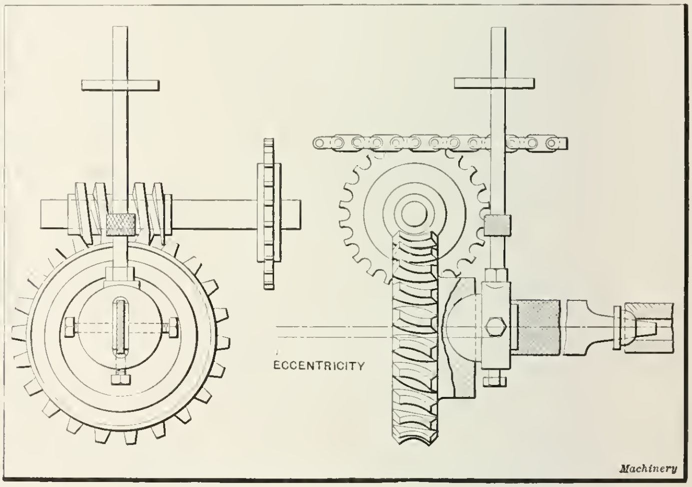


Fig. 5. Mechanism for changing Relative Position of File and Work

the action of the machine upon it, to discover whether such curves are reasonable or not. In some quarters, the file is regarded as a cutting tool which works on the wedge principle, though in essence, its action is more like that of a scraper. Its teeth are small projections, which in the case of a new file, should have sharp edges. These teeth are capable of being pressed more or less into the end of the test bar under the influence of the weight of 30 pounds. The initial cutting capacities of these teeth depend almost entirely—other things being equal—upon their sharpness, and the depth that they are caused to penetrate in the end of the bar. From the very beginning of the test, the influence of the bar upon the teeth of the file is in the direction of blunting them, so that as the test proceeds, the teeth become blunter and blunter. Accompanying this condition, there is a reduction in the depth of penetration of the teeth in the bar, although the pressure upon the file per square inch of bar surface remains constant. This reduction is due to the increase in the area of the flats on the teeth.

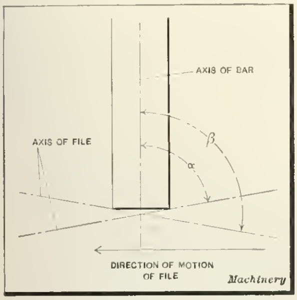


Fig. 6. Diagram showing Influence of Position of File on its Ability to cut

From the foregoing, it would seem to be fairly obvious that as the test proceeds, the rate of cutting should show signs of falling off, this being indicated in the diagram Fig. 4 by a curve, having a tangential tendency towards the horizontal which increases as the test proceeds. Under these circumstances, it is almost impossible to conceive the teeth of such a tool as the file retaining their original sharpness until the end of the test is nearly reached, and then suddenly ceasing to cut without any intermediate condition of cumulative bluntness. The irregular curves appear to be entirely beyond the ingenuity of man to explain in any reasonable and acceptable manner. In the course of the experiments already referred to, it was discovered that the cutting power of the side of a file, as indicated on the chart of the machine, was affected in no inconsiderable manner by the position of the file between the headstock, and by the relation of the axis of the file to the axis of the test bar. Thus, in practically every case which came under the notice of the writer in making these tests, the file would not cut at all if it was presented to the bar so that the angle between the axes of the file and the test bar on the leading side of the latter, as indicated by β in Fig. 6, was greater than 90 degrees; if the angle was reduced so as to be less than 90 degrees, as shown at α in Fig. 6, it would generally commence to cut. It was also discovered that the exact value of the angle between the two axes determined the rate of cutting, to a certain extent, the angle corresponding to the best position of cutting for one file not, necessarily, being the same as the corresponding angle for another file, although in most of the cases the differences were very slight. These differences, however, were sufficient to affect the results materially. It was found that the limiting angular positions of the file, for maximum cutting powers, were those in which the point end of the file axis was 1/32 inch and 5/32 inch, respectively, beyond the heel end, these measurements being made in a direction parallel to the axis of the bar and normal to the direction of motion of the file.

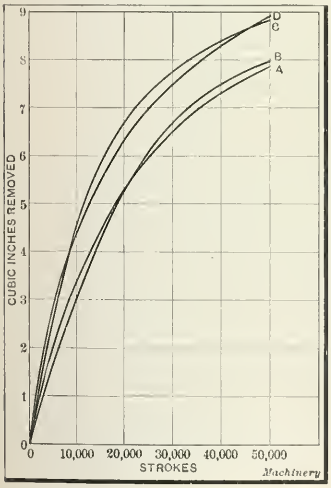


Fig. 7. Curves for Sides of Two Files of the Same Make

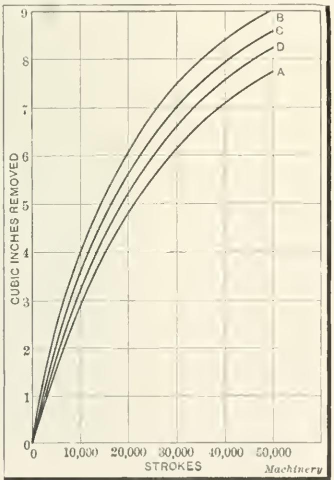


Fig. 8. Curves for Sides of Two Files that are all of the Same General Order

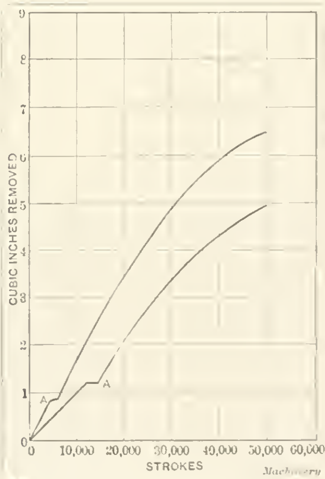


Fig. 9. Effect of changing Position on Durability of File

From a consideration of this subject, it will be seen at once that since there is such a wide diversity, it is impossible to select the best cutting position of the file in any particular case; it can only be accomplished by sheer accident. This partly accounts for the wide apparent differences in the cutting capabilities of approximately equal files. As the result of a further examination of the machine, it appeared that the mechanical action differed materially from the action of hand filing. The machine, as originally designed, holds the file so rigidly that it moves across the end of the test bar in an absolutely constant and unchanging path, while in the case of hand filing, the path of the file is changed more or less at every stroke. Therefore, the conditions of a mechanical test made on this machine differ from those which obtain when the file is used in actual practice, the result of maintaining a constant direction of motion being the formation of grooves in the end of the bar, the glazing of the face of the file, and the refusal of the latter to cut, even though it may not be worn out. To eliminate these defects in the action of the machine, Dr. Ripper and the writer designed and constructed a mechanism which, when added to the machine, removes the condition of constancy in the direction of motion of the file and its attendant influence upon the results, and causes the file to pass through a number of different angular positions with respect to the test bar, between the two extreme best cutting positions for all files as referred to above. At the same time, files of the same kind and size are treated in exactly the same way, so that the conditions of the test are maintained constant. By this means, the grooving of the end of the test bar by the teeth of the file is prevented, and each file is caused to give an average result for all the positions occupied. There are forty-eight of these positions in a complete cycle; at least one of these, and in the majority of cases two, is the best cutting position. The result obtained by the improved machine is the average cutting power of the file, and not its best or worst cutting power. Thus the results of all tests when this mechanism is used—provided, of course, that the other conditions of the test are maintained constant—are comparable with each other.

Mechanism of the Improved File Testing Machine

The mechanism by means of which this movement of the file is accomplished, is shown in Fig. 5. It consists of two ball-and-socket connections between the two ends of the file and the headstocks. The socket at the heel and tang end of the file is fixed in its headstock, while the other socket is arranged so that its center has a slight rotary movement, which is transmitted through the ball to the point end of the file. In this circular path, there are forty-eight different positions which are equally spaced, and these positions are occupied by the point end of the file during successive cutting strokes. The radius of the circular movement at this end of the file is 1/16 inch. The rotating socket is formed in the boss of a worm-wheel, which is mounted on the headstock, but set eccentric with it, as shown, the eccentricity being 1/16 inch. The worm-wheel is driven by a worm that is mounted on a plain shaft, the outer end of which carries a free sprocket wheel. The chain which meshes with this wheel is fastened to two fixed points on the frame of the machine. By this means, the sprocket wheel, having the same reciprocating motion as the table and file, is caused to rotate through its engagement with the fixed chain. This rotation is transmitted to the worm-wheel and ball-socket during the return or non-cutting stroke. During the cutting stroke, the sprocket wheel is traveling in the other direction and rotates quite freely on its hub, which is keyed to the worm-shaft; during this stroke the worm-wheel and socket are stationary, and the position of the file is not changed. Consequently, a change in the position of the file is made for each double stroke, and during each cutting stroke the file is presented to the end of the bar in a slightly different position from that occupied by it during the preceding strokes. There are forty-eight different positions in a complete cycle and the time required to complete a cycle is just under one minute, since the machine makes fifty double strokes per minute in its original form.

The point of the file is secured in the ball-holder by means of four set-screws and two small steel wedges. One of these set-screws is extended and attached to a bent arm, which rests on the reciprocating table and travels with it. This prevents the file from rotating on its own axis, as it would have a tendency to do if secured too firmly between the two headstocks. The wedges were found necessary to bring the point of the file exactly in the middle of the slot in the face of the ball. The tang of the file is inserted in a small ball holder which rests in the cupped end of adjusting screw of the headstock. This screw is longer than the one which is usually supplied with the machine, an additional nut being used on the other side of the headstock boss to get delicate adjustment of the file between the two headstocks. For files of different lengths, eccentricities of different amounts may be used, but this is hardly necessary—though some regard it so—because, in practice, it is not generally required to compare files of different lengths, so much as different files of the same length and grade. If desired, the pitch of the worm and wheel could be made different from that selected in connection with the original design, so as to obtain a cycle of positions of greater or less duration than one minute. It should be observed that the face of the file presented to the bar is not, except in two positions at the most, vertical; these two are the extreme inner and outer positions. In all other positions, the face of the file is more or less inclined to the vertical, the inclination being in one direction for half of the positions and in the other direction for the other half.

Conclusion Drawn from Carefully Conducted Mechanical Tests

A very large number of tests have been made with this apparatus on all makes and sizes of files. The majority of the results have shown that the defects found in files by the ordinary method of testing do not exist, while in no case do they exist to anything like the same extent that the ordinary test results suggest. The curves obtained by means of this apparatus are of the general character of the representative standard curve shown in Fig. 4. They show the gradual reduction in the cutting capabilities of files during the progress of the test, which can reasonably be expected. Figs. 7 and 8 show representative curves obtained by this method. The curves *A* and *B*, in each figure, represent the two sides of one file, the curves *C* and *D* representing those of another file of the same make. The two figures represent two different makes. It will be observed in Fig. 7 that there is very little difference between the two sides of each file, in a test whose length is 50,000 strokes, although it will be seen that in neither case are the two curves of exactly the same order, since they intersect, the first in one place, and the second in two. In Fig. 8, all the curves are of somewhat the same order there being no intersection of the pairs. There is, however, a greater difference between curves *A* and *B* than between curves *C* and *D*, based on a test of 50,000 strokes. On the other hand, the difference between the two files represented by Fig. 7 is greater than that represented in Fig. 8.

The results of tests extending over a very long period indicate that such differences as 30 to 1, or 10 to 1, or even 4 to 1 do not exist. The ratios commonly found range from 1 to 1 to 1.20 to 1. Other experiments with this method of testing have produced results which show conclusively that, in the case of a new file, every one of the forty-eight positions of the file has a corresponding cutting power. This cutting power is usually different for each position, so that the test invariably gives an average result, which is a much fairer result than any other. A number of experiments have also been made to determine the effect of the application of this varying position principle in cases where, according to the ordinary test, files were worn out—that is, had ceased to cut in the machine. The result was conclusive in every case; at the same time, it was astounding. Fig. 9 represents the results graphically. In the case of each curve, the point *A* is the break-down point, where, in the ordinary test, the file ceases to cut. By putting the position-changing apparatus into action, each side was caused to start cutting, and to continue cutting so that the file did not actually give out at the end of 50,000 strokes. From the results of many tests, of which the above are samples, it is felt that this apparatus supplies a much needed element to the test, and enables both file manufacturers and users to repose greater confidence in the results of the tests than has hitherto been the case.

In conclusion, and as an apposite addendum to the above, it may be pointed out that the exact chemical composition and physical properties of the test bar have a considerable influence upon the results of the tests. As there does not appear to be a test bar which is universally recognized and employed as *the* standard, it cannot be said that the conditions of file-testing are in a very healthy state. To demonstrate the fact that the influence of the physical properties of the test bar is no inconsiderable factor in the problem of file-testing, some tests were made with two similar files from the same batch on two test bars, one having a Brinell hardness numeral of 241 and the other of 186. Each file made 20,000 strokes, in which only 2.75 cubic inches of the hard bar was removed by one as against 6.25 cubic inches of the other. This is conclusive evidence that for a *standard* test there should be a *standard* test bar.

* * *

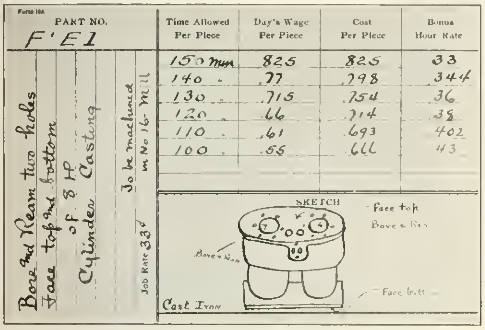
Near the old sun temple at Baalbec, in Syria, there is an enormous cut stone, probably the largest cut and finished piece of stone in the world. It is about 72 feet long, 13 feet wide, and 16.5 feet high. It is believed that the stone was intended for the sun temple which is now in ruins. There are still in the heavy walls of this temple stones of similar dimensions. Several that have been measured are about 66 feet long. These stones are placed in the wall at a height of nearly 20 feet above the ground. No indication of mortar can be detected, but the stones are so carefully cut and polished on the surface that it is only with difficulty that the joints can be detected. In fact they join so closely that a thin knife edge will not enter between them. How these blocks of stone could be lifted to such a height, and how buildings of this type could be erected, is one of the secrets of a past age of engineering.

SOME GOOD RESULTS OBTAINED BY THE BONUS PLAN

BY W. L. MYLES[*]

Much has been said and written regarding the advantages and disadvantages to both employer and employe of the bonus or premium plan of pay. Men who have given this plan a fair trial have attributed credit to it for obtaining lower manufacturing costs and higher factory efficiency for the employer, and higher wages for the employe. On the other hand, the bonus plan has been subjected to some hard criticism, principally by those who have never seen it in operation, or by those who are entirely unacquainted with its fundamental principles and ability to produce results.

Speaking from an experience of five years with the bonus plan, the writer believes that it is one of the best systems, if not the best system, now in vogue, for justly compensating the workman for the extra effort he puts forth. This plan is also instrumental in obtaining those results so earnestly sought by the manufacturer or employer, *viz:* lower costs and greater efficiency of production. One of the advantages of the bonus plan is that it justly rewards the mechanic for extra effort; it creates a spirit of cooperation which would not exist under other conditions, and lifts the mechanic and the shop to a higher plane of efficiency. This will amply repay the employer for its installation. Under the bonus plan, the mechanic realizes that the management is interested in him, and he knows that if he gives an honest day's work he will receive an honest day's pay. The amount of that day's pay is entirely in his own hands, for the more work he turns out in a given time, the more pay he receives. This system teaches him that the ability to turn out more work in a day does not require a greater amount of physical exertion, but less, for by following the methods outlined on his instruction card, he uses a little more brain energy and less physical energy to produce the same amount of work. Some of the critics of this system have claimed that it is unfair to the mechanic, as it makes a mechanical tool out of him, rendering him an object for the scrap pile in a short time. It has been proved, however, to the satisfaction of these critics, that this is entirely wrong. The tendency of this system is to awaken the mechanic out of that dreamy mechanical state in which many of our workmen are today, into new, energetic men; for, in order to earn their bonuses, they realize that they have to use their brains and hands at the same time, thereby avoiding many mistakes and accidents. The reward of extra compensation is sufficient to repay the mechanic for his extra effort which, in a great majority of cases, is but a matter of giving a little more thought and attention to his work, reducing instead of increasing the physical effort formerly employed. It is a known fact that 90 per cent of the workmen of this country are accomplishing less than 60 per cent of what they might do without physical injury or over-exertion.



Form 104

PART NO. F'E1

Bore and Ream two holes
Face top and bottom
of 8 HP
Cylinder Casting

To be machined on No 16- Mill

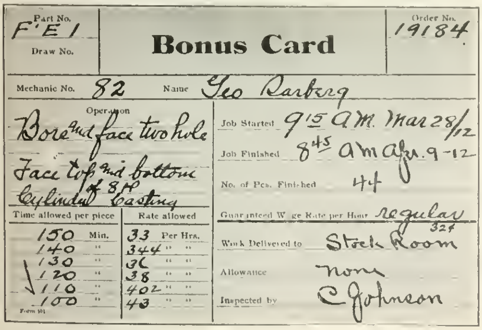
Job Rate 33¢

Time Allowed Per Piece	Day's Wage Per Piece	Cost Per Piece	Bonus Hour Rate
150 min	825	825	33
140 "	.77	.798	344
130 "	.715	.754	36
120 "	.66	.714	38
110 "	.61	.693	402
100 "	.55	.666	43

SKETCH

Face top
Bore & Ream
Bore & Ream
Face bott
Cast Iron

Fig. 1. Rate Card, showing Time allowed per Piece and Rate paid per Hour—4 by 6 inches



Part No. F'E1	Order No. 19184
Draw No.	

Bonus Card

Mechanic No. 82 Name Geo Sarberg

Operation
Bore and face two hole
Face top and bottom
of 8 HP
Cylinder Casting

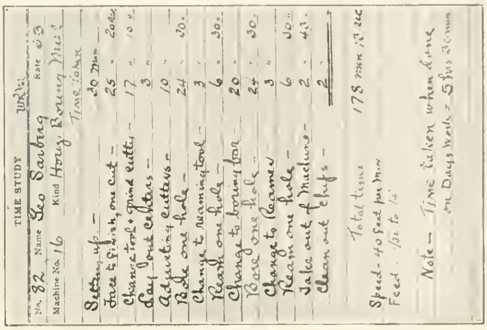
Time allowed per piece		Rate allowed	
150	Min.	33	Per Hrs.
140	"	344	" "
130	"	36	" "
120	"	38	" "
110	"	402	" "
100	"	43	" "

Form 101

Job Started 9¹⁵ A.M. Mar 28/12
Job Finished 8⁴⁵ A.M. Apr. 9-12
No. of Pcs. Finished 44
Guaranteed Wage Rate per Hour regular 32¢
Work Delivered to Stock Room
Allowance none
Inspected by C Johnson

Fig. 3. Bonus Card, showing Time allowed per Piece, Rate per Hour, and what Operations to perform—4 by 6 inches

Under the bonus system, in one shop the writer has in mind, the men are doing 40 per cent more work with about 25 per cent less physical effort. Why is this? Partly because the management has standardized the tools and equipment, and provided the mechanics with instruction cards which show exactly how the work should be done, thus eliminating many unnecessary moves. But it is mainly because the bonus offered is large enough to supply the needed incentive. Many have asked the question, "Do the majority of those working under the bonus plan earn bonuses, or is it only those who are most rapid and experienced in their particular line?" The writer can readily answer this question by referring to a chart kept by him, which shows the percentage of each class of workmen that earned bonuses. For the first three months of the present year, over 75 per cent of the men earned bonuses which gave them an average increase of 8.5 cents per hour, or about 30 per cent higher wages. Through the opportunities offered by this system for men to show their ability in mechanical lines, laborers and helpers have turned out to be good mechanics, and mechanics have become functional foremen, thereby increasing their earning power and adding materially to the efficiency of the plant.



TIME STUDY

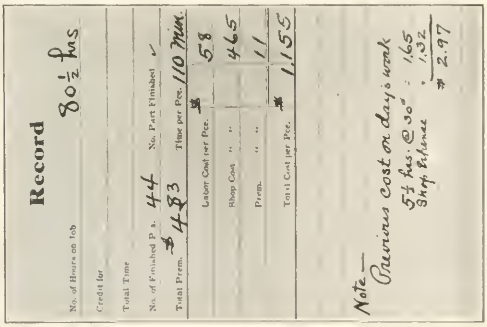
No. 82 Name Geo Sarberg Rate 33
Machine No. 16 Kind Horiz. Boring Mill

	Time taken	
Setting up —	30 min	
Face to finish, one cut —	25 "	20c
Change tool & grind cutter —	17 "	10 "
Lay out centers —	3 "	
Adjusting cutters —	10 "	
Bore one hole —	24 "	30c
Change to reaming tool —	3 "	
Ream one hole —	6 "	30c
Change to boring bar —	20 "	
Bore one hole —	24 "	30c
Change to Reamer —	3 "	
Ream one hole —	6 "	30"
Take out of machine —	2 "	43.
Clean out chips —	2 "	
Total time	178 min [illegible]	

Speed - 40 feet per min
Feed . 1/32 to 1/4

Note — Time taken when done on Days work = 5 hrs 30 min

Fig. 2. Detailed Record of Results of a Typical Time Study, on Back of Rate Card



Record 80½ hrs

No. of Hours on Job
Credit for
Total Time
No. of Finished Pcs. 44 No. Part Finished ✓
Total Prem. $4.83 Time per Pce. 110 min.
Labor Cost per Pce. $ .58
Shop Cost " " .465
Prem. " " .11
Total Cost per Pce. $1.155

Note — Previous cost on day's work
5½ hrs. @ 30¢ = 1.65
Shop Expense = 1.32
$2.97

Fig. 4. Cost Record of the Operation, on Back of Card, filed for Future Reference

The following is a general outline of the procedure followed in making time studies, setting rates, and issuing bonus cards, together with forms used by one of the leading manufacturing concerns of New Jersey, which has operated this plan successfully for some years. In order to correctly set a time and price on a piece of work, it is necessary to know each operation and move needed to complete the work in the shortest and best way. When a job is to be put on bonus, a detailed time study is made; the machine best suited for the operation is next decided upon, correct tools are supplied, and belts and equipment are brought up to proper speed. Each operation is timed separately with a stop watch; then an overall time is taken to verify it, a fair amount of time being allowed for grinding tools, etc. Fig. 1 shows a form of rate card, giving the time allowed per piece and the rate paid per hour. On the back of the rate card, there is a record of the detailed time study. It will be seen that decreasing the time per piece increases the rate paid per hour. After the time study is complete, a bonus card is issued to the mechanic to start with the work. This form includes the time allowed per piece and the rate paid per hour, also what operations to perform, the time of starting and finishing job, the part number, etc. A cost record of the operation is kept on the back of the bonus card, which is filed away for future reference.

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[*] Address: 172 Whiton St., Jersey City, N. J.

The men are guaranteed their regular day's pay, whether they make the pieces in the allotted time or not. When the job is finished, the time of finishing is stamped on the card and the number of pieces is recorded; the card is then taken to the foreman, who verifies the number of pieces and inspects the work, if no regular inspector is employed. The finishing time of the last job is always the starting time of the next job, except where special time is allowed for repairs or some other necessary work, other than the general up-keep of the machine. This eliminates a large amount of time that was formerly lost between jobs, when done under the old day-work system. The foreman's task of answering a lot of unnecessary questions, and standing over a man in order to keep him at work is reduced 50 per cent, as the instruction card states plainly what is to be done and all other information that is required on the job. Needless to say, the men working under the bonus system require no watching; all their time and attention is required for their work, if they wish to earn their bonuses.

Some of the results obtained by working men on the bonus plan of pay can be summed up as follows: Higher wages and greater efficiency for the mechanic. A reduction of the number of accidents, for many an accident is caused by inattention to work. A method of showing the foremen who are the non-producers or "deadheads" in their departments. A reduction of the "overhead" expenses of the plant. Simplification of the method of keeping costs and the production of far more accurate cost records. A reduction in the cost of manufacturing, and a marked increase in output. In general, the bonus plan benefits all parties concerned and compensates the mechanic as no other system can. For the greater effort put forth by both employer and employe, a material increase in efficiency is seen throughout the whole plant, and in addition, there is that spirit of coöperation between both parties that is so essential to a successful business.

* * *

IMPROVED TYPE OF COUPLING BOLTS

A recent number of *Page's Weekly* describes a practical type of coupling bolt which was designed to do away with the difficulty experienced in extracting the bolts when it is necessary to disconnect a shaft. The advantage of such a design will be apparent to any sea-going engineer who has had experience with broken shafts at sea. According to the writer the corrosive action of salt water upon ordinary steel is such that he has known it to take a week to get out twenty-four three-inch bolts, while the same work can be done in an hour where the improved type is in use. Figs. 2 and 3 show cross-section views of coupling flanges connected with the old style bolts. These two types are identical, with the exception that a head is provided on the bolt shown in Fig. 2, while the type shown in Fig. 3 depends entirely upon the taper for holding it in the flange. Both of these bolts are made of steel. Fig. 1 shows the improved type of bolt previously referred to. In this case it will be seen that the regular nut is provided at one end for tightening the bolt, while a similar nut is provided at the opposite end for drawing the bolt when it becomes necessary to disconnect the shaft. The nut *B* used to tighten the bolt, is best made of "Delta" metal or some similar tenacious metal of a non-corrosive nature, and washer *C* is of similar material. The nut *D* used for starting the bolt is made of non-corrosive "Sceptre" bronze with a washer of similar material. Before putting the bolt in place, it is thoroughly coated with a mixture of flake graphite and castor oil which further protects from corrosion.

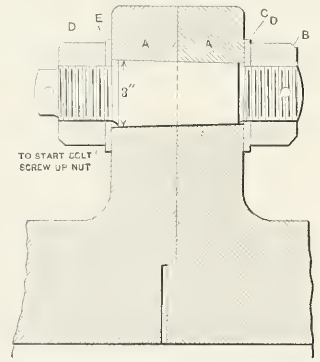

Fig. 1. New Style Bolt with Second Nut for Starting

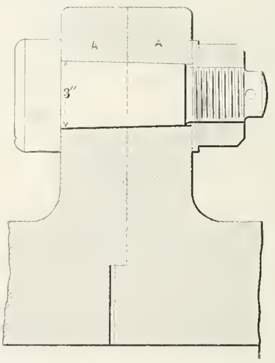

Fig. 2. Old Style of Bolt shown in Fig. 3, with a Steel Head

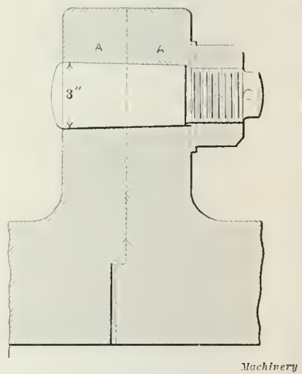

Fig. 3. Old Style Bolt with Steel Nut, Washer and Pin

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"EXPLOSION-PROOF" ELECTRIC MOTORS

The United States Bureau of Mines, Washington, D. C., has issued a bulletin (No. 46) regarding the results of an investigation of explosion-proof electric motors. The term "explosion-proof" as applied to an electric motor refers to a motor enclosed by a casing so constructed that an explosion of a mixture of mine gas (methane) and air within the casing, will not ignite a mixture of the same gas surrounding the motor. There are two classes of motors so constructed: First a class totally enclosed and built strong enough to withstand internal explosion pressures and so designed that the efficiency of all the enclosing covers can be satisfactorily maintained; second, a class provided with relief openings or valves designed to cool any products of combustion discharged through the valves. The results of tests are given in detail in the bulletin. These tests are of interest to other than mine operators, as explosion-proof motors are desirable in situations such as flour mills and other plants in which explosive gases incident to the processes of manufacturing sometimes collect.

EVOLUTION OF A SKYSCRAPER

In a paper entitled the "Evolution of a Skyscraper," read before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., November 2, 1912, Mr. N. L. Malmros made reference to some antiquated provisions that are still part of the building laws of New York City, and which indicate how difficult it is for the law-making bodies to keep pace with the advances in science and engineering. The building law of New York City contains provisions which were unsuitable and unnecessary even twenty-five years ago. One of these provisions is that relating to wall thicknesses, which works a hardship and an actual disadvantage from all points of view in the erection of high buildings. The modern steel skeleton structure does not depend on the masonry walls for support; instead the steel frame supports and holds the masonry in position. The function of the walls is principally to afford protection against the weather and fire, and as the walls are carried entirely by the steel framing at every story, their thickness need be no greater at the bottom than at the top. Nevertheless, the building laws at present in force in New York City require as great a thickness of wall in the lower stories as though they actually carried the weight of the building. As an example, it may be mentioned that a building one thousand feet high would have walls six feet thick at the ground floor. The unpierced walls along the lot lines facing adjoining buildings would have to be solidly made of this thickness for several stories up. This involves not only a waste of rentable space but places an enormous dead load on the steel structure and on the foundations—a load which detracts rather than adds to the strength and safety of the building construction. Strong efforts have been made within the past two years to frame a suitable and sane building code, but these attempts have all failed by reason of the conflicting and warring interests within the building material industries.

Mr. Malmros mentioned that he expected to see still higher buildings in New York City than the Woolworth building now nearing completion, which is about 750 feet high. He mentioned that he had been connected with the design of a proposed building 1100 feet high, of about eighty stories, which careful calculations showed, would have proved a good investment. The limiting factor in high buildings is the transportation facilities within them, and the large space taken up for elevators, halls and stairways, which require a proportionately larger space the higher the building is made. As far as the steel construction is concerned, there is no reason why a building 2000 feet high could not be erected.

Reference was made to the Singer Building, of which Mr. Malmros, acting in a consulting capacity with Ernest Flagg, was the architect. As an interesting illustration of the great amount of work connected with the building of a skyscraper of this type, it may be mentioned that the specifications covered more than eight hundred typewritten pages, and that the number of trades employed in the building of this structure, for which separate contracts were let, numbered more than seventy-five. About 1500 drawings were made in the architect's office for this building, besides all the shop and construction drawings made by the various contractors, which were also checked and corrected in the architect's office. A peculiarity of the very high building is that on account of the enormous wind pressure to which it is exposed, and its proportionately small base, it must not merely be placed upon its foundation but must be actually anchored down very securely.

* * *

A pressure of from four to thirty-five pounds per square inch of surface on work being ground on a disk wheel is recommended by the Gardner Machine Co., which has experimented extensively in determining the proper pressures for grinding. A less pressure than four pounds per square inch results in polishing and burnishing the work. For this reason it is necessary, when grinding light pieces on a horizontal disk wheel, to load them with weights when the weight of the piece does not impose a pressure of more than four pounds per square inch.

TURNING ELLIPSES IN THE LATHE

BY GEORGE E. POPE[*]

The writer believes that the following method of turning an ellipse in a lathe has not found wide application for two reasons: it will be evident from the description that it has a rather limited scope, and the principle has probably never occurred to a great many men. The possibility of applying this method is controlled by several considerations, *i. e.*, the length of the ellipse to be turned must be comparatively short, it must be on the end of a shaft, pin, or similar part, and the ratio of the major to the minor axis must not be too great. These conditions are all met with in the case of the emergency brake cam shown in Fig. 1. The design of this cam was changed from one whose section is shown in Fig. 2; this illustration also shows the method of milling with a formed cutter, the cam being milled on one side and then turned over to have the other side formed.

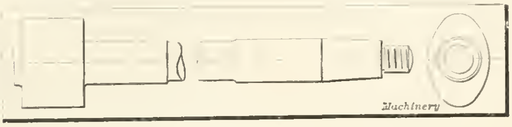

Fig. 1. Elliptical Emergency Brake Cam turned in a Lathe

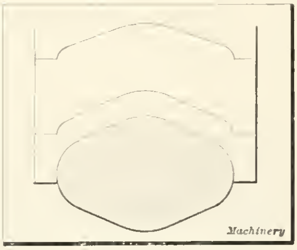

Fig. 2. Former Type of Cam produced by Formed Cutter

In Figs. 3 and 4 are shown a plan view, a partial side view, and sections of the device for turning this cam in a lathe, after changing its design to an elliptical section. Referring to Fig. 3, the device will be seen to consist in part of a square steel block *A*, that is tongued into and bolted to the faceplate and carries the fly-cutter *C*. The remainder of the device consists of the cast-iron block *B* which is tongued into and bolted to the upper surface of the compound rest of the lathe, as shown plainly in Fig. 4. A bushing *D* carries the cylindrical end of the work which has already been turned to size. This bushing is split through one side and is closed in firmly on the work by means of the bushing locks *L*; it is prevented from rotating by the pilot on set-screws *S*. This bushing can easily be replaced by others of different sizes, thus making the fixture adaptable for various sizes of work.

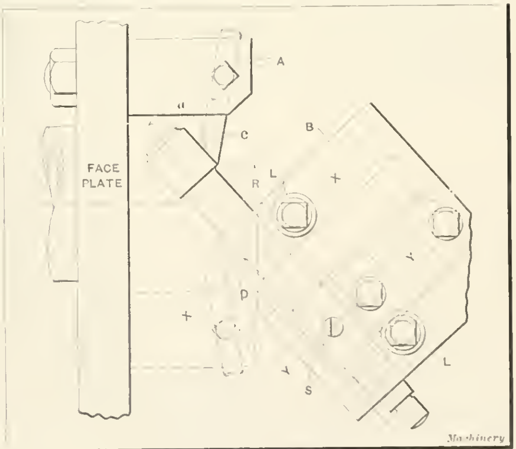

Fig. 3. Fixture for turning an Ellipse in a Lathe

It will be readily seen from Fig. 3 that in order for the elliptical section to be concentric with the shank, the axis

[*] Address: 832 State St. Bridgeport, Conn.

must pass exactly through the center of the circle generated by the point of the fly-cutter *C*. This is accomplished by taking care that the height *H* in Fig. 4, from the surface of the compound rest to the center of the split bushing, corresponds closely to the height from the surface of the compound rest to the center of the lathe spindle, and by adjusting the longitudinal position of the carriage, taking light cuts over the cam and measuring for concentricity.* A positive stop can then be clamped on the ways of the lathe to engage the forward end of the carriage, as the carriage must be moved away from the faceplate in order to remove the finished part.

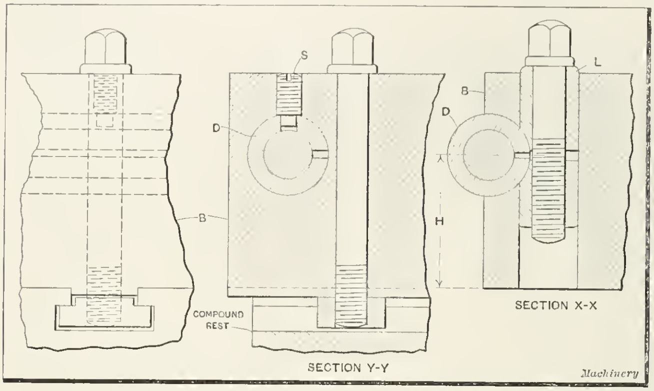

Fig. 4 Partial Side View and Sectional Views of Ellipse Turning Fixture

The compound rest is turned around to an angle *a* which determines the length of the minor axis of the ellipse, and is fed straight in on this angle in the operation of turning the cam. The major axis of the ellipse is determined by the diameter of the circle generated by the cutting point. The angle that determines the minor axis can be readily derived by the method shown in Fig. 5, which is merely the projection of a circle of diameter equal to the length of the major axis of the cam, at an angle sufficient to give an apparent width equal in length to the minor axis. In the triangle *ABC*,

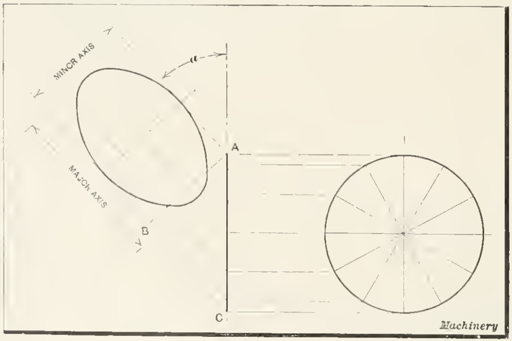

Fig 5. Method of deriving Angle of Compound Rest

AC is equal to the major axis and *AB* is equal to the minor axis, and the angle *BAC* equals angle *a*. Then $\frac{AB}{AC}$ or $\frac{\text{Minor Axis}}{\text{Major Axis}}$ equals the cosine of the angle to which the compound rest must be revolved for the desired results. This method of turning ellipses could be successfully applied to the turning of the familiar oval locating plugs used in tool work, and for a variety of other classes of work.

* * *

The best all-around aluminum mixture, says a writer in the *Brass World*, is an alloy containing 92 per cent of aluminum and 8 per cent of copper. This mixture casts well, does not crystallize in service or crack in the mold, and has a fair tensile strength.

JOINT MEETING OF THE A. S. M. E. AND V. D. I. IN GERMANY

The plans for the meeting of the American Society of Mechanical Engineers with the Verein deutscher Ingenieure which have been nearly completed, promise the most remarkable tour of the industries in Germany ever offered to American engineers. Conrad Matschoss, Dozent of the Royal Polytechnic High School of Berlin, has been in the United States for several months as representative of the German Society, arranging the details of the tour. The engineers will sail for Germany June 11, and arrive in Hamburg or Bremen June 21, where they will be received by the municipal authorities and given opportunity to visit the great shipyards before going by special trains to Leipzig. There they will be welcomed by the King of Saxony and the municipal authorities of Leipzig.

The party will leave Leipzig June 25, for a tour of industrial Germany visiting the principal cities, such as Dresden, Berlin, Dusseldorf, Cologne, Frankfurt a/M, Nuremberg, Munich, etc. It is expected that the Krupp works will be thrown open to the party and that they will be received by Baroness von Bohler, daughter of the late Herr Krupp.

The final meeting will be held in Munich July 7 in connection with the Museum of Technical Arts of which Dr. von Miller is the director. The itinerary of the society in connection with the fifty-fourth annual meeting of the Verein deutscher Ingenieure, as arranged at present is as follows:

June 21.—Reception at the landing place by the local board.
June 22.—Leipzig, official reception by the Verein deutscher Ingenieure.
June 25.—Dresden.
June 27-28.—Berlin.
June 29.—Düsseldorf—Reception by the Rhine-Westphalian Section of the Verein.
June 30-July 2.—Various functions arranged by the Rhine-Westphalian section, including a trip to Cologne and Essen.
July 3.—Bonn—By boat up the Rhine with festival at Rüdesheim; by rail to Frankfurt a/M., arriving about 6 P. M.; evening reception of welcome at Frankfurt.
July 4.—Independence Day at Frankfurt.
July 5.—Nuremberg.
July 6.—Munich—Evening reception of welcome.
July 7.—Visit to the German Museum.
July 7.—Trip on the Starnberg Lake. Evening—Final exercises in the Rathaus.

* * *

EXPERIMENTAL WORK ON KEROSENE CARBURETERS

What promises to be an investigation of more than usual interest and utility is being conducted by the State Engineering Experiment Station at the Pennsylvania State College, State College, Pa., under the direction of Prof. J. A. Moyer of the mechanical engineering department. With the increase in the price of gasoline has come the demand for some cheaper fuel that will give as good results. Kerosene would meet the demands if a satisfactory carbureter could be designed, and it is with a view of determining the merits and defects of various types of carbureters that the investigation is being carried on. The price of gasoline has nearly doubled in this country in the past year, while in England the price has risen to fifty cents a gallon for "motor spirit." The use of a mixture of gasoline and kerosene has been advocated, but without an efficient carbureter no such mixture can be used. Prof. Moyer has installed at the college a motor built to utilize the energy from either of the two fuels mentioned and suitable for use on farms and country estates. Experiments will also be made on various mixtures, and a carbureter valve will be designed to shift the fuel supply automatically from a small gasoline tank, used only for starting, to the main kerosene tank.

THE ABBOTT BALL-BURNISHING PROCESS

A METHOD OF FINISHING POLISHED WORK BY TUMBLING

BY CHESTER L. LUCAS*

Burnishing, as used in the ordinary sense of the word, consists in finishing exterior surfaces of work by rubbing with a highly polished steel hand tool, which hardens and polishes the surface metal. The Abbott ball-burnishing process produces the same effect, but in an entirely different manner, employing quantities of hardened and polished steel balls which are caused to roll over the work while under pressure. This pressure is effected by the weight of the balls which are confined within a tumbling barrel like that shown in Fig. 2. Thus, each ball acts as an individual burnishing tool, and as it rolls over the work, pressed by the mass of balls and work above, it leaves a burnished path on the work. Fig. 1 shows some representative burnishing jobs which have been efficiently handled by this process. Some idea of the action which takes place within the tumbling barrel may be gathered by noticing the balls and work which are represented in Fig. 3.

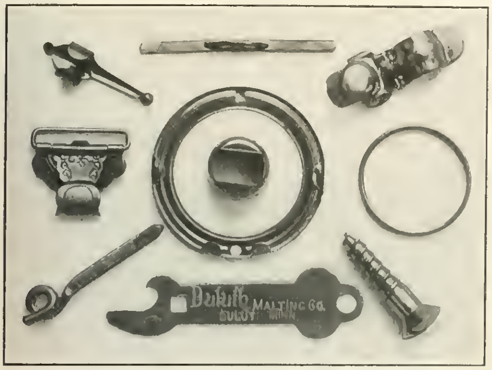

Fig. 1. Character of Work finished by Abbott Ball-burnishing Process

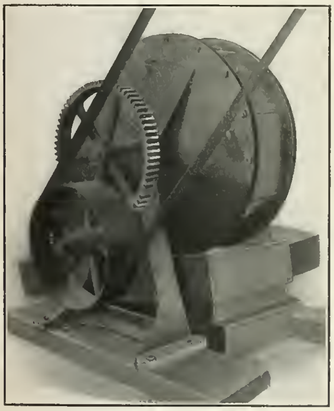
Fig. 2. Type of Burnishing Barrel used

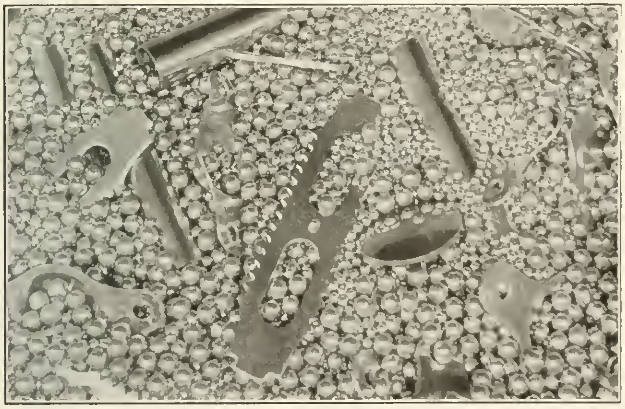
Fig. 3. View within the Barrel to show Burnishing Action of the Balls

Fig. 4 shows the general form of the ordinary tumbling barrel as contrasted with the Abbott burnishing barrel. From this it will be seen that in the Abbott barrel, the balls are confined in a deep narrow space so that the same amount of balls being restricted within a narrower space exert a heavier burnishing pressure upon the work. The Abbott ball-burnishing process cannot be used when any metal is to be removed or deep scratches are to be taken out. It is purely and simply a burnishing process for putting a high finish upon the work, and on work within its limitations is highly successful. Not only can a large amount of work be done in a short space of time, and in a very efficient manner, but many jobs which cannot be burnished by hand are efficiently finished by this process. Referring to Fig. 3 again, it will be seen that it is a simple matter for the balls to burnish the inside of a tube, the center of a deep depression, or the inside of a wire loop as shown in Fig. 1. Such pieces as these would be difficult to burnish in any other way. In order to burnish corners and depressions, it is necessary to employ balls small enough to come in contact with the surfaces of such places; therefore, on other than the very plainest of work, two sizes of balls are commonly used as shown in Fig. 3. Again, on work which is lettered, ordinary polishing processes "drag" the letters, but with the ball-burnishing process, this trouble is not experienced.

The balls used for this work are made of low carbon steel, by the heading process, carbonized and hardened clear through and then highly polished. The balls are not truly spherical, nor of an exact size, but they are highly finished and very hard. The barrels may be of the single or multiple type, having one or more compartments. The barrel shown in Fig. 7 has two sections, and gives a general idea of the construction. The compartments are octagonal in shape and are lined with maple wood so that the balls and work do not come in contact with any metal during the burnishing process. Two hand-holes are provided for each compartment with covers which may be clamped in place. The two hand-holes furnish a means for quickly removing the contents and washing out the barrel. A lubricant is employed in burnishing, which ordinarily consists of soapy water.

To burnish a quantity of work, the work and balls are placed in the barrel in the proportion of one peck of work to two pecks of steel balls. Water is then added until it stands about one inch above the contents of the barrel. In this water, about four ounces of burnishing soap chips have pre-

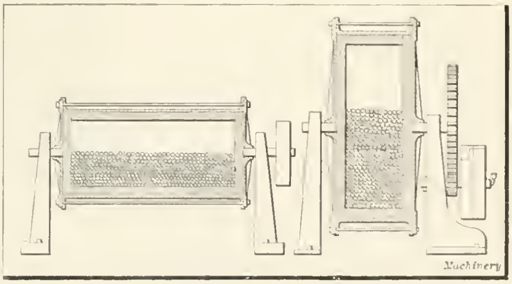

Fig. 4 Comparison of Old-style Barrel with Abbott Barrel

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* Associate Editor of MACHINERY.

viously been dissolved. The hand-hole covers are then clamped in place, and the mixture tumbled from one to five hours, depending upon the character of the work, metal, etc. The speed ordinarily employed for tumbling ranges from 10 to 30 R. P. M., the usual speed being 15 R. P. M. If after tumbling, the work has a dull or smutty appearance, the soap solution should be drained from the work and clean water substituted, to which should be added a piece of cyanide of potassium about the size of a pea. It is highly important that the balls be kept from rusting, for rust, of course, destroys their burnishing qualities. The balls are easily kept in good condition by returning them to the barrel with the soap solution on them, but in no event should they be washed in clear water and allowed to stand. The burnishing operation is the same on all kinds of metal. After the work has been burnished sufficiently, it is separated from the balls by dumping the mixture into a screen of sufficiently coarse mesh to allow the balls to drop through. A convenient arrangement to use for separating the balls from the work is shown in the illustration Fig. 5.

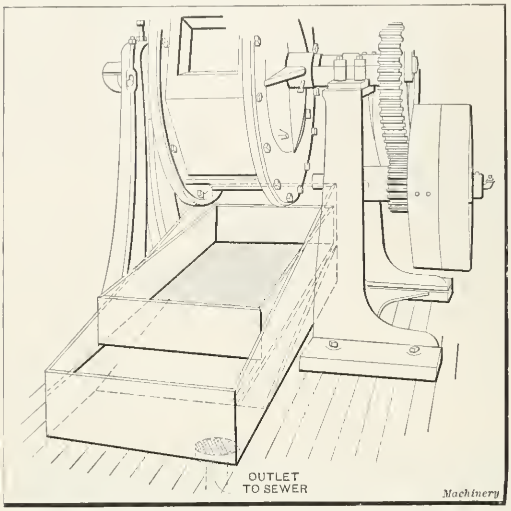


Fig. 5. Convenient Arrangement for Separating Balls and Work

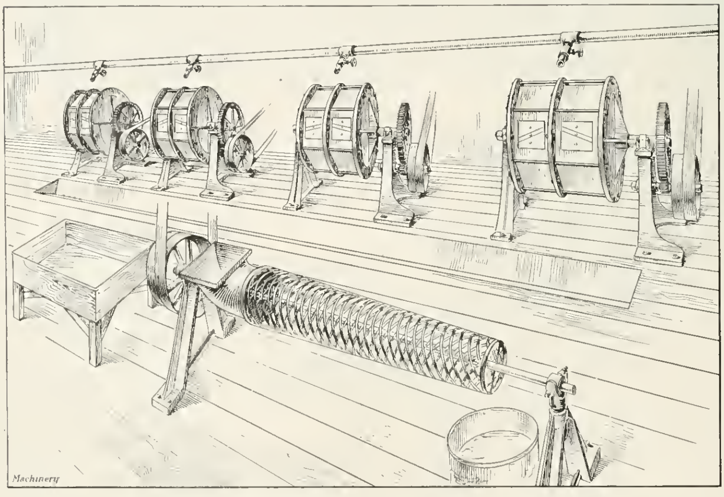


Fig. 6. Abbott Ball-burnishing Installation at Heron Mfg. Co.'s Plant

If the work is not to be plated, it is taken from the barrel and dried in sawdust, but if to be plated, it is cleaned in the usual manner and plated. The cleaning operation incident to plating is usually very troublesome on account of the rouge that is driven into corners of the work by the polishing wheels. No such trouble is experienced after ball-burnishing, as no rouge is used. It is only necessary to rinse off the soap solution, dip in potash and plate. After plating, the work is returned to the barrel and tumbled in a soap solution for a half hour to impart a high finish.

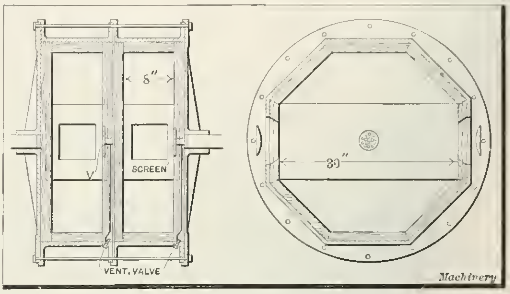


Fig. 7. Construction of Ball-burnishing Barrel

While most commonly used for small work, say under three inches in greatest dimension, larger work may be handled by a modification of the process. The difficulty in burnishing large work is due to the fact that the weight of the piece is often great enough to injure other pieces of work, and, of course, if the pieces are easily bent, there will be trouble from this source. Aside from the danger of bending large work in the burnishing barrel, a greater source of trouble is from scratches caused by the sharp edges of such pieces coming in contact with the finished faces of other pieces in the barrel. Referring to the illustration Fig. 8 a method of mounting pieces of this character is shown. Any convenient method of clamping is employed, depending, of course, on the shape of the pieces, but the fundamental idea is to support the pieces so that they cannot move in the barrel, and yet give the burnishing balls a chance to act upon the work exactly the same as though it was loose in the barrel. Mounted in this manner no possible injury can be done to the work and yet the balls have access to every part of the piece except the edge, even to the inside. It is apparent that this method cannot be used for all work, but a little ingenuity will often solve the problem without having to resort to hand polishing.

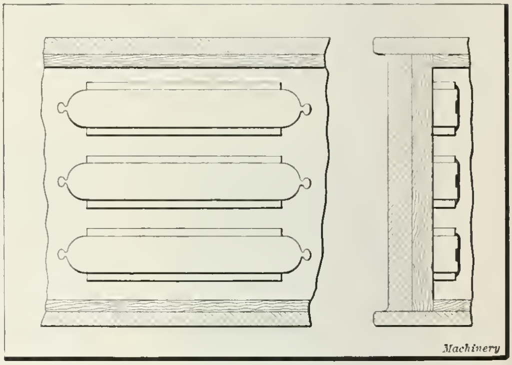


Fig. 8. Section of Barrel to show Method of Mounting Large Work

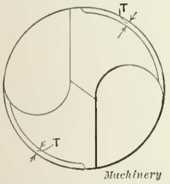
A typical installation of the Abbott ball burnishing process is found at the Heron Mfg. Co., Utica, N. Y. This installation is represented by the illustration Fig. 6, in which are shown four double barrels driven from a common shaft. A line of piping extends over the four barrels, being connected with a hot water tank on the floor above. By means of outlets over the barrels, water may be admitted to the barrels for mixing the burnishing solutions, and for cleaning the barrels and their contents after the burnishing operation. A trolley system is arranged so that after the work has been dumped from a barrel into a basket, during which operation the suds and soap solution are carried away by means of the trough in front of the barrels, the work may be carried to the sawdust box for drying. This sawdust box is of the usual type and after the work has been sufficiently dried, it is shoveled into the chute shown at the right of the sawdust box, from which it enters the revolving conical screen cylinder and is separated from the sawdust, emerging from the small end of the screen, completely dried and ready for shipment.

By the use of this apparatus, the Heron Mfg. Co., who manufactures casters of all kinds, states that it is producing twice the number of parts at half the cost, and getting a better finish than when using hand polishers. Thus an expensive polishing and buffing equipment is eliminated, as well as the high priced labor formerly employed.

* * *

CLEARANCE ON TWIST DRILLS

In the June, 1911, number of MACHINERY an article was published entitled, "Data for Fluting and Relieving Twist Drills," which gave the dimensions of the fluting cutters used for grooving twist drills and also the thickness of the web and the width of the land (portion not relieved) on twist drills. The accompanying table gives the total amount of clearance, 2*T*, for twist drills, as made by a prominent maker, the illustration showing how the dimension *T* is measured. The clearances given are for the finished drill sizes. Of course at the time the clearance is milled, the unrelieved portion of the drill is still a certain amount over the finished size. The amount of "oversize" must, of course, be added to the dimension *T* to determine the clearance in the unfinished drill. When measuring the depth of the clearance, the diameter is measured by micrometers over the relieved part. The dimension thus measured is the finished diameter of the drill less twice the dimension *T*. The thickness of the web as given in the June, 1911, number of MACHINERY is that at the point of the drill. Most makers groove their drills on a taper, which is so selected that the web is about forty per cent thicker at the upper end of the groove than at the point.



AMOUNT OF CLEARANCE ON TWIST DRILLS

Size of Drill, No.	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T	Size of Drill, Inches	Total Clearance, 2 T
80–68	No Clearance	15/64	0.016	1/2	0.033	1 1/16	0.059
67–60	0.003	1/4	0.017	17/32	0.035	1 1/8	0.061
59–56	0.0035	17/64	0.018	9/16	0.037	1 3/16	0.063
55–52	0.004	9/32	0.019	19/32	0.039	1 1/4	0.065
51–48	0.0045	19/64	0.020	5/8	0.041	1 5/16	0.066
47–44	0.0055	5/16	0.021	21/32	0.043	1 3/8	0.067
43–40	0.0065	21/64	0.022	11/16	0.045	1 7/16	0.068
39–36	0.007	11/32	0.023	23/32	0.047	1 1/2	0.069
35–32	0.008	23/64	0.024	3/4	0.049	1 9/16	0.070
31–28	0.009	3/8	0.025	25/32	0.050	1 5/8	0.071
27–24	0.0095	25/64	0.026	13/16	0.051	1 11/16	0.072
23–20	0.0105	13/32	0.027	27/32	0.052	1 3/4	0.073
19–16	0.0115	27/64	0.028	7/8	0.053	1 7/8	0.075
15–12	0.0125	7/16	0.029	29/32	0.054	2	0.075
11– 8	0.0135	29/64	0.030	15/16	0.055	2 1/2	0.075
7– 4	0.014	15/32	0.031	31/32	0.056	3	0.085
3– 1	0.015	31/64	0.032	1	0.057	3 1/2	0.085

The allowance made for grinding varies with different manufacturers from about 0.010 to 0.015 inch. When high-speed steel is used, 0.025 inch is allowed for grinding on account of the scale produced in hardening. Straight drills smaller than from about 3/8 inch to 1/2 inch are not ground after hardening, as they are made from drill rod of the correct size. On the larger sizes, however, there is considerable decarbonization of the outer shell, and it is advisable to make an allowance for grinding on all drills larger than 3/8 inch diameter, which, in fact, is the practice of many of the twist drill makers.

* * *

LIFE AND COST OF PATENTS

In an article in *Engineering* (London) of October 18, Mr. G. G. M. Hardingham gives a table stating the number of years during which patents are valid in various countries, and the total patent office fees paid for maintaining a patent during the specified number of years. It will be seen that in most countries the fees, which are given in the English monetary system the same as in the original table, are very much higher than those in the United States. It should be understood, however, that the large sums mentioned for some of the European countries are not payable in total at the time when the patent issues. In many countries yearly dues are payable in order to maintain a patent once issued. All these yearly dues have been added together so as to show the actual cost of a patent running for a specified term of years. Under the influence of the patent renewal fees in force in most European countries, a great many patents are annulled after they have been running only a few years, due to the fact that renewal fees are not being paid for them. In Great Britain, for example, statistics show that an average of 66.4 per cent of all the patents actually issued are annulled at the end of the fourth year, when renewal fees commence to become payable. Only 11.9 per cent of the total number of patents are renewed at the beginning of the eighth year; 7.6 per cent are renewed at the beginning of the eleventh year; and only 3.2 per cent run for the full term of fourteen years. It has been argued that patent renewal fees of some kind are desirable for the purpose of weeding out useless and unworked patents, but the correspondent of our contemporary, whose table is quoted, points out that there are two sides to this question. The table itself, however, is interesting as showing how cheaply a patent may be obtained and maintained for a period of seventeen years in the United States, as compared with the cost in the leading European countries. It also, probably, explains why the number of patents issued in the United States exceeds to such a large extent those issued in the other leading industrial countries.

TABLE SHOWING LENGTH OF TERM OF PATENTS AND TOTAL FEES IN VARIOUS COUNTRIES

Country	Term, Years	Total Patent Office Fees			Average Annual Cost of Entire Term of Patent		
		£	s.	d.	£	s.	d.
Germany	15	257	10	0	17	3	4
Russia	15	228	7	0	15	4	6
Austria	15	164	12	0	10	19	6
Hungary	15	118	0	0	7	17	4
Holland	15	113	13	0	7	11	6
Denmark	15	111	15	0	7	9	0
Great Britain	14	100	0	0	7	2	10
Brazil	15	98	9	0	6	11	3
Belgium	20	84	0	0	4	4	0
Spain	20	84	0	0	4	4	0
France	15	60	0	0	4	0	0
Italy	15	60	0	0	4	0	0
Norway	15	58	2	0	3	17	6
Transvaal	14	53	10	0	3	16	5
British India	11	52	13	0	3	15	3
Switzerland	15	54	16	0	3	13	0
Sweden	15	40	18	0	2	14	6
Argentine Republic	15	38	2	0	2	10	10
Japan	15	27	13	0	1	17	0
New Zealand	14	18	0	0	1	5	8
Australian Commonwealth	14	13	0	0	0	18	7
Canada	18	12	7	0	0	13	9
United States of America	17	7	4	0	0	8	6
Mexico	20	4	2	0	0	4	1
Average	15.6	77	1	6	5	1	1

Machinery

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

COMMENTS ON QUARTER-TURN BELTING ALIGNMENT

In reading Mr. M. H. Ball's article on quarter turn belting alignment in the September issue of MACHINERY, the writer is reminded of an incident which occurred some twenty-five years ago. A millwright was sent from a machine shop in central Massachusetts to install a water wheel and all of the power transmission equipment for a large mill in Maine. Included in the job there was a quarter-turn belt, 16 inches wide, that ran through five floors from the basement to the upper story. From the time he began the job, which was of some three months' duration, the quarter-turn belt was in the millwright's mind, as he had not the least idea how to install it. However, it was up to him to do it some way, and all his spare time was devoted to studying the matter. It may be said, in passing, that he had not a technical education, and therefore had no knowledge of descriptive geometry, but as the floors were all laid with hard pine tops, he did not want to cut belt holes big enough to let a wagon and oxen through. After studying the problem for some six weeks, the millwright went home for the express purpose of asking the boss how to lay out and cut the belt holes. The answer he received was, "If the pulleys were of the same size with only a single floor located midway between them, I could tell you; as it is, I don't know how." So the millwright returned to the job no more enlightened than when he left.

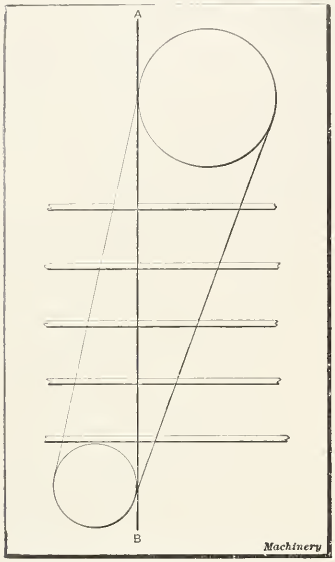


Diagram for laying out Belt Holee

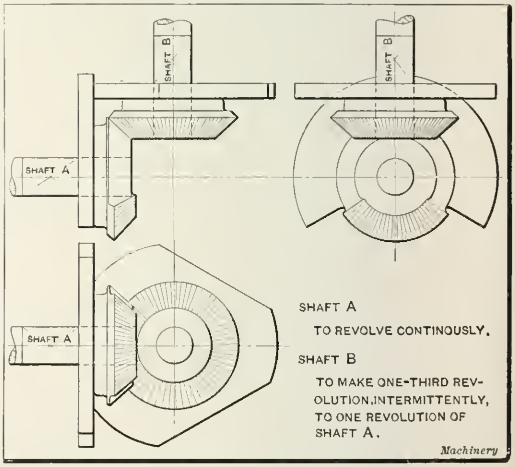
One evening he took a compass and struck two circles to represent pulleys of different diameters, one above the other; he then drew lines representing an open belt from one pulley to the other, a line from the left of the upper pulley to the right side of the lower pulley, and lines to represent the five floors, as shown in the illustration. After studying over the sketch for some two hours or more the millwright was about to give it up for the night. He took up the paper and started to fold it on the line *AB*—purely mechanically—without any purpose whatever in doing so, but still thinking hard of the subject which had troubled him so long. He raised his hand to throw the paper into the fire, when it opened at an angle of about ninety degrees and caught his eye. He stopped and looked first at one side of the fold and then at the other, and was astonished as well as delighted to see that the solution of the whole problem was before him—perfectly plain and easy to understand. The line *AB* represented the plumb line through the floors, from the face of the upper to the face of the lower pulley, and the lines representing the belt showed the distances of the belt from the plumb line each way, and also the angle which the belt made in passing through the floors. The next morning the millwright made a drawing of the same thing to scale, and then to be absolutely sure, he made a model to the same scale, cutting all the belt holes, and putting on a model belt. He then laid out all the belt holes, allowing half an inch all around, and when the belt was put on it did not strike the side of any one of the holes. The writer believes that this incident shows what persistent thought and study will accomplish under most unfavorable circumstances. S. S. JENNISON

Cleveland, Ohio

AN INTERMITTENT MOTION

The feed rolls of machines for making cardboard fillers for egg boxes require an intermittent motion for their operation. They feed cardboard into the machine while in motion, and hold it for cutting while at rest. In one case a continuously running shaft was made to give this motion through an ordinary miter gear and a properly proportioned miter gear sector. This sector engaged and turned the miter gear during one-third of a revolution and then allowed it to remain idle during the remaining two-thirds. In the design of the machine no provision was made for keeping these ratios exact, further than by correctly proportioning the gears. As a consequence of slight variations, this combination gave much trouble through the gears not meshing correctly. This caused the gears to be broken, the timing of the feed to be destroyed, and the working of the machine to be generally deranged.

The illustration shows the method used for overcoming these defects and obtaining an accurate and sure-working feed motion. It consists of a pair of flat plates attached to the shafts *A* and *B* behind the gears. The plate carried by shaft *B* is slabbed off on the three sides of an equilateral triangle, to give the correct dimension from center to edge, and the plate carried by shaft *A* is cut away to allow clearance for the plate on shaft *B* while turning. The mechanism acts exactly as before, except that when shaft *B* is idle, it is held in place by the bearing of one plate on the other. These plates limit the movement of shaft *B* to exactly one-third of a revolution for each revolution of shaft *A*. The former difficulties are thus remedied, and a smoothly running machine made possible. MILES SAMPSON



SHAFT A TO REVOLVE CONTINOUSLY.

SHAFT B TO MAKE ONE-THIRD REVOLUTION,INTERMITTENTLY, TO ONE REVOLUTION OF SHAFT A.

Mechanism for regulating Action of an Intermittent Motion

Manchester, N. H.

ATTACHMENT FOR WINDING CLOSE COILS IN SPRINGS

The spring winding attachment shown in Fig. 1 is designed to fit on the back end of an ordinary lathe headstock. The attachment can be set to produce from one to two and one-half close coils, at required intervals, so that a spring of the full length of the lathe can be wound and then cut up into lengths. This method of close coiling makes it possible to save the time that was formerly taken in closing the ends by hand or in heating the ends of larger springs before closing them up.

The attachment is driven by the screw cutting stud, through the regular change-gears, to the lead-screw, as in an ordinary screw cutting operation. The nut is kept in engagement with the screw all the time. The change-gear is loose on the screw cutting stud, but has a clutch member keyed to it; the other part of the clutch is keyed on the stud and has a spring to push it into engagement. When these two clutch members are in engagement the apron travels forward; when the clutch is disengaged the apron stands still but the spindle continues to revolve.

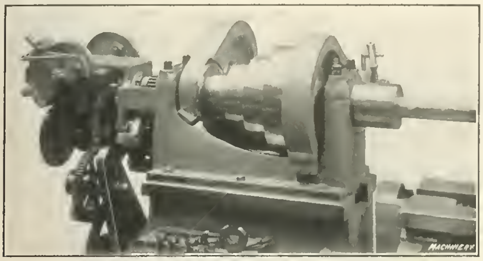


Fig. 1. A Lathe Attachment for winding Springs

The screw cutting stud is continued outward and drives a cam *A* by means of two gears, as shown in Fig. 2. This cam runs continuously and acts on a runner attached to the curved lever *B* which carries a spring plunger or pawl *C*. Each time the lever reaches the top of its stroke, the pawl carried by it acts on the ratchet wheel and picks one tooth. The ratio of the gearing which actuates the cam is such that it requires three strokes of the lever for each two coils of spring which are wound. The ratchet wheel is prevented from coming back by means of the fixed catch *D* at the top, which holds it against the weight and rope tending to pull it back. On the side face of the ratchet wheel there is a T-groove in which a dog is clamped. As soon as the ratchet wheel has been advanced through the required distance, this dog comes against a projection *E* on the inside of the ratchet mask; the ratchet and mask then travel together. The mask has a gap through which the pawl usually works; consequently it remains stationary until it is engaged by the dog on the ratchet wheel. This mask is rather larger than the ratchet wheel, the bottom of its teeth being slightly above the top of those on the ratchet, so that when it begins to move, the pawl *C* and fixed catch *D* are both lifted out of contact with the wheel and allow it to go back under the pull of the rope and weight.

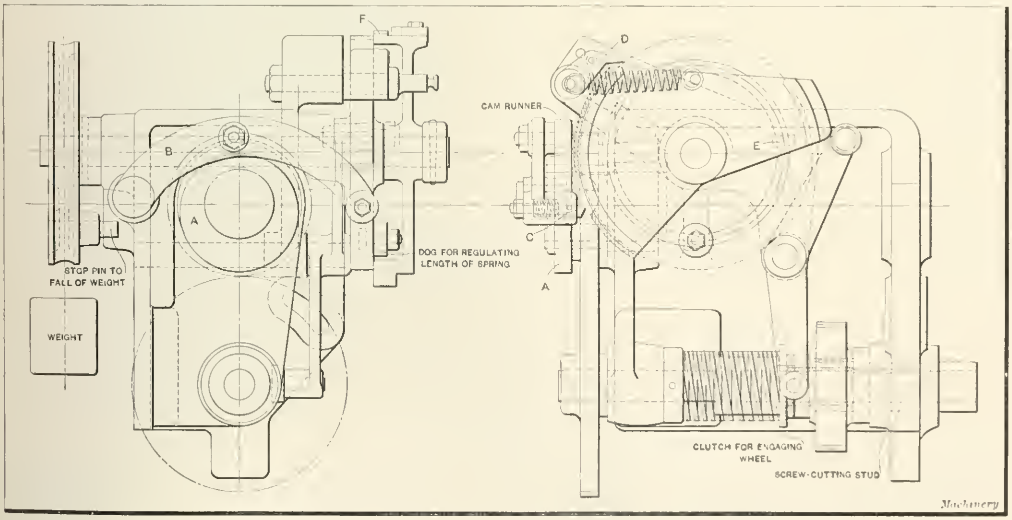

F
D
CAM RUNNER
B
E
A
C
A
DOG FOR REGULATING LENGTH OF SPRING
STOP PIN TO FALL OF WEIGHT
WEIGHT
CLUTCH FOR ENGAGING WHEEL
SCREW-CUTTING STUD
Machinery

Fig. 2. Details of the Mechanism for producing the Close Coils

Shortly after the mask begins to move, its corner comes in contact with the cam runner on the lever which controls the stud clutch. This throws out the clutch and stops the travel of the apron. The mask continues to rotate through the action of the pawl until it has produced the required number of close coils. An adjustable dog for lifting the catch now comes into action and throws the catch out of engagement with the mask; the tension of a spring then returns the mask to its original position. This releases the clutch lever and allows the drive on the screw cutting stud to be reengaged. At this point, the apron continues its forward movement for the production of another section of the spring. When the mask is returned, the fixed dog, which it carries, pushes the retaining catch into engagement with the ratchet wheel, thus restarting the latter in rotation.

Means are provided to cushion the weight so that the full shock does not come on the attachment. Suitable means have been taken to adjust the ratchet pawl so that it takes only one tooth at a time, also to have it drop clear of the ratchet wheel in order that the latter may be given time to run back when the action of the weight becomes effective. The design of the teeth of the clutch on the screw cutting stud must be such that they will have plenty of clearance and not too strong a spring behind them, as this would make the return uncertain.

The pitch of the spring is obtained in exactly the same way as the pitch of a screw produced in the ordinary manner. The attachment merely determines the length of each section of the spring and the number of close coils that are to be produced.

Keighley, England W. Haggas

CASEHARDENING PRACTICE—A COMMENT

The writer would like to make a few friendly criticisms and comments on Mr. Robert Grant's article on "Casehardening and Casehardening Practice" in the October number of Machinery. In the first place, the general methods outlined are not entirely in accordance with the most modern practice. However, the article is good and in most cases it treats of the present methods practiced all over the country.

The statement is made that carburized steel should never be quenched at the carburizing heat, but should be cooled to the hardening heat, as the latter is much lower than the carburizing heat. This would make little improvement, for the grain of the steel would be about the same as if it had been quenched at the highest temperature attained while carburizing. It is necessary to cool the steel below its lowest critical point (about 1275 degrees F.) and then reheat it to the hardening temperature, thus quenching on a rising heat, in order to secure a refined grain. Steel should never be quenched on a falling heat.

Mr. Grant's method of local hardening is not the most modern, and it is expensive and troublesome. He shows a cup-shaped piece in Fig. 6, which was only hardened at the interior of the cup, using another cup-shaped piece to prevent the outside from hardening. There is now a prepared fire paint on the market which works admirably when painted on parts of steel that are not to be hardened. This paint is in the form of a powder and is mixed up with water to the consistency of paste; it is then ready to be applied. The steel can be painted before or after carburizing. If painted before, the part of the steel which it covers will not be carburized, and consequently it will not harden. If the paint is applied after carburizing, the painted steel will not harden, although it is carburized, because the paint forms a shield which does not let the water come in contact with the steel. This makes local hardening a simple proposition, and is superior to copper coating. The use of the mandrels shown in Fig. 5, for preventing the hardening of the inside of rings, could be done away with by using this fire paint. The fire paint is also useful in corners where a thin part joins a thick part in the steel, the paint forming a fillet that leaves the corner soft after hardening and prevents breakage.

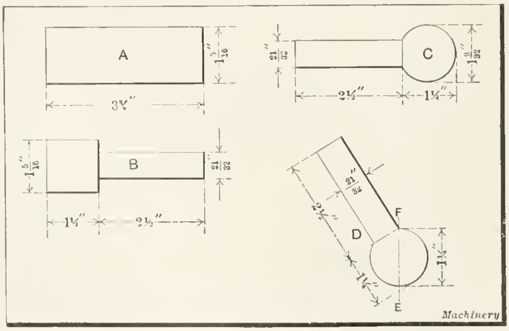
Mr. Grant says that small pieces packed in a box for carburizing may touch each other without detriment. It is hardly possible that this would be true in actual practice, because the surfaces in contact would prevent direct contact of the carburizing material; therefore these spots would get little or no carbon, and the steel would either have soft spots after quenching or the depth of case would be irregular.

The method of drawing the temper of hardened steel by heating it in a muffle is not nearly so reliable as drawing it in oil, where the temperature can be accurately gaged with a thermometer. Drawing in oil is a more rapid and accurate method. Mr. Grant says that large articles require a higher carburizing heat than small ones. The writer does not see the reason for this. Of course it takes a higher heat to penetrate a large piece in the same time as a small one, but it seems that if two pieces of steel—one small and one large—are held at the same uniform heat for the same interval of time, they will each receive the same depth of case.

Cleveland, Ohio J. E. Washburn

TURNING SPHERICAL SHAPES BY HAND

Special fixtures and methods for ball turning have been shown and described in recent issues of Machinery. The accompanying illustration shows a method which the writer recently used in a job shop where no ball turning device or lathe with a compound rest was at hand. The pieces to be turned up are stub ends to be welded onto the steering arms of automobiles for repairs. After cutting off the pieces, as shown at *A*, they were faced to the proper length and centered, and were then caught in a three-jaw universal chuck and one end was turned down, as shown at *B*. The pieces were then reversed in the chuck and the ball shape was roughed out by hand as accurately as practicable, as indicated at *C*. They were then caught in the chuck in the position shown at *D*, on the points of the chuck jaws, so that a circle could be turned to 1¼ inch diameter along line *EF*. Preferably, this should be done in an independent jaw chuck so that the circle turned in this position will agree as nearly as possible with the diameter marked 1 9/32 inch, previously turned. The pieces are then returned to the position shown at *C*, and the ball is finished, the circle turned to 1¼ inch diameter being used as a "witness" mark.



Successive Operations in Turning Ball-shaped Parts by Hand

H. W. Ricks

Santa Ana, Cal.

TURNING A BALL WITHOUT CENTERS

It was required to turn the brass ball shown in Fig. 2 without the use of centers, and in performing this operation the following method was used. A 4-inch bar was chucked in the lathe and the ball roughed out. The compound rest was next set with the pivot directly beneath the center of the ball and slowly swung around to form the work. The tool was fed in until the caliper showed that the ball had been reduced to the required diameter of 4 inches. This turning operation was continued until the work had been brought to the form shown in Fig. 2. The ball was then cut off along the dotted line leaving sufficient stock to finish.

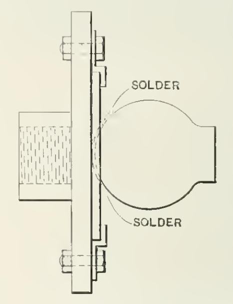


Fig. 1. Method of securing Ball to Faceplate

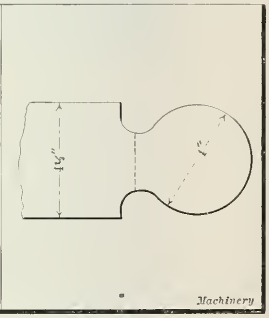


Fig. 2. Ball ready to be cut from Bar

The chuck was next removed and a faceplate mounted on the lathe spindle in its place. A brass plate was then strapped to the faceplate and a hollow was turned in it with the tool in the compound rest. The same radius was used for this purpose and, consequently, the hollow formed was of exactly the right size to hold the ball. The work was then mounted in the position shown in Fig. 1 and the tailstock brought up against it to secure it in place. Soft solder was now melted into the joint between the ball and disk, a blow torch being used for this purpose. This method of fastening proved entirely adequate to hold the work in place after the tailstock had been removed. The remaining surface of the ball was then finished. In performing this operation, it was necessary to maintain exactly the same radius on the compound rest, but this did not interfere with the possibility of moving the rest along the lathe bed to bring it into position for completing the ball.

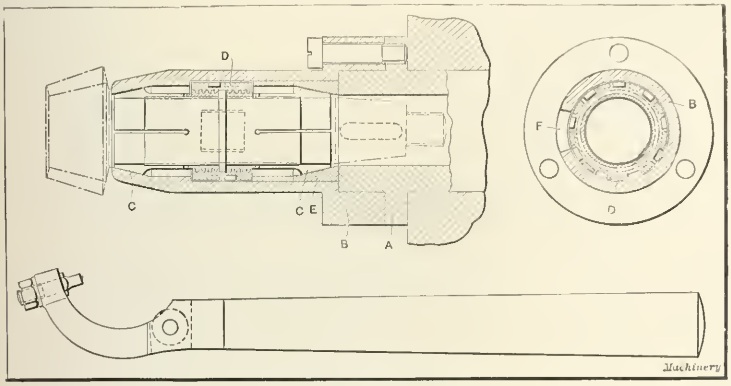
The advisability of turning balls in this way may be questioned, as some may regard the method of turning them between centers and then grinding off a more rapid process. This is true in some cases, but for the operation described in this article it was necessary to have the ball accurate to 0.0001 inch, and the method described enabled the work to be produced to meet this requirement.

New Britain, Conn. J. M. Henry

DOUBLE GRIPPING CHUCK

In the shops where the writer is employed we had to rough out some very hard nickel steel miter gears on a spur and bevel gear cutting machine. The usual chucking devices at our disposal failed to do their duty, as we could not possibly take the heavy cuts without moving the work.

The double gripping chuck shown in the accompanying engraving was, therefore, designed and proved quite effective. At *A* is shown the machine spindle; *B* is the chuck which is firmly fastened to the spindle by means of three screws. At *C* are shown two conical split collets which are fitted on the inside of the chuck, the front one resting in a taper seat, while the rear one rests in a ring *E* held against the front of the machine spindle. Both collets are threaded on the outside with a right- and left-hand thread, respectively, and are screwed into a ring *D* which holds them together. The ring has, on the outside surface, spanner holes so arranged in two rows around the circumference, that when the ring is rotated they alternately pass in front of a rectangular opening *F*. Through this opening the tooth of the spanner shown in the lower part of the engraving is inserted. Ring *D* is thus rotated, and the two collets *C* operated against the taper surfaces, so as to clamp the work firmly in position.

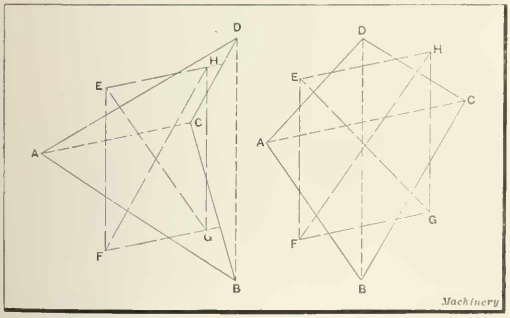


A Special Double-gripping Chuck

Turin, Italy. G. Boella

FINDING THE CENTER OF GRAVITY OF ANY FOUR-SIDED FIGURE

In many calculations pertaining to the design of machinery, it is necessary to find the center of gravity of irregular polygons, and the following is a simple method of obtaining the center of gravity of any four-sided figure. Two cases are possible, as shown in the illustration. To find the center of gravity of the four-sided figure *ABCD*, each of the sides is divided into three equal parts. A line is then drawn through each pair of division points next to the points of intersection *ABCD* of the sides of the figure. These lines form a parallelogram *EFGH*; the intersection of the diagonals *EG* and *FH* locates the required center of gravity.



Method of finding the Center of Gravity of any Four-sided Figure

McKees Rocks, Pa. August H. Anger

[To prove that *EFGH* is a parallelogram, a line is drawn connecting points *B* and *D*. This forms two triangles *BCD* and *BAD* having the common base *BD*. It can be shown that a line which subdivides any two sides of a triangle proportionately is parallel to the third side. The line *EF* divides the sides *BA* and *DA* in the ratio of 2 to 1, and so it is parallel with *BD*. The line *GH* divides sides *BC* and *DC* in the ratio of 2 to 1, and so it is parallel with *BD*. Hence the lines *GH* and *EF* are parallel to the common line *BD* and with one another. To prove the sides *EH* and *FG* parallel with one another, a line is drawn connecting points *A* and *C*. The same method will then show that the lines *EH* and *FG* are parallel to the common base line *AC* and, consequently, to one another. Hence *EFGH* is a parallelogram. Editor.]

ERASING INK MARKS FROM TRACINGS

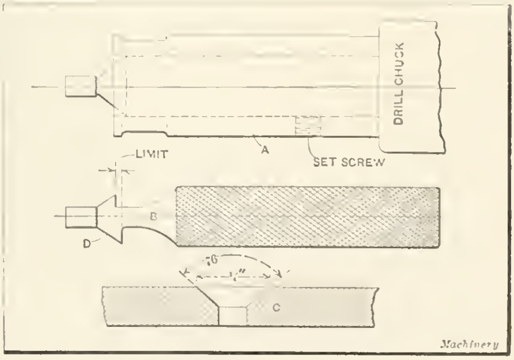
The writer, a draftsman of twelve years experience, has read many articles on the well worn subject of "Erasing Ink Marks from Tracings," but has seen nothing that agrees entirely with what he has found to be the most satisfactory method. To begin with, an ink line is one of considerable breadth and thickness. When an eraser is applied it grinds the ink up into minute particles, which are worked into the cloth as soon as the glaze is broken; these particles of ink are only removed by much unnecessary rubbing. The following is a more satisfactory method:

Place a triangle or other hard, smooth surface beneath the line or spot that is to be erased from the tracing cloth; then with a very sharp knife remove the ink which lies on top of the cloth. This means the ink which has not actually sunk into the cloth; do not scratch into the cloth. If sufficient care is exercised, the knife need scarcely break the glaze. Then, still keeping the triangle under the tracing and using a hard pencil eraser—do not use an ink eraser—it will be found that the remainder of the ink can be completely removed with little injury to the cloth. By this method, the troublesome grit coming from an ink eraser is avoided, and by applying a small amount of soapstone, the surface of the cloth is renewed sufficiently to prevent the pores filling up with dust and becoming unsightly. As a general thing, a knife is tabooed as an eraser, and with good reason, but when used according to the method outlined, the writer has found it far superior to an ink eraser.

Auburn, N. Y. Raymond H. Farwell

STOP-SLEEVE AND GAGE FOR COUNTERSINKING

The writer has had considerable difficulty in accurately countersinking holes in thin sheet metal; hence, a gage or stop-sleeve was finally devised which answered the purpose so well that a description of it may be of interest to others who may have met with trouble of the same kind. The countersinking of holes in sheet metal to a uniform depth com-



Stop-sleeve and Gage for Countersunk Holes bines the difficulties of ordinary countersinking with the additional difficulty that the sheet metal is apt to spring away somewhat from the tool. Trouble is also met with on account of slight bends in the sheet.

The stop shown at *A* in the accompanying illustration is a sleeve which is placed over the countersink. The top of the sleeve fits against the face of the drill chuck and is prevented from falling off the tool by a set-screw. Openings near the bottom provide an outlet for the chips. The bottom face of the sleeve is hardened and slightly drawn. It is then polished as smoothly as possible with fine emery so that it will not mark the stock. When the countersink has reached the proper depth, the face of the stop will revolve on the stock and thus prevent the tool from entering further. The pressure on the sleeve will tend to straighten out any bends in the sheet metal and make certain that every hole will be countersunk to a uniform depth.

A test gage for countersunk holes which may be of interest is shown at *B*. It is provided with a pilot for entering the drilled hole. One side of the gage proper is ground away, as indicated, to a level lower than that of the other side. In this way, the allowable limit of variation in depth of the countersunk hole is given on the gage in a very convenient way. The part *D* is ground and by using Prussian blue or red lead in gaging, the angle of the countersunk hole can be easily tested.

Many draftsmen when dimensioning a countersunk hole give its depth. This is not a convenient dimension for the shop men to work from, as it is practically impossible to measure the depth accurately without a gage; hence, countersunk holes should be dimensioned as shown at *C*, the diameter at the top and the angle being given. F. A. PARSONS

Milwaukee, Wis.

JIG FOR DRILLING HOLES CLOSE TO A SHOULDER IN SCREWS

A jig for drilling holes close to a shoulder in a screw is shown in Fig. 2. The hole to be drilled is for the threading tool to run into, when cutting threads up to the shoulder on the screw shown in Fig. 1. The jig is placed in the tailstock of a lathe, and the drill is held in a chuck in the headstock.

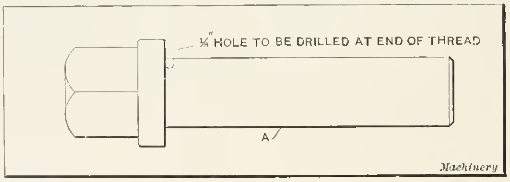


Fig. 1. Screw to be drilled

In operation, the body *A* of the screw, Fig. 1, is held with the left hand in the V-part of the jig, with the shoulder against the cut-away portion *B* (the face *B* is equal to the radius of the drill or the distance *C* from the center), while the right hand is used to run the tailstock spindle out, or, in other words, to feed the work against the drill.

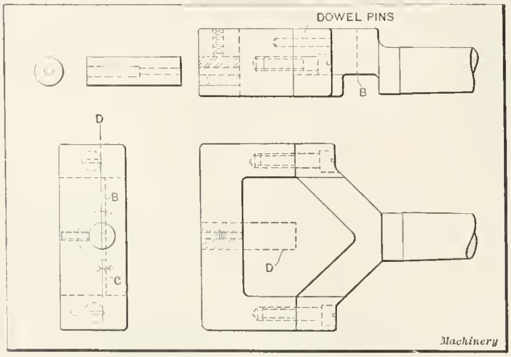


Fig. 2. Jig used for drilling Holes close to Shoulders in Screws

In this jig the work is quickly done with a sufficient degree of accuracy, and if the drill used is ⅛ inch in diameter, screws of ⅛ inch pitch or less and of various diameters can be drilled, which makes this a handy jig for drilling odd half-dozen lots, as well as a greater number of pieces.

The long bushing *D*, shown in Fig. 2, is for supporting the drill on small diameters, as it projects further through the cap, as shown by the dotted lines. M. F.

A SWAGING OPERATION

In swaging the piece *A* to the shape *B*, Fig. 1, and in other similar work, trouble is often experienced in obtaining a satisfactory means of locating the work, owing to the flash which spreads entirely around the piece. In Fig. 2 is shown a punch and die for swaging this part. The work is located between the spring-operated holders *A* and directly over the die, which has a hole *B*, 3/32 inch deep, in it. The small end of ejector pin *C* forms the bottom of the hole in the die. When the piece is swaged into the die, this pin compresses the rubber pad which is used for ejecting. A small ring is formed on the work by the hole through which this ejector slides; this is afterwards removed by a drilling and reaming operation through boss *D*, Fig. 1. BACON

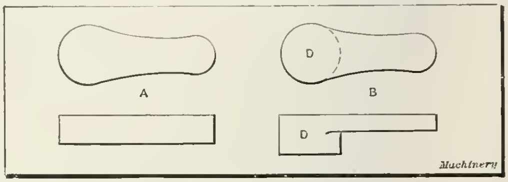


Fig. 1. Piece of Work before and after Swaging

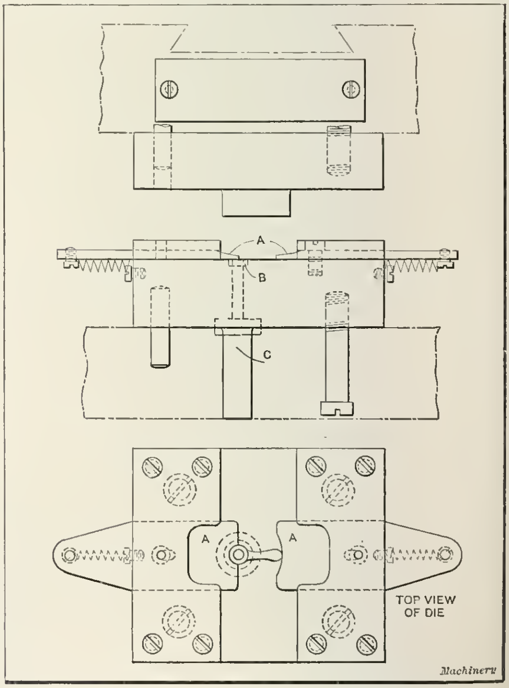


Fig. 2. Punch and Die for Swaging Operation

MACHINING AN AUTOMOBILE SPIDER

The piece shown at *B* in Fig. 1 is known as an automobile spider. It has four arms which are finished on the outside, and a hole bored through the center. The machining operations on the spider are carried out as follows: In the first operation the spider is gripped in a three-jaw chuck, as shown in Fig. 1, one jaw being cut out to allow one of the arms of the spider to set into it, thus furnishing a drive. While the hole through the spider is being bored and reamed with tools held in the turret, one side of the spider is faced with a back facer bar which is operated through the spindle, and the side next to the turret is faced with tools held on the cross-slide. In this operation the ends of the arms of the spider at *A* are also turned.

Before the second operation on this spider is done it is necessary to drill a small hole *A*, Fig. 2, which is used to locate the spider on the turret for the second operation. This hole is drilled in a jig as shown, which consists of a base on which the spider is set and an upper half which locates the hole. Fig. 3 illustrates the method of machining the arms in the second operation, this being quite a departure from ordinary turret lathe practice, in that the tools are held in the headstock spindle, and the work on the turret. In place of the regular turret a special turret is used for holding the spiders, each spider being located in the same position as the preceding one by means of the hole mentioned above and the pin *A*, Fig. 3.

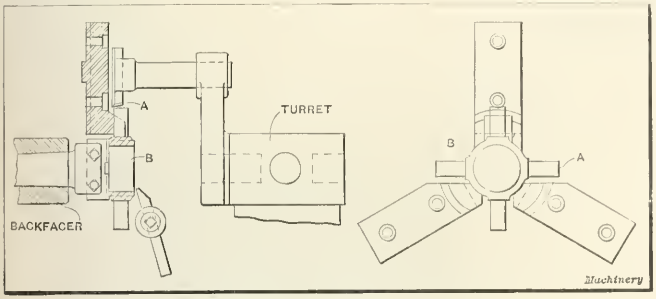


Fig. 1. First Operation—Turning, Boring and Facing

It is obvious that if there are four turret faces on the regular turret, the same will be true of the special turret, and each indexing of the turret brings another arm in line with the spindle, where it is operated upon. When the four arms are finished the machine is stopped and another spider put on. The machining on the arms of the spider is done with a hollow mill held in the spindle. In this mill there are three blades for turning, one facing blade *C*, which faces the end of the arms, and a small combination center-drill *D* which centers each arm. As the arms on the spider are opposite, they can be set between centers and ground, a pin being used to drive them by simply coming in contact with one of the arms not being ground; this saves the necessity of using a dog and is much quicker. F. SERVER

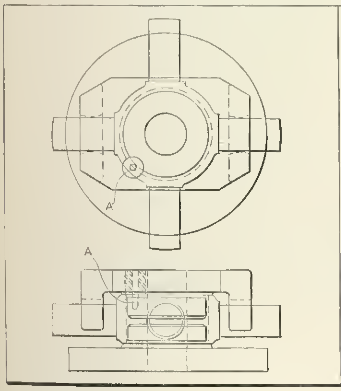


Fig. 2. Jig for Drilling Locating Hole

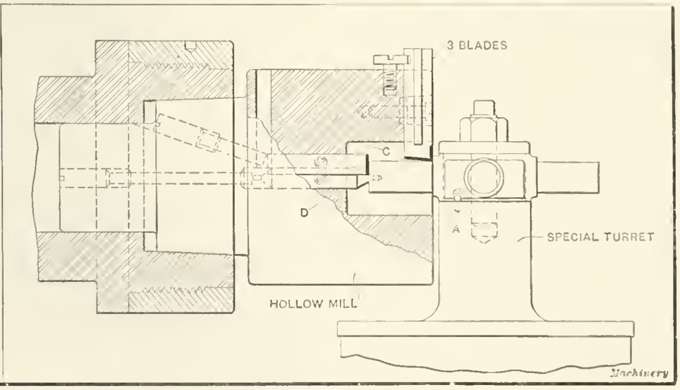


Fig. 3. Turning and Facing the Spider Arms

A COMPARISON OF SELLING METHODS

Some time ago we were in the market for a machine tool and wrote to two manufacturers who advertise in these columns. The selling methods of these two companies differed sufficiently to cause comment. Our letter asked for information regarding prices, the type of equipment that would be best suited to our requirements and the correct method of installation. The replies came promptly but the difference can be noted from the following: Firm No. 1 enclosed a blueprint photo of machine and a printed pamphlet of general information on the method of installation, etc. Their letter made no mention of the special information we asked for and appeared to be a stereotyped form. Nor was this information included in the pamphlet, and to complete a poor argument, the letter was signed in typewritten characters, no writer's name appearing. Firm No. 2 sent an attractive catalogue with prices—which, by the way, were higher than those submitted by firm No. 1—and a three page letter *fully* answering all of our requests, and calling attention to a few salient points not mentioned in the catalogue. They advised that their salesman would reach us within three days to enter into the matter still more fully. In conclusion, the letter was personally signed by the head of the firm, thus giving that touch of individuality which means so much. The salesman arrived on time, explained some minor points—the letter had covered nearly everything—closed the order, and the machine was shipped in three weeks. Although we would have paid for it on delivery, the builder insisted that we take up the thirty day trial offer, which was done. Needless to say, the machine is still in use and further purchases are now contemplated.

The reason for asking the special question concerning installation and equipment was that remodeling was necessary to accommodate the machine. It was necessary to start this work at once, in order to be ready when the machine arrived; consequently it was a matter of absolute necessity for us to have these questions answered. We notified firm No. 1 that the order had been placed, but received a stereotyped "follow up letter"—signed in typewritten characters as before. While merits, of course, were the final considerations governing our selection, the first impressions made by the letters went a long way in making the decision. It does seem as though some firms should adopt twentieth-century methods of selling their goods. One thing more; these firms were located in the same town and manufactured the same line of machines, so that both had equal opportunities of securing the business.

New Britain, Conn. J. M. HENRY

PUBLISHING TECHNICAL INFORMATION

In the September issue of MACHINERY, appeared an editorial comment on an article recently published in *Canadian Machinery*. The article in question spoke of the selfishness of some engineers who refrained from giving out useful technical information which was the result of personal research. Modern methods and ways of thinking are making this type of men a thing of the past.

There are, of course, various reasons for this policy, one of which was brought out by an experience which the writer recently had. The superintendent of a certain factory, having noted one of the writer's articles on a method of performing an important operation, came to him and said, "I don't believe in this sort of thing and the president also expresses himself as being against it." Upon being asked for the reason he replied, "Simply because we do not believe in the general education of the masses." The writer refrained from making any comment, but to him it surely seems a narrow-minded view. The article did not reveal any trade secrets or information of that nature, being merely a description of a short cut in machine production.

Some people appreciate the publicity which comes from advertising, etc., but fail to appreciate the publicity value of giving out their methods of manufacture to the trade. Competition makes it necessary for every short cut to be applied, but does not, in the writer's opinion, require withholding information that would be helpful to a great many mechanics. This only refers to information that could be made public without loss to the works where the method originated.

It will generally be observed that the shops which guard their fancied secrets so jealously are the ones in which time, money and energy are wasted most freely. The reason for this is that their narrow-mindedness prevents them from accepting other known and tried methods of improving their working conditions. Perhaps they are ashamed of their methods. If this narrow view were broadened, it would clear away much of the mystery which surrounds the intelligent use of modern machine tools and appliances, and the benefits received would fully repay manufacturers for giving out information which is at their disposal. J. M. H.

DRAWINGS AND THE EYE-SIGHT

There is altogether too much unnecessary eye-strain among draftsmen that is weakening their sight. This is not brought on entirely by the continuous use of the eyes; other causes of eye-strain are making and reading drawings with lines of inadequate thickness, using lead pencils that are too hard, and making tracings from pencilings whose lines are barely distinguishable through the cloth.

The exercise of a little discretion in selecting drawing materials and in drafting-room practice may be made the means of saving both the draftsmen and those who use their drawings from eye-strain. It is more difficult to trace a penciled drawing made on buff or cream colored paper than one made on white paper. Many draftsmen use but one degree of hardness in lead pencils—generally a 5-H or 6-H on all shades and grades of drawing paper. They do not appear to realize that there is a proper degree of hardness of lead for different papers, that will make a drawing "seeable" and "readable" through tracing cloth in all conditions of light, whether the day is stormy or bright. In most drafting-rooms, the papers used have a coarse-grained surface and are either white, buff or cream colored. Experience has shown that on white drawing paper, a 5-H pencil makes lines of sufficient weight, on the buff color a 4-H should be used, and on the deeper shades a 3-H is desirable. Since a much greater pressure can be secured in making lines with a lead pencil than with a pencil compass, the lead in the compass should always be one degree softer than the pencil. If this method is followed, all drawings will have good black lines, which will lessen the strain on the eyes, especially when making tracings.

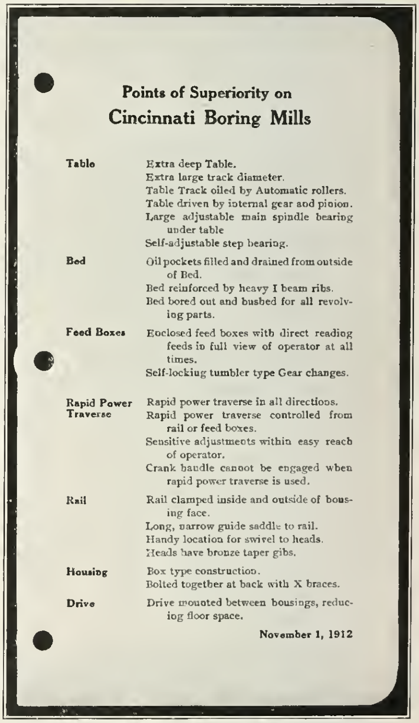
Another means of relieving eye-strain is to make the light and shade lines thicker. The day of elaborate drawings for shop use has passed. Plainness and simplicity in drawings is both required and appreciated by workmen. It is better to use a drawing pencil having too blunt a point and make thick lines, than to use one filed down to a point like a needle. In making tracings, plenty of ink should be used. The lines that were formerly made for shade lines should now be the light lines, and the shade lines should be made just double the thickness. The lettering and figures on the drawing should be made with a coarse pen, and at least 5/16 inch high and 3/16 inch wide. Blueprints taken from such tracings are far more useful in the shop than many of the ones with sight destroying hair-lines, dwarfed letters and figures, and feeble looking arrow-heads that are now in use. All this may seem a radical change from the present method, but its general adoption would be a change in the right direction, as it would enable those with dimmed eyesight to read drawings more easily and prevent damage to the sight of those whose eyes are still good. JAMES E. COOLEY

Hartford, Conn.

PRICE SHEETS FOR SALESMEN

On page 235 of the November issue, engineering edition, attention is called to the loose-leaf price books that are now generally used by machinery salesmen. We have been sending out our price lists in this form for the past six years, the size of the sheet being 7¼ by 4 inches, suitable for the Morden No. 6 loose-leaf binder. All information which we issue for the use of salesmen, such as dimensions, talking points, motor information, etc., is printed on sheets of this size, and we have just adopted a scheme of reinforcing the holes as shown by the sample sheets enclosed. These price lists are referred to constantly by the salesmen, and unless some provision of this kind is made, the holes are soon torn through and new sheets must be supplied.

Cincinnati, Ohio CINCINNATI PLANER CO.



Points of Superiority on
Cincinnati Boring Mills

Table	Extra deep Table. Extra large track diameter. Table Track oiled by Automatic rollers. Table driven by internal gear and pinion. Large adjustable main spindle bearing under table Self-adjustable step bearing.
Bed	Oil pockets filled and drained from outside of Bed. Bed reinforced by heavy I beam ribs. Bed bored out and bushed for all revolving parts.
Feed Boxes	Enclosed feed boxes with direct reading feeds in full view of operator at all times. Self-locking tumbler type Gear changes.
Rapid Power Traverse	Rapid power traverse in all directions. Rapid power traverse controlled from rail or feed boxes. Sensitive adjustments within easy reach of operator. Crank handle cannot be engaged when rapid power traverse is used.
Rail	Rail clamped inside and outside of housing face. Long, narrow guide saddle to rail. Handy location for swivel to heads. Heads have bronze taper gibs.
Housing	Box type construction. Bolted together at back with X braces.
Drive	Drive mounted between housings, reducing floor space.

November 1, 1912

Morden Price List Sheet with Reinforced Holes

REFITTING A WORN STRAP ON AN ENGINE CONNECTING-ROD

The writer read with considerable interest an account in the August number of MACHINERY of how a number of rings that had been bored out too large were saved by shrinking and reboring them. This recalled to his mind a job of a somewhat similar nature which he saw done while an apprentice. A large engine was being repaired and generally overhauled. The strap for the connecting-rod required refitting, but instead of making an entirely new strap, the old one was heated to a red heat across the end and immersed in cold water for about one-half the thickness of the stock; thus the outside portion contracted and compressed the inner portion in a manner similar to that explained in the article referred to. This method might be used to advantage in many cases, if it were better known.

Los Angeles, Cal. John A. Wood

EFFICIENCY OF WORM GEARING

We have read with much interest the article published in the September issue of Machinery entitled "Efficiency of Worm Gearing for Automobile Transmission." We have made a large number of tests on worm gearing in these works and our results do not confirm the results given in the article in question. We should be glad, therefore, to have certain points explained. The general trend ef the tests given in Tables I to V shows that the efficiency decreases with decreasing load, which is entirely opposite to our results.

It appears to us that the loss in friction is proportional to the working pressure between the teeth, and, therefore, when the working pressure is less, the loss in friction is less. However, in Table III, "Second Speed" test, the loss at 36.95 H. P. is 0.84 H. P., and at 19.12 H. P., 1.14 H. P.; also, in the same table on the "Direct Speed" the loss at 49.35 H. P. is 1.21 H. P., and at 30.73 H. P., 1.89 H. P. We cannot see how these figures—and there are several similar cases in the other tables—can be substantiated.

We also note that later in the article appears the following remark: "The higher loads indicated were abnormal for the gears under consideration, and would not occur in any use to which the gears would normally be put." A consideration of the tables shows that as the highest efficiencies are always obtained at these abnormal loads the gear should surely be taken to be correctly rated for these loads, and a *smaller* and (according to these results) *more efficient* gear should be designed for the *normal* working load required. It also appears from the tables that if the load were still further increased, an efficiency of 100 per cent might readily be obtained.

In conclusion, we may say that our experience gives the following general results, *viz:* that the efficiency of a correctly designed gear increases considerably under light load and decreases under overload, and that the temperature rise of the oil is an exact measure of power loss in the gear.

Manchester, England. Henry Wallwork & Co., Ltd.

I have read with much interest the comments made by Henry Wallwork & Co., Ltd., Manchester, England. In drawing the efficiency curves in Fig. 11 (September number) no attempt was made to smooth out the curves and so eliminate any inconsistencies which appeared. In the very nature of things it is impossible to obtain absolute accuracy in results where it is necessary to measure small differences of power, as in this case, especially when the speed of the instrument measuring input varies from that of the one measuring output.

I note that Henry Wallwork & Co. questions the decrease of the efficiency with decreasing load, and that their tests show entirely opposite results. It is certain that the friction of the gears does not vary directly with the tooth pressure. In other words, in wide variations of tooth pressure the friction does not vary widely. This being the case, the efficiency must increase with the load. Take an extreme case as an example: Assume that the friction does not vary at all, and is, in a given case, let us say, one horsepower. If, under these conditions the gear transmits two horsepower the efficiency would be 50 per cent. If the same gear transmitted 100 horsepower the efficiency would be 99 per cent. Of course, this is not intended to apply to any actual gear system, but is merely mentioned to illustrate the point that, in general, it should be expected that the efficiency would increase with the load until the breaking down point of the gear surface is reached.

In reference to the statement that the loads indicated were abnormal for the gears under consideration, this statement merely refers to the load to which the gears will be subjected when placed in an automobile transmission. It would be perfectly proper and normal to transmit the higher loads by means of these gears, but they are certainly in excess of what would occur in an automobile.

Providence, R. I. William H. Kenerson

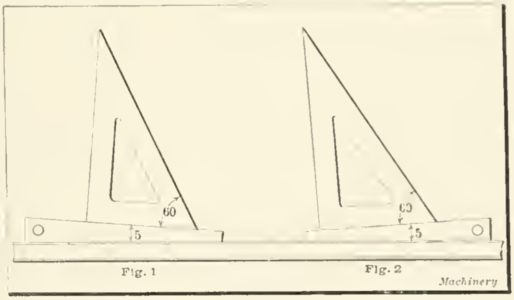
"DEVICE FOR DRAWING DOTTED LINES"

On page 215 of the November, 1912, issue of Machinery, engineering edition, I note an article entitled "Device for Drawing Dotted Lines." As the device referred to in said article is the subject of a patent granted to the writer (965,945, dated August 2, 1910) please print this notice in the December issue to inform your readers accordingly, so that they may avoid infringement thereof. It is the intention of the writer, who is a patent attorney, to prosecute any form of infringement of said patent to the fullest extent.

13-21 Park Row, New York Benjamin Roman

SUPPLEMENTARY ANGLE FOR DRAFTSMEN

The supplementary angle shown beneath the triangles in the accompanying illustration consists of a piece of celluloid with two of its sides or edges at an angle of five degrees to each other. With one of these angles, and the regular 45 or 30—60-degree triangles, all angles at intervals of five degrees from 0 to 360 degrees can be drawn. Fig. 1 shows the 60-degree angle combined with a 5-degree angle in such a way as to make it possible to draw an angle of 65 degrees. In Fig. 2 the 5-degree angle is reversed, making it possible to draw an angle of 55 degrees.



Method of using the Supplementary Five-degree Angle

Drafting Room

[A device of a somewhat similar nature has been invented and patented by James Dangerfield, and was described in the August, 1903, number of Machinery. The difference between the device here mentioned and that of Mr. Dangerfield's is that the latter consists of a set of ten angles from 1 to 10 degrees. This makes it possible to obtain accurately every whole-degree angle from 0 to 360 degrees. Sets are also made with two additional $\frac{1}{4}$- and $\frac{1}{2}$-degree angles, making them practically as universal as the regular draftsman's protractor. —Editor.]

DRILLING HOLES IN GLASS

Occasionally we are called upon to do small jobs of drilling holes in glass. The common method known to the writer is a long and tedious process, *viz:* placing a short piece of brass tubing the diameter of the hole desired in the drill chuck and grinding the hole through the glass with powdered emery and oil. A more effective and simpler way is to take a rat-tail file about the size of the hole to be drilled and break it at about the middle so that while drilling it will not wedge the hole. Place the tang end of the file in the drill press chuck and run at high speed. Place the glass under the rapidly revolving file and let the file come gently in contact with the glass by moving the handle up and down. For a lubricant use turpentine. In this way holes are drilled in one-fourth the time required by the old method.

Chicago, Ill. O. M. Hance

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

ACTION OF BELTS WHEN THE SHAFTS ARE OUT OF PARALLEL

The answer in the October number to the inquiry regarding the action of belts on pulleys is correct in part only. The crowning of the pulley faces causes the belt to run to the "high side," that is, crowd to the center where the diameters are largest, as you state. But when the shafts are out of parallel the belt runs to the "low side," and if the shafts are badly out, the belt will run off from the low side. In other words, a high side made with a "monkeywrench" (shafts out of parallel) does not act like a crowned face. I have had many years' experience with pulleys and belts and have never known them to act in the contrary way, as described in your answer.

Amherst, Nova Scotia B. G. Cox

DIES FOR NAIL-MAKING MACHINERY

G. W. E.—I would like to obtain information on the making and tempering of dies used in nail-making machinery. At present we have to anneal, redress and temper the dies whenever they become worn, having for this purpose a gas stove with pyrometer for hardening and an oil bath with thermometers for tempering. We feel, however, that our practice is defective in comparison with that of some American firms, who we believe, regrind the cutters several times without drawing the temper. We have tried grinding the vees inside to about a fifty-degree angle, but encountered the difficulty that carborundum wheels will not keep the necessary sharp edge. Apparently it would be necessary to use a steel disk studded with diamond dust to secure the desired result by grinding.

A.—The subject is of sufficient importance to make a full reply from any reader having had general experience on the maintenance of nail-making machinery, of general interest. We will be glad to receive contributions on the subject.

STRAIGHT FACE VS. CROWN FACE IDLER PULLEYS

W. M. F.—Are idler pulleys which run on the outside of opposite side of the belts on transmission pulleys usually made with straight or crown face—and why?

A.—Practice differs. The H. W. Caldwell & Son Co. furnishes straight face pulleys for idlers. The reason given is that the driving and driven pulleys having crown faces, of course, the belt is kept in the center of these pulleys by the crowning. If the intermediate idler pulleys are also made with a crown face, and if the crown is not exactly in line with the crown of the driving and driven pulleys, there will be an objectionable moving back and forth of the belt. The Dodge Mfg. Co. makes idler pulleys both crown and straight face, depending upon the condition, but the greater part of its product is made with the crown face, and crown face pulleys are furnished when not otherwise specified. The reason given for preferring the crown face idler pulley is that it is often necessary to "lead" the belt slightly and a crown face idler assists in doing this. No objection, however, is offered to the straight face idler, and either type is furnished when specified.

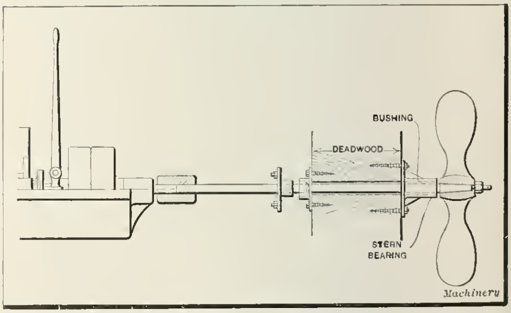
TOOLING FOR INTERCHANGEABLE MANUFACTURE

A. L. B. Co.—The question has arisen in our factory as to whether or not it is necessary to build a model machine to construct the tools, jigs and fixtures for same, provided the machine is known to be practically correct from a manufacturing standpoint, but not mathematically correct in all its parts. The machines were originally built without drawings and little by little were improved until we have a practically standard machine. About two years ago one was disassembled and drawings of the parts made, no assembly of the machine having been made or any methods used to check the accuracy of the parts. We attempted to use these drawings in conjunction with parts of the machine in making jigs and fixtures, but found that it was not feasible to proceed in this manner because of variations in dimensions of parts. The question is, how should we proceed? Do you think it necessary to build a sample machine first to check the drawings for accuracy and then make the tools and jigs to manufacture the parts?

A.—The exact procedure in tooling for manufacturing is something on which probably there would be no general agreement among toolmakers and manufacturing experts who were given the problem to solve. It would depend very largely on the type of machine, size of parts and the degree of accuracy required. In general, we would say that the handmade machine should be disassembled and accurate drawings made of every part. No changes whatever should be made in dimensions or shapes except in those parts immaterial to the working of the machine. Having made the drawings, jigs should be made for each part using the part to get the shape, distance between holes, etc. Where great accuracy of related parts is required, and trouble in the functioning of the machine is anticipated, the jigs for the parts should be made simultaneously, and changes made if required to secure closer adjustments. Having proved the dimensions and shapes of these parts satisfactory, the drawings should be changed and corrected when necessary to agree. The work should be laid out so that the machine can be assembled, and each part checked by the pieces produced in the jigs. When the work has proceeded to the finished stage, a complete manufactured machine will have been produced from the jigs, each jig having been proved as the work proceeded. It cannot be said that this procedure would invariably result in an absolutely perfect machine, but the probabilities are that the change required would be of an insignificant character, not expensive to make. Suggestions from readers who have had experience in tooling for interchangeable manufacturing are invited.

HOW TO FIX A BUSHING ON A PROPELLER SHAFT

S. H. S.—Will you kindly advise me if there are any effective methods of fixing bushings on propeller shafts where they bear in the stern bearing of a boat? The illustration shows the manner of installation. The shafts are tobin bronze and the bushings are bronze, being from ¼ inch to ⅜ inch thick, 8 inches long on a 2½-inch diameter shaft. I have shrunk and pinned the bushings on and have sweated them on, but they all work loose sooner or later. The bushings run in lignum vitæ lined bearings or bronze bearings. The reason I have deduced for the peculiar loosening up of the bushings is that, being under water, more or less sand and dirt get into the stern bearing and quickly wear it so as to let the shaft pound or hammer, which causes the bushing to stretch and loosen on the shaft. The harder and thicker the bushings are made, the longer they last, but all of them loosen if used long enough.



A.—The oxy-acetylene process might be used to secure a sectional bushing which could be applied as a series of narrow rings and successively welded to the shaft. This method is slow and rather expensive and perhaps the readers can suggest simpler and more effective methods.

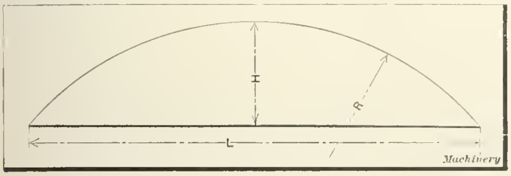
TO FIND RADIUS OF ARC WHEN LENGTH OF CHORD AND HEIGHT OF ARC ARE GIVEN

J. E. H.—Kindly give me a formula for finding the radius of a circular arc when the length of the chord and the height of the arc or segment of the circle are given, as indicated in the accompanying illustration.

A.—A formula for obtaining the radius of a segment, when the data mentioned above are given, was published in MACHINERY in November, 1906; this formula may also be found in the engineering handbooks. If L is the length of the chord; H the height of the arc; and R the radius to be found, then:

$$R = \frac{\dfrac{(\frac{1}{2} L)^2}{H} + H}{2}$$

This formula looks rather cumbersome and could be somewhat simplified so as to take the form:

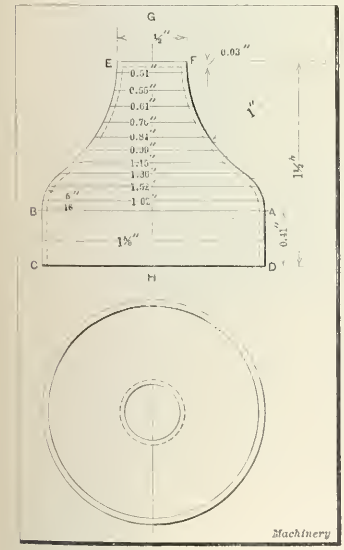


$$R = \frac{(\frac{1}{2} L)^2 + H^2}{2H}$$

The second form of the formula, however, requires more numerical calculation than does the first, which, therefore, is preferable.

TO FIND THE AREA OF A SURFACE OF REVOLUTION

R. B. H.—I would like to see a formula published for finding the outside area of sheet metal cups. An example of the kind of cups referred to is shown in the accompanying illustration.



A.—No general formula can be given for obtaining the area of a symmetrical body of the form shown in the illustration. However, the approximate area can be found by a comparatively simple method. In the illustration, the dimensions written in common fractions are the given dimensions. Those written in decimals are found by actual measurement on a figure drawn to scale. The method of finding the area is as follows: First separate such areas as are cylindrical, conical or spherical, as these can be found directly by exact formulas found in all engineering handbooks. In the example shown, $ABCD$ is a cylinder, the area of the surface of which can be easily found. The top area EF is simply a circular area, and can thus be computed separately. The remainder of the surface generated by rotating line AF about the axis GH is found by the approximate method to be explained. From point A, set off equal distances on line AF. In the present case each division indicated is ⅛ inch long. From the central or middle point of each of these parts draw a line at right angles to the axis of rotation GH, measure the length of these lines or diameters (the length of each is given in decimals), add all these lengths together and multiply the sum by the length of one division set off on line AF (in this case, ⅛ inch), and multiply this product by π. This gives the approximate area of the surface of revolution.

In setting off divisions ⅛ inch long along line AF, the last division does not reach exactly to point F, but only to a point 0.03 inch below it. The part 0.03 inch high at the top of the cup can be considered as a cylinder of ½ inch diameter and 0.03 inch height, the area of the cylindrical surface of which is easily computed. By adding the various surfaces together we get the total surface of the cup as below:

Cylinder, 1⅝ inch diameter, 0.41 inch high,	2.093 square inches
Circle, ½ inch diameter,	0.196 square inches
Cylinder, ½ inch diameter, 0.03 inch high,	0.047 square inches
Irregular surface,	3.868 square inches
Total,	6.204 square inches

The method used in finding the area of the irregular shaped part of the cup is based on the Pappus or Guldinus rule, which states that the area of a surface generated by the revolution of a line about a central axis equals the length of the line, multiplied by the path of its center of gravity, the line being considered as a fine wire. As it is a matter of considerable difficulty to find the center of gravity of an irregularly curved wire, the simplest way in which this method can be applied is to divide the irregular shaped line into a number of parts, each one of which can be considered as a straight line, having its center of gravity at the middle of the line. In this way we find the area of each one of the divisions by multiplying the length of the division by the circumference of the circle which passes through its center of gravity. As all the divisions, in our case, were made of equal length, the simplest method was to add the lengths of all the diameters of these circles together, and then multiply by π and by the length of each division, ⅛ inch.

In testing out the accuracy of this method, the surface of a half-sphere 6 inches in diameter was found by dividing a great circle into parts ¼ inch long and finding the area by this graphical method. The exact area of this half-sphere is 56.55 square inches. The graphical method, using only an ordinary draftsman's scale, compass and triangle, gave an area of 55.28 square inches, which may be considered fairly accurate for an approximate method. The half-sphere was selected for the test case because it presents one of the difficult shapes for the application of this method, as the curved outline merges from a vertical into a horizontal direction; the surface being convex throughout, the errors are also likely to be all in one direction. A more accurate result may be expected when part of the surface is convex and part concave.

* * *

NEW ALUMINUM REDUCTION PLANT

The General Electric Co., Schenectady, N. Y., is building seven vertical water wheel type direct-current electric generators for the new plant of the Southern Aluminum Co., at Whitney, N. C. Each machine will have a rating of 5000 K. W., delivering 20,000 amperes at 250 volts at a speed of 170 R. P. M. They will be the largest direct-current machines built. Two similar direct-current generators of the same type rated at 2500 K. W. and two 1250 K. V. A. alternators will be also installed. The Southern Aluminum Co. is capitalized at $8,000,000 and will become an important factor in the production of aluminum. The plant will be in operation about the middle of 1914, and will rank among the greatest and best equipped for the manufacture of aluminum in the United States. In the complement of buildings are nine furnace rooms, wherein the aluminum will undergo the various processes incident to conversion into aluminum. Each of these structures measures 60 by 500 feet and one electrode factory of similar dimensions is also included in the group. Aluminum, because of its lightness and toughness, is becoming of more and more importance in many lines of industry. Aluminum wire and cable are displacing copper for the transmission of high tension electric energy. It is made from a clay known as bauxite, found extensively in Georgia and the Middle West. The Southern Aluminum Co. will treat only alumina which has been made from bauxite. The engineering work is in charge of Dr. Paul Heroult, a prominent French engineer.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

AMERICAN HIGH-SPEED SENSITIVE RADIAL DRILL

The American Tool Works Co., Cincinnati, Ohio, has added to its line the high-speed sensitive radial drill illustrated herewith. This machine is designed for drilling and tapping small holes at high speed. It is said to combine the high-speed efficiency of the plain sensitive drill with the productive capacity of the radial drill. Convenience in operating a machine of this type is an essential feature, as the actual time consumed in drilling a hole is often very small as compared with the time which elapses before the machine is set to drill the next hole. The importance of this consideration has been kept in mind in designing the present machine, and all levers and other operating members have been conveniently located for the workman, in order to simplify the operation of the machine as much as possible.

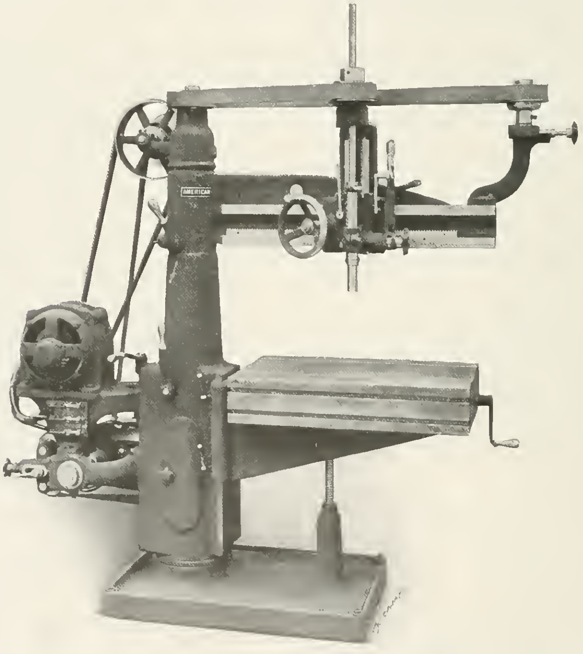


Fig. 1. Motor-driven Radial Drill equipped with Elevating Table and Tapping Attachment

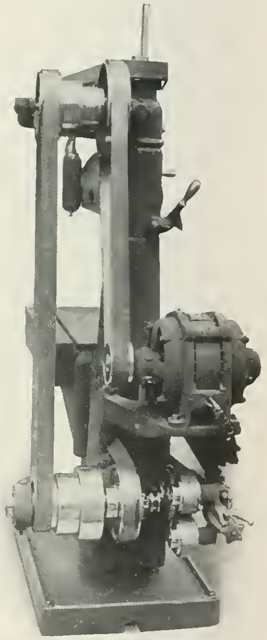


Fig. 2. Arrangement of the Drive

The feed lever is located on the head within easy reach of the workman's right hand, affording a convenient means of operation and obviating any possibility of interference with the work set up on the table. Another advantage of the ratchet lever feed used on the American sensitive radial drill lies in the fact that the lever is automatically disengaged from the rack pinion shaft when it is placed in its vertical position, so that the spindle can be quickly adjusted up and down by means of a small star knob on the end of the rack pinion shaft. This affords a rapid and convenient method of bringing the drill to and from the work.

The head is accurately balanced and can be moved rapidly along the arm by means of a rack and pinion operated by a handwheel. This handwheel is located on the front of the head on the operator's left-hand side, enabling him to swing the arm with his right hand and at the same time adjust the head along the arm with his left hand. The arm binding lever is located on the column end of the arm, where it is always within easy reach of the operator. The head is of very simple design, consisting of a main saddle which has a bearing on the arm and carries an auxiliary head upon a vertical dovetail. The sliding head is so arranged that it can be moved to or from the table, thus affording accommodation for quite a wide range of work. The auxiliary head can be securely clamped at any point along the dovetail by means of a lever conveniently located on the front of the saddle, while the head proper can be firmly bound to the arm by a lever on the back of the saddle which is within easy reach of the operator when he stands at the front of the machine.

In the elevating table type of machine shown in Fig. 1, the table is of semi-box construction, affording a large working surface. It has a bearing of ample width on the face of the column which insures a high degree of rigidity, and is equipped with a gib adjustment and two binders for locking it securely in position. The vertical movement of the table is accomplished from the front by means of a crank which imparts motion to the elevating screw through a pair of miter gears located under the table. The arm is of the American parabolic beam and tube section which has proved itself to be exceptionally rigid on the larger sizes of radial drills. Its construction is such that the lower line is parallel with the table, thus enabling the full capacity of the drill to be utilized at any point along the arm. It swings easily on the column and may be securely clamped in any position by means of a convenient binding lever. The arm does not move vertically; therefore provision is made on the head for variable heights of work.

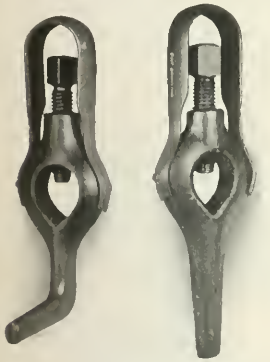
There are no gears in the driving mechanism of this drill from the countershaft to the main spindle, the drive being effected by means of a two-inch double belt running at high speed. This drive transmits an abundance of power directly to the spindle of the drill, the spindle belt being kept at the proper tension by turning the star knob located on the arm bracket. All of the driving and idler pulleys are equipped with special ball bearings which consist of a double set of hardened and ground ball races and cones; one set is located at each end of the pulley journals. These bearings are so constructed that they are dustproof and form a retainer for the lubricant; vaseline or graphite is preferable for this purpose and need only be renewed at long intervals. The countershaft is especially designed for high-speed work and provides for two speeds. The hanger boxes are of an improved gravity and wick oiling type, taking their supply from large oil reservoirs and only needing attention at long intervals. The countershaft carries a three-step cone pulley with a pair of friction pulleys 10 inches in diameter and 3 inches face, and should run at 310 and 387 R. P. M.

This machine may be equipped with a tapping attachment, and with belt-driven machines so equipped a single-speed countershaft is furnished with six spindle speeds which are obtained through a three-step cone pulley and a pair of friction pulleys of different diameters located on the rear of the machine.

The spindle is of high-carbon crucible steel, accurately ground and provided with a dustproof self-lubricating ball thrust bearing. It has six changes of speed ranging from 300 to 900 R. P. M. in geometric progression, and is provided on the top with an adjustable stop-collar which may be used as a depth gage. The column is of tubular section, ribbed internally to provide the necessary rigidity. In addition to the type of machine illustrated, this radial drill is built with a stationary table, or with a pedestal base which makes it especially suited for large sizes of work. The regular equipment includes a countershaft and belts, no wrenches being required. All of the motor-driven machines are regularly equipped with a tapping attachment.

BILLINGS & SPENCER SAFETY LATHE DOG

The safety lathe dog illustrated herewith is the product of the Billings & Spencer Co., Hartford, Conn. This form of dog embodies the simplicity, strength and convenience of the ordinary dog with the additional advantage of safety. The essential parts are the same as the design which is universally used, including the regular square head, so that no special tool is required for adjustment. The guard consists of a cover for the screw which is easily manipulated, being merely pushed to one side when it is required to uncover the screw head. The guard is then sprung back into position forming perfect protection for the operator. This dog has been thoroughly tested in the manufacturers' shops and has proved efficient under all conditions.

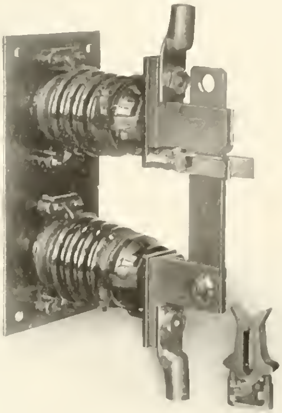


Billings & Spencer Safety Lathe Dog

LOCKING DEVICE FOR ELECTRIC SWITCHES

The locking device for electric switches here illustrated has recently been developed by the General Electric Co., Schenectady, N. Y., to eliminate the delays which are frequently caused by having machinery shut down through interruption of the power service. This device prevents the blade of a disconnecting switch from opening except where it is intentionally pulled by the operator. Instances are on record where the blades of a disconnecting switch, not protected by this device, have been thrown open or partially open by magnetic repulsion and destroyed when a short circuit has occurred on the line. In such a case, the destruction of the switch means that the circuit will be put out of commission while a new switch is being installed, unless there are duplicate circuits.

This safety locking device is a unit in itself and can be easily applied to any G. E. type L, Form G6 switch by merely clamping it to a support placed between the clip block and the insulator cap. It is designed to be operated with a switch hook and consists essentially of two brass bell cranks, hinged together at the ends of two shorter arms and held closed by compression springs. The projections or jaws in the outer ends of the two longer arms close in front of the blade, thus preventing the latter from coming out of the clips. Each bell crank is provided with a dog which moves in a slot in the bell crank elbow, the dog being hinged at this point. Two compression springs, one pressing outward from the switch base against the elbow of each crank and also against the dog, keep the bell cranks closed and the dogs pressed against the back of the switch blades.



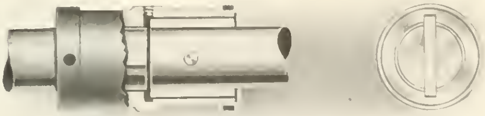
Locking Device to prevent Electric Switches from being accidentally opened

To open the switch, the outer ends of the bell crank are pressed back away from the blades, allowing the dogs to come forward and rest upon the sides of the blades; in this position they hold the jaws apart in front of the blade and allow the switch to be opened. Withdrawing the blade of the switch from between the dogs causes the jaws to automatically close against the sides of the blades and to snap shut as soon as the blade is completely withdrawn. As the outer edges of the jaws are beveled, the switch blade can be readily pressed back to the closed position between the clips, when the jaws close automatically in front of the blade, locking the latter in the closed position. The operator cannot forget to lock the switch closed because it automatically locks itself. This device is made in standard sizes to fit 300, 600, 800 and 1200 ampere switches, and can also be furnished for a switch of any other capacity.

MC EWEN IMPROVED STEEL COUPLING

A new form of flexible coupling, constructed entirely of crucible steel, has recently been introduced by McEwen Bros., Wellsville, N. Y. It is known as the McEwen coupling, and being small and consequently light in weight, it is particularly suited for classes of service in which it is necessary to reduce inertia as far as possible.

The keys extend right through the shafts and are set at right angles; provision is made to take care of a reasonable amount of non-alignment, but the ample key bearing surface and exceptionally good lubrication does away with any noise or tendency towards serious wear. This type of coupling was first used on McEwen Bros.' pumps, direct-connected to steam turbines, where it was kept in continuous service for several months at a time. The ability of the coupling to stand up under such a severe test appears to demonstrate its fitness for a variety of classes of service; such as reversible motor drive for machine tools, blowers, rotary pumps, and a variety



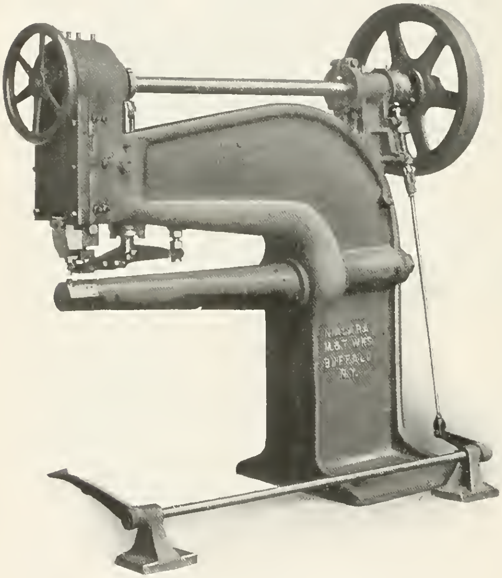
McEwen Improved Steel Coupling

of other cases where high speeds make the conditions of service particularly trying.

NIAGARA PUNCHING AND RIVETING PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has recently added to its line the punching and riveting press illustrated below. This machine is designed to handle punching and riveting work in the manufacture of pipe, culverts, etc. Two thicknesses of material are punched and, at the same time, a rivet put in the hole punched on the previous stroke is headed, the rivet being inserted with the head upward. This method of combining riveting and punching in one operation, saves time, but is only applicable when the rivets are uniformly spaced. The distance between rivets can be varied from 1 5/16 to 2 3/4 inches.

The rivet header and punch are mounted in adjustable holders fastened to separate slides; these slides are actuated by two eccentrics and pitmans from the main shaft. It is also possible to use this machine entirely for punching holes or for riveting, or it may be used for punching and riveting alternately. When it is desired to use the machine entirely for riveting, the operator can quickly put the punch out of operation by means of a gag. When it is desired to punch without riveting, the rivet punch will run idle. The stripper or hold-down, which is actuated by a cam, clinches the material while it is being operated upon, and then strips the stock from the punch on the up stroke. The press is provided with an automatic jaw clutch and the motion of the slides can be started either by means of a hand-lever or a foot treadle. When the lever and treadle are released, the slides stop automatically at the top of the upward stroke. The machine has a throat 36 inches deep and the horn is a steel forging 5 inches in diameter at the outer end and 7 inches in diameter at the inner end. The press will upset a rivet cold up to ¼ inch in diameter, and will punch a hole ⅜ inch in diameter through ¼-inch iron or its equivalent. The gross weight of the machine is about 3600 pounds.



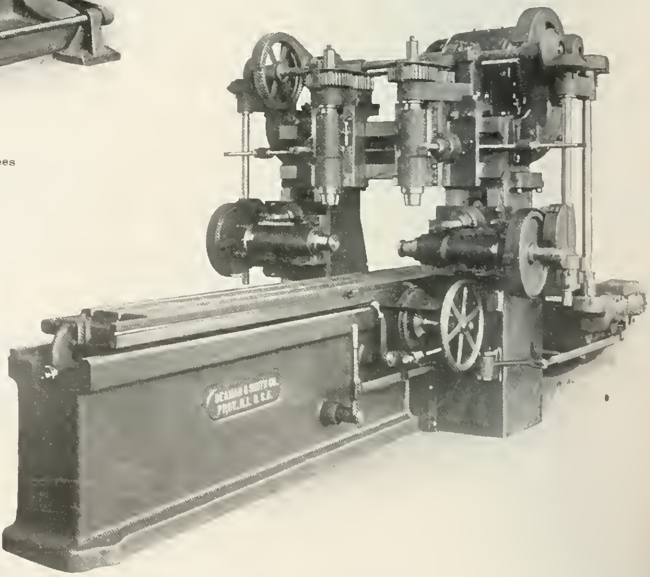
Niagara Punching and Riveting Press

BEAMAN & SMITH FOUR-SPINDLE MILLING MACHINE

The four-spindle milling machine illustrated herewith is a recent design built by the Beaman & Smith Co., Providence, R. I. Reference to the illustration will show that there are two horizontal and two vertical spindles, the former having a vertical movement on the uprights and the latter a horizontal movement on the cross-rail. The table has a working surface 17 inches wide by 10 feet long; it has three T-slots finished from the solid metal and two rows of holes for stop-pins. The movement of the table on the bed is 10 feet 9 inches, and it is provided with a power traverse of 10 feet per minute in either direction. The automatic stop and feeds are arranged to maintain the desired rate at any spindle speed, which is a very important feature, as the rate of feed determines the quantity of work produced. The table is operated by a screw revolving in a bronze nut, the thrust being taken by ball bearings. Positive feeds for the table are provided by means of a geared feed-box which is conveniently located, and the change from one rate to another can be quickly obtained. There are nine changes ranging from 1 inch to 12.3 inches per minute at a driving-shaft speed of 500 R. P. M.

The spindles are of crucible steel and run in boxes of hardened bronze. They have a 6-inch independent adjustment and the ends are tapered to 3¼ inches in diameter for face milling cutters; No. 12 Brown & Sharpe taper holes are provided for cutter shanks and arbors. Each spindle has a hole through its center for the retaining bolt. The front bearings are 3⅞ inches in diameter by 5 inches in length, and are provided with means to compensate for wear. The rear bearings are 2¾ inches in diameter by 4¾ inches in length. All of the spindles are driven in unison. The gearing for the vertical spindles has a ratio of 7¾ to 1 and gives a spindle speed of 66 R. P. M. For the horizontal spindles, the gearing ratio is 21¾ to 1 and gives a speed of 23 R. P. M.

The machine is driven by a variable speed, 10-horsepower motor, geared to the driving shaft in the ratio of 3 to 1; the motor speed ranges from 500 to 1500 R. P. M. This machine can also be arranged to be driven by a 5-inch belt on a three-section cone with steps ranging from 11½ to 16 inches in diameter. When belt driven, the countershaft has tight and loose pulleys 14 inches in diameter and runs at 360 R. P. M.



Beaman & Smith Four-spindle Milling Machine

The construction of the machine is in accordance with the latest practice. The quick running shafts are mounted in bronze lined boxes; the bearings are finished by grinding; all sliding surfaces are scraped to an accurate fit; all gears are cut from the solid, the bevel gears being made by the Bilgram process; and many of the gears are of steel. The distance between the uprights is 30 inches; and from the ends of the vertical spindles to the top of the table, the least distance is 9 inches and the greatest distance, 15 inches; the least distance between centers is 10⅝ inches and the greatest distance, 30 inches. From the center of the horizontal spindles to the center of the table, the least distance is 4 inches and the greatest distance, 10 inches; between the ends, the least distance is 6 inches and the greatest distance, 18 inches. The weight of the machine is approximately 20,000 pounds.

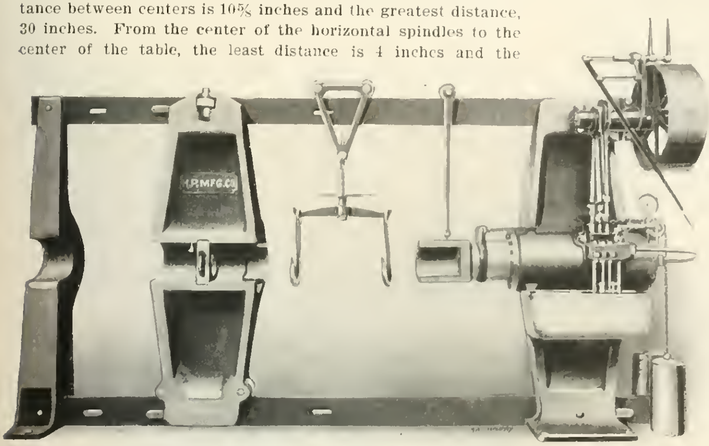


Fig. 1. Press for forcing Railway-car Wheels on and off Axles

THREE HYDRAULIC PRESSES

The Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio, has recently placed upon the market three hydraulic presses which are illustrated in Figs. 1, 2 and 3. The press shown in Fig. 1 is designed for forcing railway-car wheels on and off the axles, and delivers a firm steady pressure that will seat the wheel securely. Strength in all parts is obtained by the use of steel instead of iron or semi-steel. The steel cylinder is much lighter than when made of cheaper material, and is also far more dependable in service. Pressures up to 2500 pounds per square inch are available, and this is quite sufficient for the work done by this machine.

The ram has a long bearing in the cylinder which insures freedom from binding. As soon as the pressure is released, the ram is drawn back by weights and chains, and in order to enable it to withstand heavy pressure, the ram is faced with a hardened steel bearing. The resistance head is provided with a throat which serves the double purpose of a guide and stop. The parallel bars are slotted and provided with keys for shifting the resistance head to the right distance from the ram. This resistance head, in addition to the adjustable lifting hooks and hollow pressure block, shifts on the parallel bars by means of rollers. The press is operated by a motor drive or by a power attachment, with tight and loose pulleys for operating with a belt. It is equipped with from one to four pump plungers which can be arranged to drive the ram at any desired speed. The bronze pump flanges are driven by eccentrics and knockout attachments control the speed of the pump without stopping it.

The portable inverted press illustrated in Fig. 2 was built for the U. S. Government for forcing and general purposes; it is to be used at the Purdue University Experiment Station. One of its striking features is the unobstructed daylight space which makes it possible to place the press in contact with all sizes of machinery. By simply boring a hole in the platen, the press can be used for forcing wheels on and off shafts. The ram is returned by a rack and pinion which is placed back of the cylinder to be out of the way. The parts of the press taking stress are constructed of steel, the cylinder being made separate from the beam. The wheels have roller bearings which make the movement of the press from place to place an easy matter. The pump is small and compact, having a ⅝ inch piston with a 3½ inch stroke; the piston guide is made in one piece and serves the double purpose of guide and fulcrum for the pump handle. A safety valve in connection with the pump protects the frame against overload.

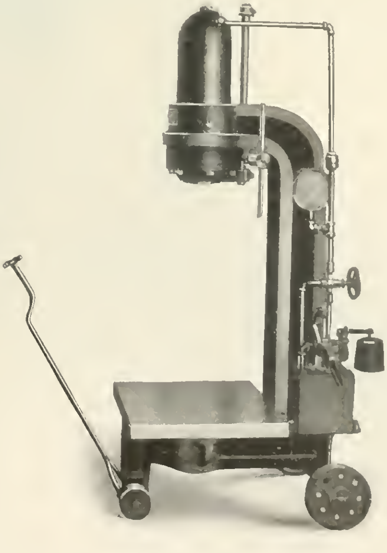


Fig. 2. Forcing Press built for Purdue University Experiment Station

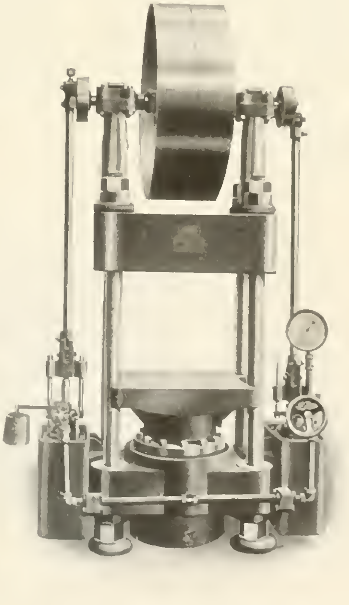


Fig. 3. Forming Press designed for Heavy Work

Fig. 3 illustrates a forming press which could also be applied to a variety of general classes of heavy work. The press is entirely above the floor line and can be easily installed. The speed of the ram in starting is increased by placing two pumps on the press. The platen, pressure head and strain rods are of steel, and are designed to withstand the great stress to which they are subjected in operation. A maximum stress of one hundred tons will seldom be exceeded in the general run of work, but a safety valve and pressure gage are provided to guard against overload. The power attachment is very simple and is located where it will not interfere with the operation of the press in any way.

EDGEMONT PLATE-TYPE FRICTION CLUTCH

The plate-type of friction clutch shown in Figs. 1 and 2 is an addition to the line of friction clutches manufactured by the Edgemont Machine Co., Dayton, Ohio. This friction clutch consists principally of three disks, enclosed in an outer casing provided with a hub on which the pulley or pulleys are held. (A two-piece sheet steel pulley is shown in place in Fig. 1). As shown in Fig. 2, the outer casing is provided with an internal rib, slotted to fit two keys formed on the "floating" disk which is faced on both sides with "burn-proof" brake lining. This central disk is free to "float," but cannot rotate independently of the outer casing.

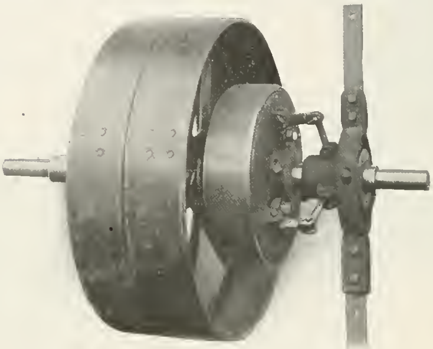


Fig. 1. Edgemont Friction Clutch with Pulley attached

The lever plate to the right (see Fig. 2), is provided with lugs, and is also furnished with a hub to which the plate to the left, is keyed, but is free to slide laterally when operated by the studs and levers shown. These two plates form the outer friction members of the clutch, and when brought into contact with the friction surfaces of the "floating" disk, rotate the outer casing and consequently the pulleys which are held on it. The lever plate which is held to the countershaft by a set-screw or key is drilled to receive three studs, provided with adjusting nuts, and held in the plate to the left. These studs are pulled out by the shoe ends of the levers which are held in the lever plate and operated by the other three levers, sliding sleeve and shifter.

Now, when the shifter rod is forced to the left, it forces the sliding sleeve inward "expanding" the levers, and through the medium of the cam ends of the levers in the lever plate, pulls out the studs, drawing the plate in and exerting a friction between the three surfaces. Then as the lever plate is held to the countershaft, it follows that all the members of the friction clutch rotate when held together by the friction exerted between their surfaces. When the shifter rod is forced to the right, the action on the levers is just the reverse of that described, and as coil springs are interposed between the inner surfaces of the two outer plates, they are automatically separated when the studs are allowed to go back. The adjusting nuts on the studs are used to give the desired amount of friction required for driving.

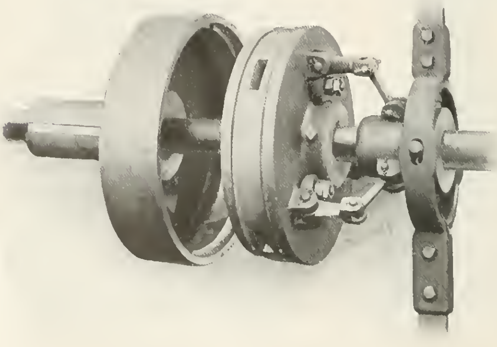
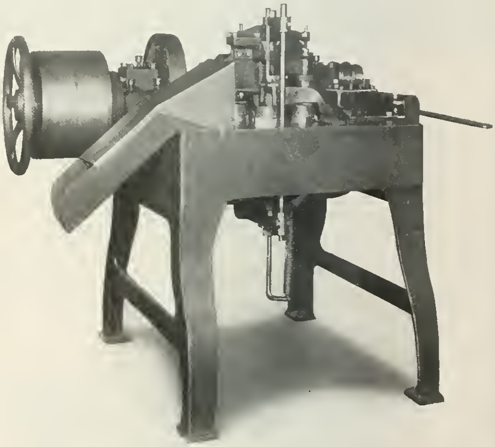


Fig. 2 Details of the Clutch Mechanism

One feature of this clutch, which is especially commendable, is that its friction plates do not require oiling. The friction lining can also be renewed without removing the clutch from the shaft. This clutch can be operated at high speeds, and is suitable for very heavy duty. It can be applied to line-shafting, countershafts, etc., and is furnished in either the extended sleeve type (shown in Fig. 2), or with the cut-off coupling; this type is used for connecting two line-shafts, and enables one section of the "line" to run while the other shaft is stationary, or when the clutch is "connected" both shafts can be rotated.

BLISS AUTOMATIC TRIMMING AND CURLING MACHINE

A special machine recently designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for trimming and curling the flanges of drawn cups, is shown in the accompanying illustration. The machine consists of a vertical turret with six spindles, each of which is equipped with a chuck. The spindles are revolved continuously by spur gearing, and the turrets intermittently by a Geneva movement. The operator places a cup on the chuck as it appears in front of him; the chuck then moves in position for the trimming cutters. There are two rotary cutters which are mounted in a slide and driven by a chain and sprockets. The slide moves by cam action in toward the chuck and the flange on the cup is trimmed. The scrap is discharged through the machine.



Bliss Automatic Trimming and Curling Machine

The curling of the edge is done at the two succeeding positions. When the first of these positions is reached, the edge is started, and at the next position, it is finished. For all three positions, the blank is held onto the chuck by an upper spindle which descends and clamps the blank after it has been placed in position. The discharge of the blank is effected by means of two fingers. These fingers descend on the cup, gripping it at the edge and lifting it up until a third finger strikes it; this throws the cup in a horizontal direction into the discharge chute.

The machine is semi-automatic, as the operator simply places the cup on the chuck and the machine does the rest. The capacity is about 30,000 cups in ten hours, and it will take either straight, taper, or spherical shells up to 3 inches diameter by 1½ inch high.

BRADFORD HEAVY PATTERN LATHE

The Bradford Machine Tool Co., Cincinnati, Ohio, is building a new 18-inch heavy pattern, quick change gear lathe. One of the interesting features of this lathe (a general view of which is shown in Fig. 1) is the back-gear speed-changing mechanism. In previous designs, two friction clutches for engaging the medium and large back-gears, were placed directly on the back-gear sleeve. In this design, only one friction clutch is required, which has the advantage of engaging the higher speed of the cone, as well as giving two gear reductions for driving the lathe spindle when taking heavy cuts.

With the two-speed countershaft which is regularly furnished with the lathe, eighteen spindle speeds are available. The six fast speeds are obtained by locking the cone to the face gear and disengaging the back-gear in the usual manner. The method of obtaining the remaining twelve speeds will be more clearly understood by referring to the detail view of the headstock, Fig. 2. The cone pulley, by means of an expanding clutch ring in the left end, drives double cone gears with which the back-gears *A* and *B* are in driving connection. These latter gears afford two distinct drives for the lathe spindle, the drive being in each case through the clutch member *C*, the back-gear sleeve and pinion meshing with the regular face gear *G*. The clutch member *C* and the friction clutch member *D*, are engaged and moved simultaneously by the steel cross-piece *E*, which is caused to slide on a cylindrical stud by handle *F*, and the connecting link shown. A movement to the right or left of clutch members *C* and *D*, causes the former to clutch first with either of the gears *A* or *B*, respectively, and, in both instances, the driving cone pulley is engaged in sequence by the friction clutch ring in the end of the pulley. The two back-gear speeds are available at all times without stopping the lathe. Lever *F* is provided with stop pins which prevent the action of this lever from subjecting any of the bearings or rotating parts of the lathe to end thrust.

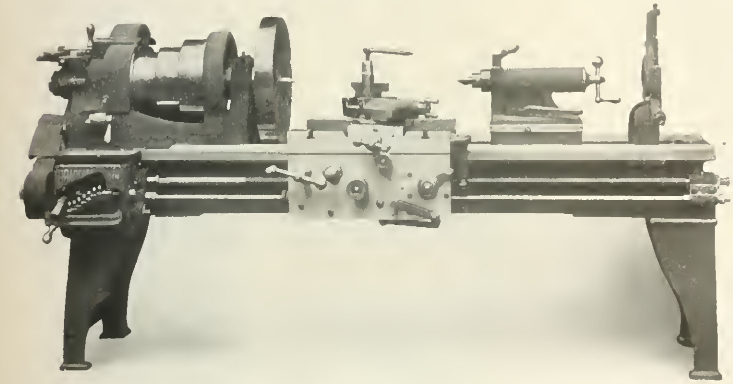


Fig. 1. Bradford 18-inch Lathe with Friction Double Back-gears

Aside from the back-gear mechanism, this lathe is similar in its general construction to designs previously built by this company. The swing over the bed is 20¼ inches; over the rest, 11⅝ inches; and over the carriage, 13¼ inches. The size of the front spindle bearing is 3 1/4 by 5 1/16 inches, and the rear bearing, 2½ by 3¾ inches. The back-gear ratios are 10.95 to 1 and 3.31 to 1. The lathe will cut threads ranging from 3 to 46 per inch, including 11½ pipe threads. The spindle is made of high-carbon crucible steel and is mounted in adjustable taper bronze bearings. It extends through the hood, allowing the use of draw bars and tubes for drawing attachments. The bed is of extra weight and depth and is webbed in two-foot sections, which gives great rigidity.

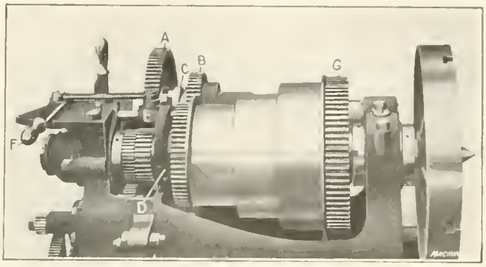


Fig. 2. Headstock of Bradford Lathe

LA SALLE COMPENSATING QUADRANT CRANE

A one-ton "compensating quadrant crane" now being built by the La Salle Machine & Tool Co., La Salle, Ill., is shown in Figs. 1 and 2. This crane was designed for service on trucks and, at the present time, is made without a turntable; that is, the crane cannot be swung horizontally. A turntable, however, which will swing from 180 to 360 degrees, can be supplied. The lower end of the boom of this crane is segment shaped and has shrouded teeth which engage corresponding rack teeth on the base. These gear teeth are shrouded to the pitch line, not so much for strength, as to provide a rolling bearing for taking the vertical thrust due to the weight of the boom and load. The shrouding is machined on the outer surface, and the gear teeth are relieved of all vertical bearing stresses.

The position of the boom is changed by turning the crank and pilot wheel shown. The motion of the crank is transmitted to the screw through gunmetal bevel gears having a ratio of

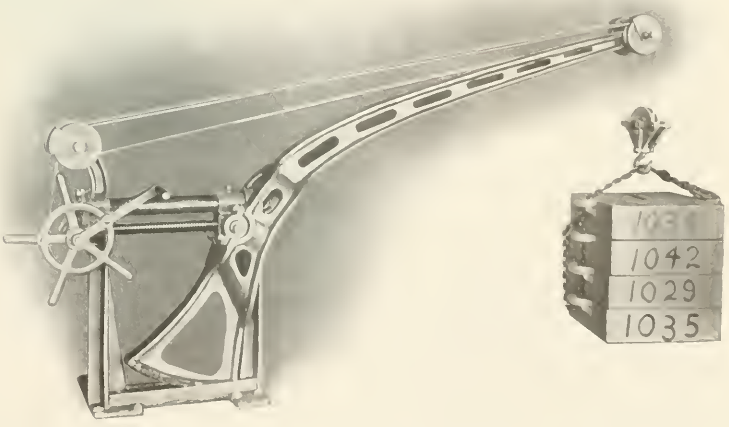


Fig. 1. La Salle One-ton Crane with Boom lowered

1½ to 1. The screw, in turn, engages a nut that is trunnioned in the boom and slides along a cylindrical rod above the screw. With this construction, one man can raise a load of one ton from the lowest to the highest position in thirty seconds.

Because of the compensating feature of the crane, the thrust on the screw is very slight and in some positions of the boom, the thrust is practically eliminated. The load also remains at about the same level whether the boom is in its lowest or highest position. The hoisting cable can be operated either by an electric hoist, in case the crane is mounted on an electric truck, or by a hoist designed to be driven directly from the transmission of a gasoline truck.

The frame, boom and nut are made of open-hearth steel castings. The tie-rod upon which the nut slides is made of cold-rolled steel covered with brass tubing. The screw is made of

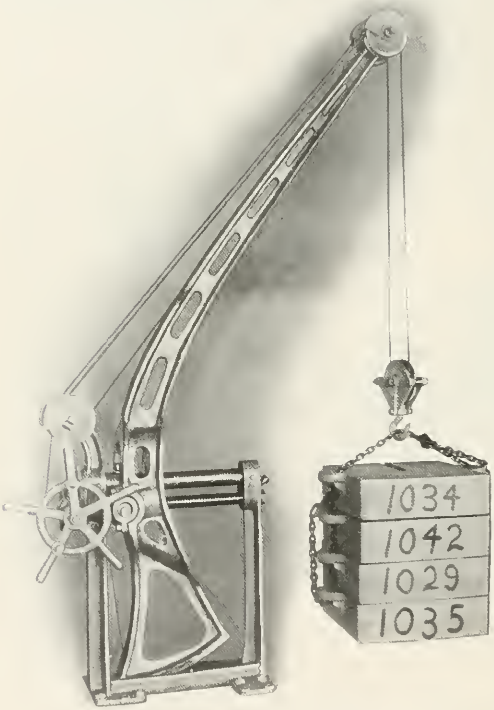


Fig. 2. La Salle Crane with Boom raised

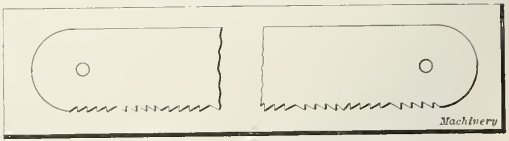
30 per cent nickel steel to avoid corrosion and is mounted in self-aligning radial and ball thrust bearings. The nut is lined with phosphor-bronze.

The figures on the weights (see illustrations) show the test load used on this crane. With this load, it is possible for one man, by means of the crank, to raise the boom from the lowest to the highest position without over-exertion. This crane has a maximum reach from the front of the frame, of 7 feet, and a minimum reach of 2 feet. The maximum and minimum heights are 9 feet 10 inches and 6 feet 2 inches, respectively.

REITLINGER DOUBLE-ACTION HACKSAW BLADE

A new type of hacksaw blade, recently placed on the market by Alex. Reitlinger, 201 William St., New York, is shown in the accompanying illustration. The design of this saw is decidedly novel. The teeth are arranged in groups of four, the teeth of each group being set in the opposite direction to those of the adjacent groups. The idea of this design is that the saw may be made to cut on both forward and return strokes. It will, of course, be evident that this type of saw is driven by a machine which is not equipped with means for lifting it out of engagement with the work on the return stroke.

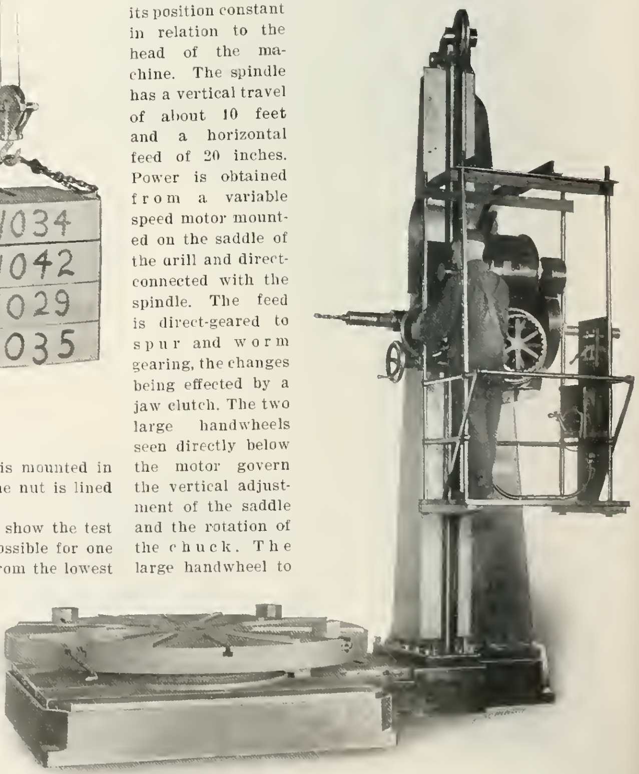
It is claimed that the ability to cut on both the forward and return strokes gives this saw a materially increased cutting capacity. An idea of the capacity may be gathered from the fact that, in a recent test, a piece of 1½-inch steel shafting was cut in three minutes and thirty-three seconds. These saw blades are now being made ½ inch in width with 16 teeth to the inch. It is also intended to make saws of this design having 11, 24 and 32 teeth to the inch; this range will provide for making saws of all necessary sizes for different classes of work.



Hacksaw designed to cut on Both Forward and Return Strokes

BAUSH BOILER SHELL DRILLING MACHINE

A boiler shell drilling machine, in which the shell is held in a four-jaw universal chuck after being rolled and may be rotated from the operating position of the drill, is one of the latest products of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. The operator stands in a cage (see accompanying illustration) which moves on the column to keep its position constant in relation to the head of the machine. The spindle has a vertical travel of about 10 feet and a horizontal feed of 20 inches. Power is obtained from a variable speed motor mounted on the saddle of the drill and direct-connected with the spindle. The feed is direct-geared to spur and worm gearing, the changes being effected by a jaw clutch. The two large handwheels seen directly below the motor govern the vertical adjustment of the saddle and the rotation of the chuck. The large handwheel to the left controls the quick adjustment of the spindle and the small one in front of it governs the clutch. The handwheel on the shaft parallel with the spindle provides for a hand feed for hand drilling or facing.



Baush Boiler Shell Drilling Machine

The machine is provided with roller and ball bearings throughout so that its operation is extremely light and sensitive, although the machine itself is of extremely massive construction, having a gross weight of approximately 30,000 pounds. The saddle is accurately counterbalanced and is raised and lowered by means of a screw which precludes the possibility of its dropping. The chuck has a capacity for shells ranging from 36 inches to 72 inches in diameter and up to ten feet in length; by reversing the work end for end, the capacity of the machine may be increased for work 20 feet in length. The chuck and its operating mechanism is a self-contained unit, so that the chuck may be lifted off the table and replaced again without the necessity of adjusting any gearing. The screws are equipped with ball thrust bearings which makes them easy to operate. The table is provided with T-slots so that it may be used for strapping down ordinary pieces to be drilled.

The machine stands 16 feet 1½ inch in height and the overall length is 14 feet. The top working surface and bed is approximately 7 feet square.

SHAW FIXED-TONGUE SWITCHES FOR MONORAIL CRANE SYSTEMS

An important improvement in the construction of monorail crane systems, in the form of a fixed-tongue track switch, has recently been made by the Shaw Electric Crane Co., Muskegon, Mich. The advantage of this fixed-tongue switch over the old-fashioned moving-tongue type, lies in the fact that it does not have to be set for the desired direction of travel. As the name implies, there are no moving parts to this switch, but it is still possible for the operator to select his route.

As the fixed-tongue switch does not have to be set for a change of direction, there is neither delay nor expenditure of effort for this purpose. Trolleys run through the track switch in all directions without stopping, and as there are no open ends of track, a serious source of danger has been eliminated. Reference to Fig. 1 will show that the two I-beams constituting the main or straight-through track and the third I-beam constituting the spur or curved track, terminate near the point of tangency of their center lines, and have a cast-steel extension piece or tongue rigidly secured to them. The projecting portion of this tongue is on the same level with the bottom flange of the I-beam and is a continuation of it. The tongues are so shaped that open slots are left between them through which the truck sides of the trolley pass in moving over the switch.

When the operator approaches the track switch at which he desires to run from the main line to a spur track, he pulls the steering lever which is located on the trolley near the controllers. This raises a horizontal roller to a position in which it engages a curved rib on the under side of the central tongue switch; the leading truck then swivels and is diverted onto the spur track. The trailing truck is guided onto the spur track by a positive and very simple means which is not dependent upon any action taken by the operator. No steering is necessary to return from the spur to the main line or to run through a switch on the main track in either direction.

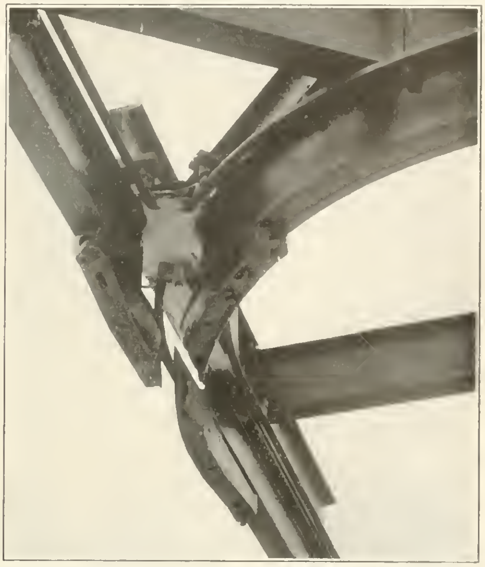


Fig. 1. Arrangement of the Shaw Fixed-tongue Track Switch

The details of the trolley design have been carefully worked out to secure a maximum efficiency of operation. Steel is employed in the construction of the main frame, the truck sides, the gears, and in all other parts where the weight of the load becomes effective, except in the rope drum and other compression members. The sizes of wire rope employed are especially liberal in proportion to the load, and the hook is a steel drop-forging which swivels on a ball bearing. Convenient

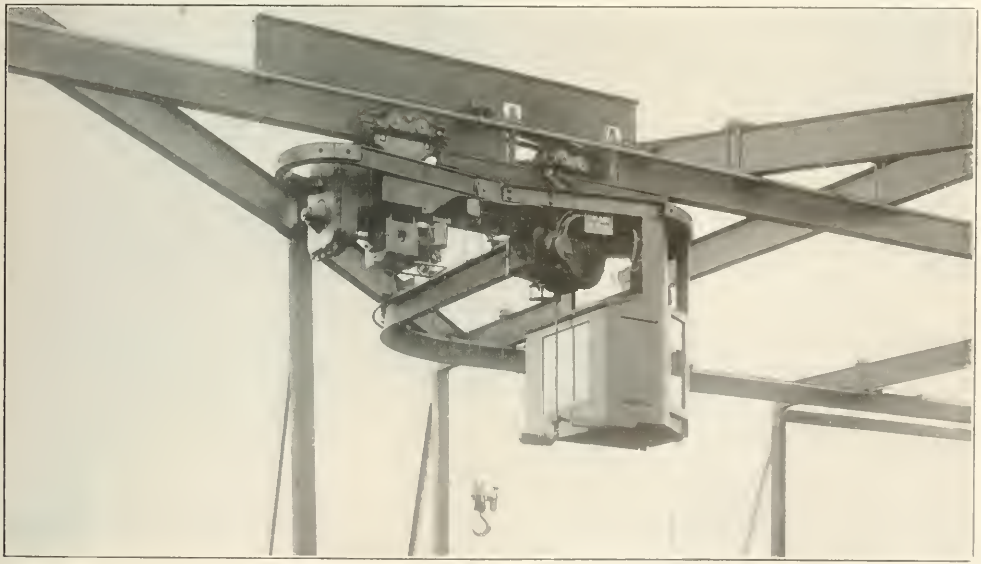


Fig. 2. Trolley and Hoist of the Shaw Monorail Crane System

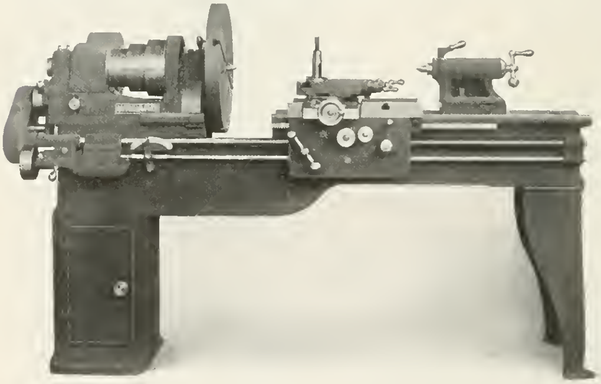
facilities have been provided for inspecting all internal parts without undue loss of time.

Curved buffers are provided at both ends of the trolley, forming a simple provision against collision with other trolleys, whether on curved or straight sections of the track. The hoist is equipped with motor and load brakes, the latter being of the multiple disk type and located in the hoist gear case. An automatic limit switch is also provided to prevent the lower block from being accidentally wound up into the trolley machinery. The motors have been designed especially for monorail work and embody the latest features applied for this class of service. The cage is arranged with a seat for the operator and all appliances necessary for giving him the requisite control over the crane.

WILLARD GAP-BED ENGINE LATHE

The gap-bed engine lathe illustrated herewith is built by the Willard Machine & Tool Co., Cincinnati, Ohio. This lathe is so designed as to make it suitable for both jobbing and manufacturing purposes. By removing the filling piece from the bed, the lathe may be made to handle work 21 inches in diameter up to 6½ inch face. When the filling piece is replaced, the lathe is transformed into a standard engine lathe which swings 13½ inches over the shears and is just as convenient to operate as any standard lathe of this type.

The headstock is of massive construction having a bearing of 21½ inches on the bed. The spindle is made of 60-point carbon crucible steel; the front journal is 2⅜ inches in diameter by 4 inches in length, and the rear journal is 1 13-16 inch diameter by 3 inches in length. The bearings are of phosphor-bronze, carefully scraped to fit the spindle. The hole through the spindle is 1 5-16 inch in diameter, and is bored to fit a bushing for a No. 3 Morse taper. The tailstock spindle is 1¾ inch in diameter, the tailstock having a travel of 5¼ inches.

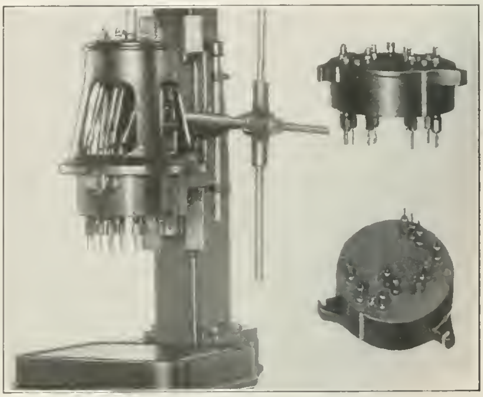


Willard Gap-bed Engine Lathe

The carriage has a bearing 18 inches long on the V's. The bridge is 7¼ inches wide, and is equipped with a dial for use in screw cutting. The compound-rest is of new design, being unusually large and of particularly rigid construction. The crank handle for moving the carriage is at the left-hand side of the apron, which is an unusual arrangement for a gap-bed lathe. This handle is usually located at the right-hand side of the apron, where it is inconvenient for the operator to use it. A gib is attached to the carriage at the right-hand side of the apron for the purpose of stiffening it when it overhangs the gap. This lathe is furnished with 6, 7, 8, and 10-foot beds. It has a cabinet leg under the headstock end, an extra large faceplate, and the filling piece previously referred to, as part of its regular equipment. A cabinet leg for the tailstock end can be furnished as an extra.

CLUSTER BOXES FOR "NATCO" MULTIPLE-SPINDLE DRILLERS

The illustration presented herewith shows the head of a No. 9 multiple-spindle drilling machine, made by the National Automatic Tool Co., Richmond, Ind., equipped with a cluster box. Two other forms of cluster boxes are shown at the right-hand side of the illustration. These cluster boxes, or drilling heads, are used for special jobs of multiple drilling; they are made interchangeable, different cluster boxes being used for each class of work.



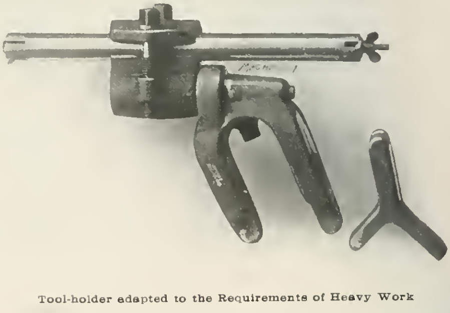
"Natco" Drilling Machine equipped with a Cluster Box or Multiple Drilling Head

The boxes are driven by universal-joint spindles or a center-shaft drive. The universal-joint spindles can be detached quickly and are recommended in preference to the center-shaft drive. One reason for this is that it often makes it possible for simpler boxes or heads to be used. The universal-joint spindles also enable the adjustable rails to be used on the same machine.

With the cluster box equipment, a larger number of holes can be drilled than is possible when the machine is equipped with adjustable rails. The head has a circular range of 8⅜ inches, and the use of special cluster boxes enables this range to be increased. The machine is equipped with adjustable stops so that holes of predetermined depth can be drilled. The machine on which these drilling heads are used is the same as that illustrated in the New Machinery and Tools section for November, except that the one previously described was equipped with eight adjustable steel rails for carrying the drill spindles.

KRIEGER TOOL-HOLDER

The Krieger Tool & Mfg. Co., Grand Rapids, Wis., has recently placed upon the market the tool-holder shown below. The design has been developed to eliminate the spring which occurs with many other types of holders when taking heavy cuts. It will be seen from the illustration that this holder has two shanks, only one of which need be used on light work. For heavy work, the ring is taken off the toolpost. One shank of the holder is then placed on each side of the tool-

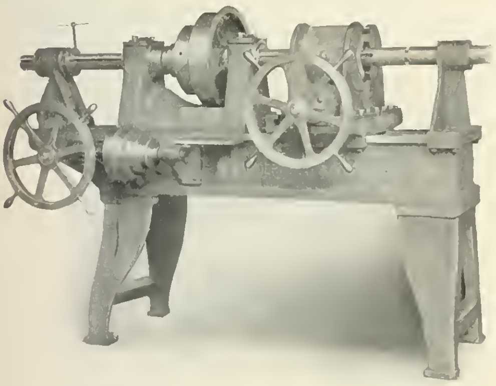


Tool-holder adapted to the Requirements of Heavy Work post and the Y-shaped clamp goes through the slot in the tool-post. The three ends of this clamp engage with the shanks of the tool-holder, which is held securely in place when the set-screw is brought down upon the Y-clamp.

This tool-holder can be adjusted one inch below or one inch above the center of the lathe, and has been found particularly suitable for boring operations on stuffing-boxes and other classes of work where holes of different diameters are required.

UNDERWOOD ARMATURE AND AXLE BEARING BORING MACHINE

The machine illustrated herewith is a recent product of H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., and is designed for boring the babbitted bearings of axle and armature shafts of the Westinghouse and General Electric motors used in electric car service. In addition to this work, the machine can be used for boring a variety of work such as large pulleys, etc. The design of this machine enables it to be operated by unskilled labor.


Underwood Armature and Axle Bearing Boring Machine

The handwheel toward the right operates a powerful self-centering chuck which holds and centers split or round bearings in correct alignment with the boring-bar, no particular skill being required to do this work both accurately and rapidly. The jaws of the chuck will take bearings ranging from 4 to 12 inches outside diameter, and special oil grooves can be cut in a bearing after the box is bored. The cutting tool is held directly in the bar, the latter being of ample strength to bore with a single-ended cutter. In order that extremely accurate boring may be done on bearings of harder material than babbitt, an outboard support and extension bar are provided.

The bearings in the headstock are made to compensate for wear without changing the alignment of the spindle, and wide-faced pulleys make it possible to bore large sizes of work without the use of gearing. The feed is automatic, with three changes, and there is a hand control with provision for a quick return of the spindle. It has been possible to shorten the bed of the machine through the provision of means for telescoping the feed mechanism under the headstock, the headstock forming a cover for the slide. During a recent test, a split babbitt-lined bearing of 5 inches bore and 11 inches length was bored out in less than one minute.

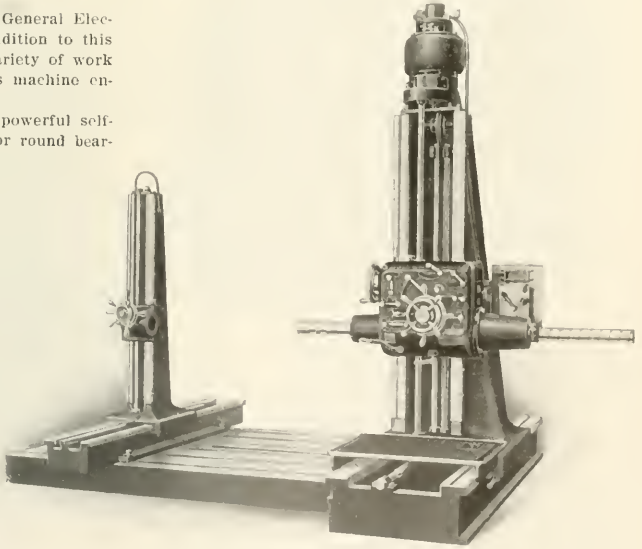
ROCHESTER BORING, MILLING, DRILLING AND TAPPING MACHINE

The Rochester Boring Machine Co., Rochester, N. Y., has brought out a new design of boring, milling, drilling and tapping machine. The operating levers and handwheels are located on the saddle within easy reach of the operator, so that the machine is convenient to work, and all changes of feed, speed and traverse in all directions, are obtained from a convenient position. The machine can be quickly started, stopped or reversed, independently of the motor or main drive. The saddle is of box construction, and is so designed that the entire operating mechanism is readily accessible.

The machine is regularly equipped with electric motor drive. The constant-speed motor is mounted on top of the column where it is out of the way of chips and dirt, and drives the vertical shaft, which transmits power to the driving mechanism enclosed in the saddle, through rawhide gearing. This arrangement simplifies the drive and gives a high power transmission efficiency. When belt drive is preferred, the machine is driven by a single pulley at the rear of the bed, the pulley being mounted on a splined shaft, which operates the vertical driving shaft in the column through bevel gears. The driving pulley is equipped with a clutch for starting, stopping and reversing.

The spindle is made of hammered, high-carbon crucible steel, and it is journaled in long taper bearings of phosphor-bronze, which are adjustable from the side and located at each end of the saddle, so that they are far enough apart to give a rigid support to the spindle. The feed and drive are applied between the bearings, the spindle being driven by two large spline keys fitted into a steel sleeve on which the driving gear is mounted. This sleeve is journaled in independent bearings, and clearance is provided between the sleeve and spindle to eliminate any vibration from the driving gears.

The concentric screw feed allows full traverse to be obtained without resetting. The method of feeding is through a long bronze nut engaging a square thread on the spindle. The nut only comes into contact with the sides of this thread and engages with the thread for the full length of the nut, so that an ample bearing surface is secured. The end thrust in either direction is taken on ball bearings of large diameter. The nut rotates at the same speed as the spindle when the feed is disengaged, and when the feed is applied, it is rotated faster than the spindle, according to the change-gear that is engaged; if the feed is reversed, the nut rotates slower than the spindle. This differential speed between the nut and spindle gives feed in either direction. The bar is controlled through positive planetary gearing by means of a handwheel, whether running or at rest.


Rochester Combination Boring, Milling, Drilling and Tapping Machine

A wide range of feeds and speeds is provided to meet all requirements. The vertical milling feeds are provided for the saddle, and horizontal milling feeds for the column, independent of the boring feeds. All feeds are reversible and any desired change can be instantly obtained. The range of speeds can be readily changed to meet special requirements, giving faster or slower speeds of the same relative ratio. The power rapid traverse for the saddle, column and spindle is independent of the feeds. The power rapid traverse and feeds cannot engage together, and automatic limit stops are provided for every traverse in every direction.

GARDNER DISK AND RING WHEEL GRINDER

Fig. 1 illustrates a special disk grinder which is interesting because it is said to be the first disk grinder built with two spindles set parallel with each other. The rear spindle is mounted in the solid base of the machine and driven by a pulley belted to the countershaft in the usual way; this spindle has no lateral movement. The front spindle is driven from a pulley on the outer end of the rear spindle, a weighted idler being provided to maintain the required tension on the short connecting belt. The front spindle is mounted in a head provided with a lateral adjustment which can be accurately regulated by means of the graduated handwheel shown beneath the front disk wheel. The table for supporting the work can be swung across the face of the wheel, but it is generally kept fixed in the position shown in the illustration. The purpose of this machine is to provide a rigid and accurate method of finishing two surfaces which must be parallel with each other, but in different planes. The method of regulating the adjustment of the movable spindle is particularly useful when it is required to have these surfaces at an exact distance from each other.

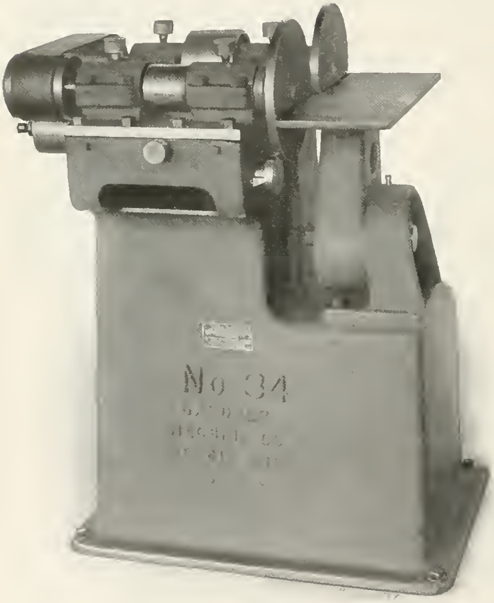


Fig. 1. Disk Grinder for finishing Parallel Surfaces in Different Planes

The novel features of the machine shown in Fig. 2 are the water shields and the angle-plates for holding the work on the lever feed tables. The hoods are of simple construction; they can be readily removed when adjusting or changing the ring wheels, and give free access at both sides for setting the work on the holder. It has been found that the wheels can be flooded with water when running at high speed, the pump for this purpose being set at the rear of the machine. The operation of the hoods is so efficient that scarcely a drop of water is thrown outside of the guards. The special angle-plates on which the work is held are provided with raised edges at the back and sides; these edges catch all water falling on the plate and return it to the pump. It is said that this equipment affords a particularly satisfactory method of applying water to grinding machines of this type. These machines are the product of the Gardner Machine Co., Beloit, Wis.

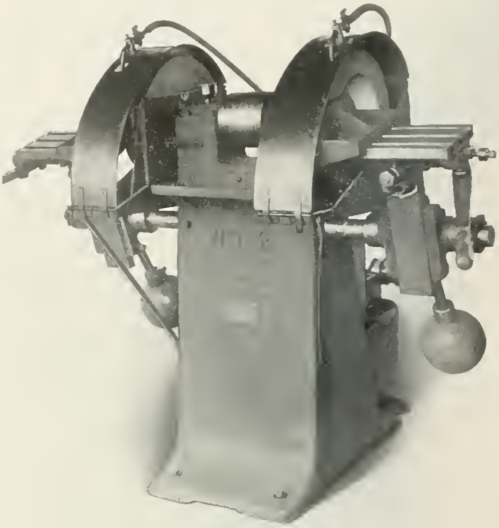


Fig. 2. Ring Wheel Grinder with Water Shields and Angle Plates for holding Work

CALCULATING CHART

The accompanying illustration shows an interesting calculating chart that has been brought out by Mr. George M. Purver, 146 E. 8th St., Brooklyn, N. Y., for facilitating multiplications and divisions in cases where exact results are required. The slide-rule, as is well known, gives only exact figures to very few places, and while it is satisfactory for most practical calculations where the assumed values themselves are approximate, there are conditions when the exact product is required. It is for cases of this kind that the calculating chart has been prepared. It gives instantly the product of all numbers of two figures only, and the product of a number of two figures with a number of four figures with

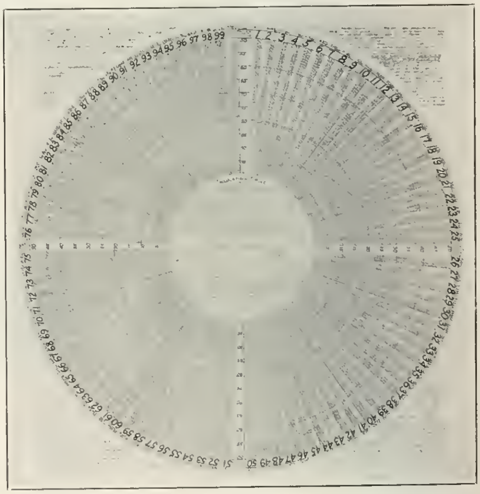
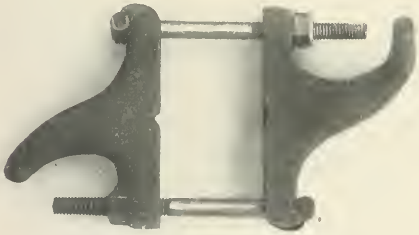


Chart for Rapid Multiplication and Division--Actual Diameter, about 15 inches a slight calculation, which by training can easily be performed mentally. From a mathematical point of view the arrangement is rather unique, and there are several interesting points in the working out of the chart. Of course multiplications of numbers with any number of digets by other numbers of any number of digets can also be performed by writing down the results of the multiplication of any two figures by any other two figures, which shortens considerably the ordinary work of multiplication.

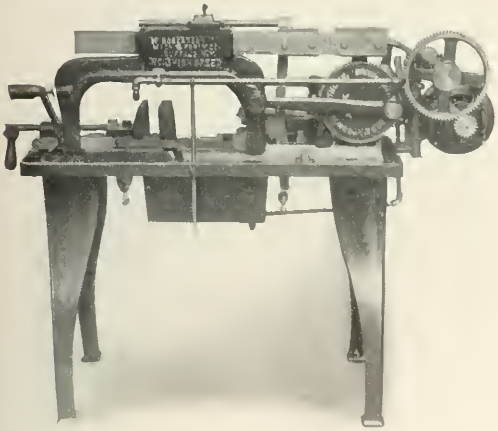
MICHAUD SAFETY LATHE DOG

The safety lathe dog illustrated herewith has recently been placed upon the market by Elmer J. Michaud, Willimantic, Conn. The clamping members of this dog are drop-forgings, held together by bolts in the manner shown. It will be seen that the clamping members are provided with curved extensions which come out over the exposed ends of the bolts. The dog is mounted so that these extensions revolve ahead of the bolts, making it practically impossible for the operator's clothing to be caught or for him to be injured by the sharp edges on the bolt and nut.


The Michaud Safety Lathe Dog

ROBERTSON MOTOR-DRIVEN POWER SAW

The W. Robertson Machine & Foundry Co., Buffalo, N. Y., has recently equipped its No. 3 Economy power saw with a direct-connected motor drive. The method of attaching the motor to the saw frame is shown in the illustration, no drilling of extra holes being required for mounting it in place. The motor is back-geared and is a self-contained unit of standard make; it is compound-wound and no starting box is required.


Robertson Economy Power Saw No. 3 equipped with Motor Drive

This machine cuts on the draw stroke and is equipped with this company's standard mechanical lift for the return stroke, which raises the blade from the work and greatly reduces the strain which it experiences in service. The maximum cutting capacity is 6 by 6 inches and the machine is so arranged that 10-, 12-, or 14-inch blades may be used. A friction band clutch in the driving gear provides for starting, and an automatic stop throws out the drive when the cut is completed. A rotary brass pump is used for pumping the lubricating fluid from the tank to the blade.

ROCKFORD HIGH-DUTY PRESS WITH AUTOMATIC BRAKE

The illustrations show a high-duty press manufactured by the Rockford Iron Works, Rockford, Ill., and also the patented automatic brake with which this machine is equipped.

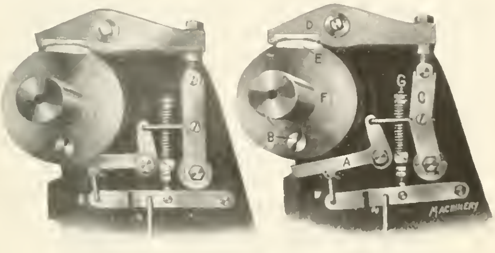


Fig. 1. Brake Mechanism of Rockford High-duty Press in the "Engaged" and "Released" Positions

The design of this brake has been developed with the view of saving a large percentage of the power which is consumed in operating some types of brake mechanism. The Rockford brake is automatic in its action and is applied only at the top of the stroke. The brake is not applied at any other point during the shaft cycle so that friction losses are reduced to a minimum, only a sufficient amount of resistance being applied to stop the machine at the top of the stroke. The saving of power effected by this device in shops where a large number of presses are in operation will be appreciated.

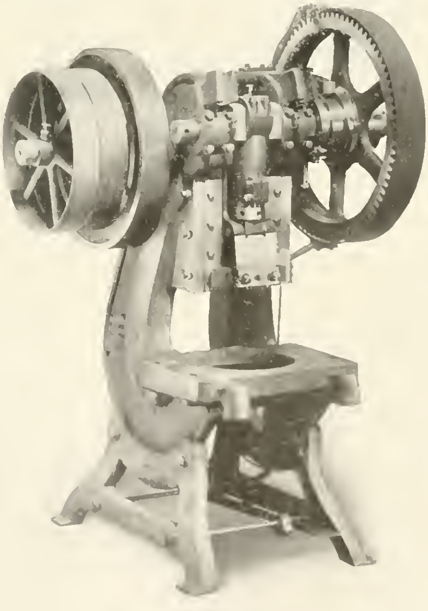


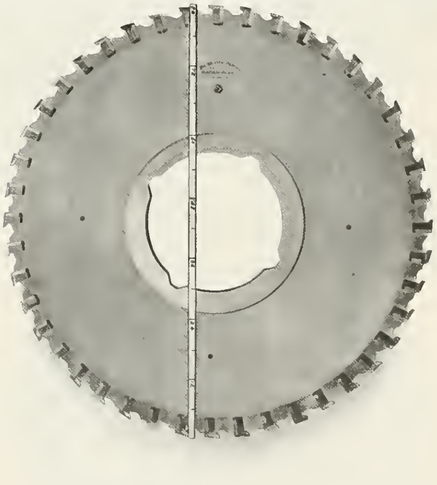
Fig. 2. Rockford High-duty Press equipped with Automatic Brake

The action of the brake is automatically controlled by the treadle. When the treadle is depressed, the clutch release pawl *A* is drawn down, releasing the clutch pin *B* which is forced forward by a spring into one of the three hardened tool-steel contact points on the flywheel. Just before the clutch pin *B* is released, and by means of the same pressure on the treadle, the toggle-joint *C*, which holds the brake *D* against a hardened tool-steel projection *E* on the driver *F*, is broken. This releases the brake *D* which is so held until the foot is removed from the treadle. The brake is placed on the right-hand side of the press so that all torsional strain on the shaft is eliminated, and this arrangement gives plenty of room on the left-hand side for the attachment of automatic feed equipment, oiling devices, etc.

HUNTER DUPLEX INSERTED-TOOTH SAW BLADES

The Hunter Saw & Machine Co., 57th and Butler Sts., Pittsburg, Pa., has recently manufactured two of the largest inserted-tooth, metal-cutting saw blades which have ever been placed upon the market. They have been given the trade name of "Hunter duplex," and are made from steel plates 1 inch in thickness and of special analysis to give the best results when subjected to the method of heat treatment used.

The finished saw is 84 inches in diameter, and has a collar on either side which is 26 inches in diameter by 1 inch in thickness. These collars are riveted to the body of the saw and have four equally spaced keyways milled in them by which the saw blade is driven. Forty-four pockets are milled around the periphery of the saw and roughing and finishing teeth are inserted alternately in them. At the bottom of these pockets, the plate is drilled and tapped to admit a hexagon-headed brass screw which is used in setting the teeth to the proper height. These teeth are made of the best grade of high-speed steel, so that they have an ample cutting capacity, and each tooth is reinforced and rigidly held by a tool-steel wedge. An idea of the size of this saw may be gathered from the fact that the teeth weigh 1¾ pound each, the wedges ¾ pound each, and the saw blade 2000 pounds. These saws were designed for cutting 40-inch ingots, and an idea of their capacity may be gathered from the fact that they are capable of cutting 24-inch ingots in ten minutes. They are driven by a 75-H. P. motor.



Hunter Duplex Inserted-tooth Metal-cutting Saw Blade

NEW MACHINERY AND TOOLS NOTES

Bench Lathe: B. C. Ames Co., Waltham, Mass. A bench lathe equipped with a head that has an extra large spindle. The capacity of the machine is for work up to 2½ inches in diameter.

Pipe Wrench: Erie Stamping & Mfg. Co., Erie, Pa. A convenient form of pipe wrench made from a steel stamping and produced in such a way as to supply the demand for an adjustable pipe wrench at a moderate price.

Hollow Set-screw: Goodwin Hollow Set-Screw Co., Waterbury, Conn. A hollow set-screw designed to be driven in with a suitable wrench, but which has projections on its inner surface that make it possible to use a screw-driver in place of the regular wrench.

Motor-driven Buffing Lathe: Northampton Emery Wheel Co., Leeds, Mass. A motor-driven buffing and polishing lathe. The motor is completely enclosed and bolted to an adjustable bed, which has a vertical adjustment of 4 inches to provide for regulating the belt tension.

Automatic Wire Straightener and Cutter: F. B. Shuster Co., New Haven, Conn. An automatic wire straightener and cutter which has a capacity for lengths up to 67 feet and is said to be the largest machine of its type ever built. It is intended for cutting reinforcements for concrete flooring.

Metal Sawing Machine: Vulcan Engineering Sales Co., Chicago, Ill. A small metal sawing machine in which the saw blade is driven from the periphery by means of steel rolls journaled in removable steel bushings held in the double driving gear. The periphery drive makes a greater portion of the blade available for cutting.

Combination Saw and Rotary Planer: Vulcan Engineering Sales Co., Chicago, Ill. A combination saw and rotary planer mounted on a circular base. This machine is particularly suited to the requirements of structural steel shops. As it combines the functions of two machines in one, it should be a particularly useful equipment.

Horizontal Boring, Drilling and Milling Machine: Lucas Machine Tool Co., Cleveland, Ohio. A new size of precision horizontal boring, drilling and milling machine, known as model No. 31. This machine is similar in its essential details to preceding types built by this company. The new machine is the smallest one of the line.

Adjustable Boring Tool: Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. An adjustable boring tool in which the bar is made from high-carbon steel tubing. The cutter is held by a drop-forged eye-bolt which has a square yoke at one end to carry the cutter, and a threaded section at the other end for tightening the cutter in the bar.

Open Side Grinding Machine: Detrick & Harvey Machine Co., Baltimore, Md. An open side grinding machine similar in design to the open side type of planers. This machine is intended for grinding such pieces as railroad frogs, switches and crossings, safe and vault parts, and similar classes of work which cannot be handled with cutting tools.

Bench Filing Machine: B. C. Ames Co., Waltham, Mass. A new machine which is a modification of the preceding type manufactured by this company. In the new design, a bench countershaft has been added to the equipment to carry the belt out of the way of the operator, and there is a graduated swivel under the table for securing any desired angular setting.

Planing Machine with Reversing Motor: Woodward & Powell Planer Co., Worcester, Mass. A planing machine driven by a reversing motor which has the Triumph-Monitor system of control. The machine is without overhead gears, belts, belt-shifter or driving pulleys, the motor being coupled to the driving shaft. The controller is fastened to the planer housing.

New Cage-operated Traveling Wall Crane: Cleveland Crane & Engineering Co., Wickliffe, Ohio. A new type of cage-operated electric traveling wall crane which has a capacity of ten tons and consists of two main parts—the bridge proper and the trolley. An important feature of this crane is that the bridge is driven by two motors, which eliminates the use of a through lineshaft and simplifies the design of the machinery.

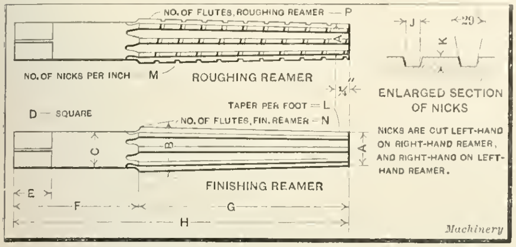
Broaching Machine with Motor Drive: J. N. Lapointe Co., New London, Conn. A motor-driven machine adapted for broaching various shaped holes of small sizes, which has the motor mounted on the same base with it. The switch is conveniently located on the front of the countershaft bracket and the machine has a large ball thrust bearing to receive the pressure from the screw; the countershaft is also equipped with ball bearings.

Geared Double Facing Head: Rochester Boring Machine Co., Rochester, N. Y. A geared double facing head for use on the Rochester horizontal boring machine. The faceplate on the head is geared to run slower than the bar and is made independent of it. The facing head on the outer support is also geared and runs slower than the boring-bar; this head is driven by the extension of the boring-bar through gears at the back of the column.

Automatic Screw Machine: Flanders Mfg. Co., Pontiac, Mich. An automatic screw machine which is the design of Mr. John J. Grant, and has a number of novel and interesting features. This machine has four spindles, all of which are at rest during the non-cutting movements of the machine. These spindles are fitted with the usual type of spring collet, but the stock is fed through without the intervention of feed sleeves or shells. Six changes of feed for the cutting movements are obtained by a simple gear-box, and the cams on the machine never require changing to suit different diameters and lengths of work. There is a constant rate of speed for the return movements, for feeding the stock and for the forward movements of the turret, regardless of the cutting speed. The same countershaft which drives the spindles provides for the constant speed drive, but in the case of the spindles, there are three rates of speed. This number may be doubled by transposing the pulleys on the countershaft and machine.

TAPER REAMERS FOR STANDARD TAPER SOCKETS

Several years ago, some tables were published in MACHINERY giving general dimensions of taper reamers for standard taper sockets, including Morse, Brown & Sharpe, and Jarno tapers. Complete data for the making of these tools have not, however, been published in any form, as far as the writer knows. The accompanying tables, therefore, have been prepared with an idea of placing on record all the information that might be required by the toolmaker in making these tools. Special attention is called to the information given for the making of the roughing reamers, which are made smaller in diameter at the small end than the finishing reamers, and which are provided with a groove cut like a thread on the cutting edges, as indicated. The purpose of this groove is to break up the chips. On ordinary right-hand reamers this groove is cut left-hand. The sides of the groove incline at an included angle of 29 degrees. The object of selecting this angle is to make it possible to use a tool having the same included angle as an Acme threading tool for grooving. A tool with inclined sides is preferable to a square tool on account of the greater ease with which the grooves or nicks can be cut. While the shape and exact dimensions for these grooves may seem to be rather unimportant details, yet in manufacturing it is important to so standardize all operations that standard tools can be used. The corners of the grooving tool are slightly rounded to prevent hardening cracks.


NO. OF FLUTES, ROUGHING REAMER — P
NO. OF NICKS PER INCH M
ROUGHING REAMER
TAPER PER FOOT = L
D — SQUARE
NO. OF FLUTES, FIN. REAMER — N
B
C
A
E
F
G
H
FINISHING REAMER
J
K
29°
ENLARGED SECTION OF NICKS
NICKS ARE CUT LEFT-HAND ON RIGHT-HAND REAMER, AND RIGHT-HAND ON LEFT-HAND REAMER.
Machinery

Notation used in Tables of Taper Reamers

In addition to the standard Morse, Brown & Sharpe, and Jarno taper reamers, dimensions of reamers for sockets for the so-called American taper are also included, so that the tables cover practically all reamers used for making taper sockets.

Tables of this kind are of value not only to the toolmaker who may be called upon to make a reamer for a standard taper socket, but also to the user of these tools, who often needs to find out certain dimensions on tools he is about to order, and to the machine designer, who has to keep in mind the tools used in the manufacturing processes. It also enables the designer to choose such tapers for taper locking bolts, etc., as can be reamed with standard taper reamers.

TABLE I. TAPER REAMERS FOR BROWN & SHARPE STANDARD TAPER SOCKETS

No. of Taper	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	0.200	0.250	0.312	0.350	0.450	0.500	0.600	0.750	0.900	1.045	1.250	1.500	1.750	2.000	2.250	2.500	2.750	3.000
B	0.252	0.318	0.416	0.444	0.564	0.667	0.803	0.958	1.119	1.346	1.573	1.838	2.114	2.385	2.656	2.927	3.198	3.469
C	7/32	9/32	3/8	13/32	1/2	19/32	23/32	27/32	1	1 7/32	1 7/16	1 11/16	1 15/16	2 1/8	2 3/8	2 5/8	2 7/8	3 1/8
D	5/32	7/32	9/32	5/16	3/8	7/16	17/32	5/8	3/4	29/32	1 1/16	1 1/4	1 7/16	1 19/32	1 25/32	1 31/32	2 5/32	2 11/32
E	1/4	5/16	3/8	7/16	1/2	5/8	3/4	13/16	7/8	1	1 1/16	1 1/4	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8
F	1	1 3/8	1 3/4	1 1/2	2	2 1/2	3 1/8	3 1/4	3 3/8	3 1/2	3 3/4	3 7/8	4	4 1/8	4 1/4	4 1/4	4 1/2	4 1/2
G	1 1/4	1 5/8	2 1/2	2 1/4	2 3/4	4	4 7/8	5	5 1/4	7 1/4	7 3/4	8 1/8	8 3/4	9 1/4	9 3/4	10 1/4	10 3/4	11 1/4
H	2 1/4	3	4 1/4	3 3/4	4 3/4	6 1/2	8	8 1/4	8 5/8	10 3/4	11 1/2	12	12 3/4	13 3/8	14	14 1/2	15 1/4	15 3/4
J	1/32	1/32	1/32	1/32	3/64	3/64	1/16	5/64	5/64	3/32	3/32	7/64	7/64	1/8	1/8	9/64	9/64	9/64
K	0.025	0.025	0.025	0.025	0.025	0.025	1/32	1/32	1/32	3/64	3/64	3/64	3/64	1/16	1/16	1/16	1/16	1/16
L	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	0.5161	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
M	3 1/2	3 1/2	3 1/2	3 1/2	3	3	3	3	3	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	6	6	6	6	8	8	8	8	8	10	10	10	14	14	14	14
P	4	4	4	4	4	4	5	5	5	6	6	6	6	6	8	8	8	8

Machinery

TABLE II. TAPER REAMERS FOR JARNO STANDARD TAPER SOCKETS

No. of Taper	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.100	1.200	1.300	1.400	1.500	1.600	1.700	1.800	1.900	2.000
B	0.144	0.269	0.400	0.531	0.659	0.787	0.916	1.044	1.169	1.297	1.422	1.550	1.675	1.800	1.928	2.053	2.181	2.306	2.431	2.556
C	1/4	15/64	3/8	15/32	19/32	11/16	13/16	15/16	1 1/16	1 1/8	1 3/16	1 5/16	1 7/16	1 1/2	1 5/8	1 3/4	1 13/16	1 7/8	1 15/16	2
D	3/32	11/64	9/32	23/64	29/64	33/64	39/64	45/64	51/64	27/32	57/64	63/64	1 5/64	1 1/8	1 7/32	1 5/16	1 23/64	1 13/32	1 29/64	1 1/2
E	3/16	9/32	3/8	1/2	5/8	3/4	3/4	7/8	7/8	1	1	1 1/16	1 1/16	1 1/8	1 1/4	1 1/4	1 1/4	1 1/4	1 1/4	1 3/8
F	7/8	1 1/4	1 1/2	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 3/4	2 15/16	3 1/16	3 1/8	3 1/4	3 3/8	3 7/16	3 9/16	3 3/4	3 7/8	4	4 1/8
G	7/8	1 3/8	2	2 5/8	3 3/16	3 3/4	4 5/16	4 7/8	5 3/8	5 15/16	6 7/16	7	7 1/2	8	8 9/16	9 1/16	9 7/8	10 1/8	10 5/8	11 1/8
H	1 3/4	2 5/8	3 1/2	4 3/8	5 1/8	5 7/8	6 5/8	7 3/8	8 1/8	8 7/8	9 1/2	10 1/8	10 3/4	11 3/8	12	12 5/8	13 5/8	14	14 5/8	15 1/4
J	1/32	1/32	1/32	3/64	3/64	1/16	1/16	5/64	5/64	3/32	3/32	3/32	7/64	7/64	7/64	7/64	7/64	1/8	1/8	1/8
K	0.025	0.025	0.025	0.025	0.025	1/32	1/32	1/32	1/32	3/64	3/64	3/64	3/64	3/64	3/64	3/64	3/64	1/16	1/16	1/16
L	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600
M	3 1/2	3 1/2	3 1/2	3 1/2	3	3	3	3	3	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	6	6	6	8	8	8	8	8	8	8	10	10	10	10	10	12	12	12
P	4	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6

Machinery

TABLE III. TAPER REAMERS FOR MORSE STANDARD TAPER SOCKETS

No. of Taper	0	1	2	3	4	5	6	7
A	0.252	0.369	0.572	0.778	1.020	1.475	2.116	2.750
B	0.369	0.510	0.741	0.979	1.280	1.790	2.559	3.375
C	11/32	15/32	21/32	7/8	1 1/8	1 1/2	2	2 5/8
D	1/4	23/64	1/2	21/32	27/32	1 1/4	1 1/2	1 31/32
E	5/16	1/2	5/8	13/16	1	1 1/4	1 5/16	1 1/2
F	1 1/2	1 7/8	2 1/4	2 5/8	3	3 3/8	3 3/4	4 1/2
G	2 1/4	2 13/16	3 3/8	4	5	6	8 1/2	12
H	3 3/4	4 11/16	5 5/8	6 5/8	8	9 3/8	12 1/4	16 1/2
J	1/32	3/64	1/16	5/64	3/32	7/64	1/8	9/64
K	0.025	0.025	1/32	1/32	3/64	3/64	1/16	1/16
L	0.625	0.600	0.602	0.602	0.623	0.630	0.626	0.625
M	3 1/2	3 1/2	3	3	2 1/2	2 1/2	2 1/2	2 1/2
N	6	6	8	8	8	10	14	14
P	4	4	5	5	6	6	8	8

Machinery

TABLE IV. TAPER REAMERS FOR THE AMERICAN TAPER SOCKETS

No. of Taper	1	2	3	4	5
A	0.300	0.416	0.586	0.758	1.033
B	0.435	0.574	0.750	0.943	1.286
C	3/8	[illegible]	11/16	3/4	1 3/16
D	9/32	3/8	1/2	19/32	7/8
E	3/8	1/4	5/8	5/8	1
F	2	2 7/16	2 5/8	3	3 7/8
G	2 3/4	3 1/16	3 5/8	3 3/4	4 3/8
H	4 3/4	5 1/2	6 1/4	6 3/4	8 1/4
J	1/32	3/64	1/16	5/64	3/32
K	0.025	0.025	1/32	1/32	3/64
L	0.591	0.621	0.543	0.592	0.623
M	3 1/2	3 1/2	3	3	2 1/2
N	6	6	8	8	8
P	4	4	5	5	6

Machinery

STRING DROP-FORGING

BY J. W. JOHNSON*

String-forging is the most economical way of drop-forging small pieces like those shown in Fig. 4. By string-forging is meant the forming of small pieces in a string, without cutting off each piece separately after forging. A section of untrimmed work made by string-forging is shown in Fig. 1. The advantages of handling work by this method are first that it is an extremely rapid operation, in that more forgings can be made per day, and, moreover, there is less liability of the drop-forger spoiling work by misplacing it in the dies than when transferring from the breakdown to the face impressions when drop-forging in the ordinary way. Likewise in trimming, the work may be handled more rapidly than is the case when each separate piece must be picked up and laid in the dies separately. While relatively few forgings can be string-forged, still many of the smaller forgings, say under three inches square in size, can be handled successfully in this way. No breakdown can be employed when string-forging is resorted to, for it would be obvious that the time gained by the string-forging method would be lost if it were necessary to shift the string to the breakdown for every forging. From the above it will be gathered that any forging which may be forged without a breakdown, if it does not exceed the approximate limits of three inches square, may be advantageously made by string-forging.

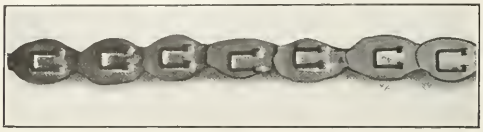


Fig. 1. Section of a String of Sixteen Forgings made in One Heat

The small yoke for which the dies shown in Fig. 2 were constructed is made of steel. It is approximately ¾ inch wide and 1 inch long, the bosses on the ends being 5/16 inch in diameter. The dies used for this job had faces five by seven inches and the thickness of the blocks was seven inches each. Care should be taken in selecting blocks for string-forging dies for, even though the forgings be very small, the faces must not be too small or the amount of "beating surface" will be insufficient, and thus shorten the life of the dies. As will be seen, the dies are fitted with finishing impressions, and there is also a cut-off at the corner to sever the strings of completed forgings.

For making these forgings, 7/16 inch round steel bars were used. The advisability of using round stock might be questioned, but owing to the large variety of rectangular sizes that would accumulate if other than round stock were employed, it is better to use round stock, even though in some instances an extra blow is required. The bars, of lengths convenient for handling, are heated and the forgings made by striking in the finishing impressions. From two to three blows complete each forging, after which the string is advanced to bring the completed work to the clearance cut at the rear side of the dies, thus permitting another piece to be forged. As many forgings as possible are made in one heat, leaving them all on the string. At the end of the heat the completed string of forgings is cut from the bar and the remainder of the bar is reheated to form another string.

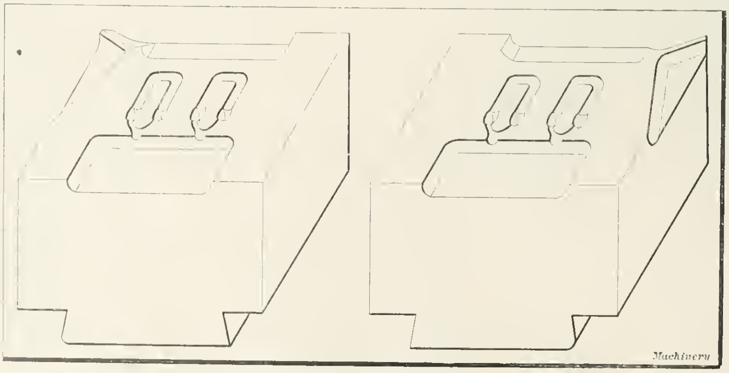


Fig. 2. The Drop-forging Dies

For this work a 500-pound board drop was employed, striking from 30 to 40 blows per minute, and at this rate of speed from 4000 to 4500 completed forgings per day is the output. Work like this is best handled on a board hammer in preference to a steam hammer, and in fact, in the writer's opinion, steam hammers are inferior to board hammers except in the case of very large presses. The constant breakage of parts on a steam hammer is a great source of trouble.

For trimming these forgings from the string, the die shown in Fig. 3 is employed. This trimming die does not differ from the ordinary trimming die except that it is cut away on both ends in order to permit the rest of the string to clear. The tongue which trims the center of the yoke is dovetailed into the die as a separate piece, and in case of breakage, it is only necessary to fit a new center piece. In trimming, the first forging in the string is fitted over the die opening and the press tripped, after which the string is advanced until the second forging is in line and so on until all of the forgings are trimmed from the strip.

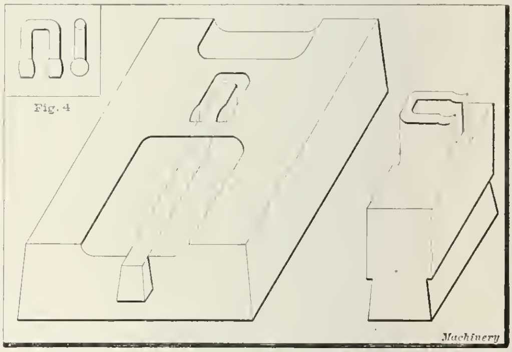


Fig. 3. The Trimming Die Fig. 4. Details of Forging

Another method of string-forging that is often employed when the work is very small is to provide the forging dies with three impressions in a row, so that three forgings are completed at a time. In trimming such work, however, the pieces are treated separately.

* * *

The Cleveland Planer Works uses chrome-nickel steel having a tensile strength of about 140,000 pounds per square inch of section, for the tool-holding studs in clapper-boxes. The ultimate breaking strength and tensile strength of this chrome-nickel steel is about the same, which is a peculiar advantage for tool-holding studs because of the abuse to which they are often subjected. Often a tool will be clamped close to the studs on one side and the nuts on the near studs will be screwed down first. Then when the nuts on the outer side are screwed down, a heavy stress is thrown on the first studs tightened, sufficient oftentimes to stretch or break them. If made of low carbon steel they will be stretched out of lead, thus causing great trouble, but if made of steel having equal elastic and tensile strengths the studs break before stretching much out of lead.

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A man doesn't get behind the times because of age as often as because he just quits trying to keep up.

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EFFICIENT PRODUCTION OF CYLINDRICAL WORK[*][†]

SHOWING HOW TOTAL EFFICIENCY CAN BE INCREASED BY ROUGH LATHE TURNING PREPARATORY TO CYLINDRICAL GRINDING

Turning is one of the oldest of the mechanic arts, and the lathe is one of the oldest metal working machines; but the lathe has been a very inefficient tool until the present time. We now have lathes so designed that they can be made efficient. As a rule, however, we are not using the modern high power lathes as we should, and are losing what they were designed to save, *viz.*, *time;* while we use them as roughing machines, we also use them as finishing machines.

Most cylindrical work must finally be brought to a size within small limits, and be truly cylindrical within still smaller limits; this led mechanics to study the art of refined turning. When this art had reached a high degree of refinement, men discovered that it did not satisfy them, and cylindrical grinding was introduced to give greater refinement than could be obtained with the lathe. At that time, it was the somewhat natural conclusion that the grinding machine should take up the work after the limit of refinement had been reached with the lathe, and the early grinding machines were designed with this object in view. Later, however, it was shown that ground cylindrical work could be produced at a cost no greater than the turning alone, by simply using the lathe to remove the larger portion of the metal and not at all as a means of refinement. The entire responsibility for refinement of the work was then transferred to the grinding machine.

While some understand this method and are using it to produce cylindrical work efficiently, the great majority are still under the spell of tradition, and are turning what they call "good work"—work that shows care and skill on the part of the operator and accuracy in the lathe. Such care in producing turned work is even more senseless today than the old-time practice of shaping acorns on screw heads, and putting cast-iron eagles on the tops of machine tools. In the former case, the grinding machine removes all trace of the lathe's accuracy and the operator's skill in a moment of time, while the latter remained for years to gratify the taste of those who had an eye for such artistic embellishment. The developments of the last few years have brought us face to face with the fact, that, except in rare cases, efficiency in the production of cylindrical work means the use of the lathe as a roughing tool only, and the adoption of the modern grinding machine for refinement.

Most lathe operators and foremen seem to understand roughing to be simply turning work a few thousandths over the finish size. In reality, this is not roughing at all, but simply turning to a certain degree of refinement. It is difficult to secure roughed work from lathe operators, *i. e.*, work that is not in any sense refined. Tradition causes most operators to consume much more time than would be necessary if the work were merely roughed; sometimes they understand roughing, but confuse it with a certain degree of refinement. Roughing is not refinement of any degree, and refinement does not necessarily mean perfection. There are many degrees of refinement, but never degrees of accuracy or perfection. Accuracy and perfection are final and fixed; they have no limits.

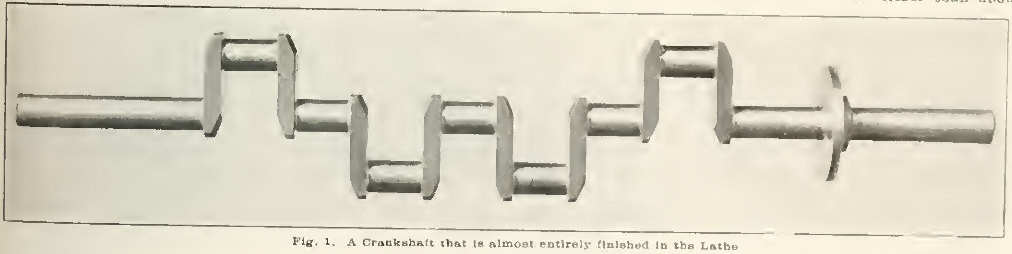

Fig. 1. A Crankshaft that is almost entirely finished in the Lathe

Those who would produce cylindrical work efficiently must recognize the fact that different cases require different degrees of refinement; but whether the work requires a very low degree of refinement or a degree closely approaching accuracy, the lathe work to be efficient, should be the same, *viz.* as *rough* and as *cheap* as it is possible to make it. The lathe of today should only be a roughing tool, and the grinding machine a refining tool only—not a perfecting tool. Some grinding machines may produce greater refinement than others, but none can produce exact and perfect cylinders. While it is true that many mechanics look upon a high degree of refinement as accuracy, and speak of it as such, it is evident that this is not the case. When these facts are generally recognized, there will be greater efficiency in the production of cylindrical work. Because these facts about roughing and refining are not well understood, and because men do not combine the lathe and grinding machine in a well defined and efficient manner, the machine industry and railroads are losing large sums of money every year.

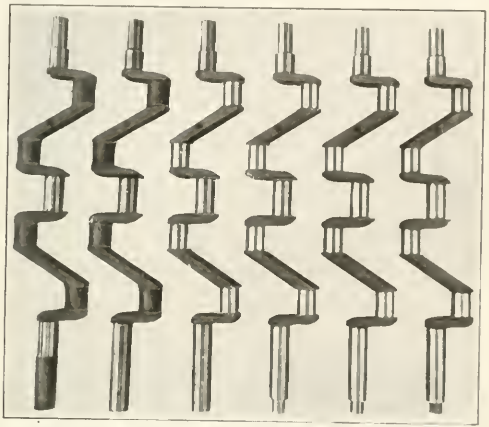

Fig. 2. Crankshaft requiring practically No Lathe Work in finishing

This loss is due to the fact that we turn closer than about 1/32 inch above the finished size. The word *about* is used because we lose by turning carefully. To require lathe work to be turned to thousandths today is like burning money for the fun of it. We are losing by allowing workmen to use any but the coarsest feeds that it is possible to use in each case. In some cases, it is even advisable to use the screw cutting gears. Feeds as coarse as four to the inch should be used in some cases, and feeds of six, eight and ten to the inch should be quite common. When the work is too frail to allow such coarse feeds to be taken with one cut, a second, or even three cuts should be made at a faster cutting speed; for, while it is true that very coarse and imperfect turning will require longer to grind than close, careful turning, the combination of coarse, cheap turning with grinding will produce cylindrical work more efficiently. The modern grinding machine will remove metal most efficiently when that metal is in the form of coarse screw threads. High ridges do not increase the cost of production, and we lose money when workmen are allowed to caliper cylindrical work on the tops of the ridges, as nearly all of them do. This accounts for the misunderstanding about coarse turning and the allowance for grinding. Calipering on the tops of the ridges makes it necessary to turn with a relatively fine feed to enable clean grinding to be done. To avoid this, some workmen use a broad nose tool with the coarse feed, which necessitates the use of a slower cutting speed, because more metal is removed than with a pointed or grooved cutting tool. Ridges left by a more pointed tool do not increase the cost of producing that work, but decrease it.

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[*] Abstract of paper by Mr. C. H. Norton, of the Norton Grinder Co., Worcester, Mass., to be presented before the American Society of Mechanical Engineers, December, 1912.

[†] For additional information on grinding, see "Commercial Grinding," by F. B. Jacobs, in the October issue of MACHINERY, and other articles there referred to.

We lose money by allowing workmen to measure roughed work elsewhere than at the end. Hours are wasted in calipering at several points and then resetting, and again turning the portions that have been put out by spring or tool wear, to secure straight work. It is very simple to feed a slight distance at the end of the work by hand, where the calipering can be done correctly, however coarse the power feed may be later on, or however high the ridges. The fact is overlooked that the modern grinding machine was designed to do all of the straightening and all of the sizing, regardless of what the errors of roughing may be. It is also forgotten, or has never been known, that the art of producing cylindrical work has progressed beyond that stage where it was necessary for the lathe to do its best before the grinding machine assumed the work of refinement.

The modern grinding machine is actually a correcting machine. The roughing can be rough, and roughness does not mean an approximate refinement. It is easy to figure the saving in time of turning a piece of work 6 inches in diameter by 6 feet long, when the last cut before grinding is made with a feed of six per inch, instead of thirty-two per inch, which is common. When it is considered that the grinding machine will grind this six per inch work to the finish size, in less time than is required to file thirty-two per inch work, we see the great possibilities for reducing the cost of producing work with the lathe, if combined with a modern grinding machine. In some cases money is lost by roughing at all in the lathe. Efficient production of cylindrical work is usually accomplished by first roughing in the lathe, but there are cases when the difference in favor of grinding without any roughing in the lathe is very great. The most important study for those who would secure efficient production of cylindrical work is the roughing of that work. It is here that we find the greatest possibilities for saving. If all would make a careful study of the roughing preparatory to grinding, instead of trying to improve upon the methods of grinding advocated by grinding machine makers, the result would be a more efficient production of cylindrical work and a clearer view of the real reasons why the grinding machine maker advocates certain methods. The reason why the modern heavy grinding machine was introduced would also be better understood.

At a works where large numbers of cylindrical pieces 1⅛ inch in diameter and about 10 to 11 inches long are manufactured, five minutes was required to turn about 1/16 inch from the diameter of each piece with a high-speed steel tool, the work being revolved as rapidly as the tool would stand. The plan was to turn close to the finish diameter, and care was taken to secure work that was smooth, straight, and round, so that time might be saved when grinding. They considered the grinding expensive and thought that this expense must necessarily be added to the cost of turning. The grinding in this case took one minute. The total time for producing these pieces was six minutes. A change was made in the shape of the tool point, and the size limit for turning, increased. The traverse feed was also increased, the cutting speed remaining unchanged. Each piece of work was now turned in one minute, while the grinding time was doubled so that it took two minutes. The saving of time resulting from the change was three minutes, or one-half of the original time.

Some idea of the time lost by allowing lathe work to be turned straight, smooth, and close to size, before grinding, may be obtained from the following illustration of actual work on some forgings about 4 feet 6 inches long. The turned portion had to be brought to a finish of 2 inches plus or minus 0.0005 inch in diameter, and 3 feet long. The lathe operator turned these pieces in the same manner that the majority of operators are now turning such work, *viz.*, as such work was turned before grinding machines were introduced, except that 0.010 inch was left on the diameter for grinding. The turning required two cuts, as there was more than ⅛ inch to remove and the work was somewhat frail, as well as irregular. The first cut was considered a very coarse heavy cut by the workman. The second was like the last cut in the majority of shops, *viz.*, it gave what the lathe men and most foremen call "a good job." When ready for grinding, the time consumed by turning was 25½ minutes. This appears to be too slow, but the forging was so slim that it would allow little, if any, increase in each roughing cut, and the lathe was an old-time low-power, frail machine. The grinding time on this job was three minutes, making a total of 28½ minutes.

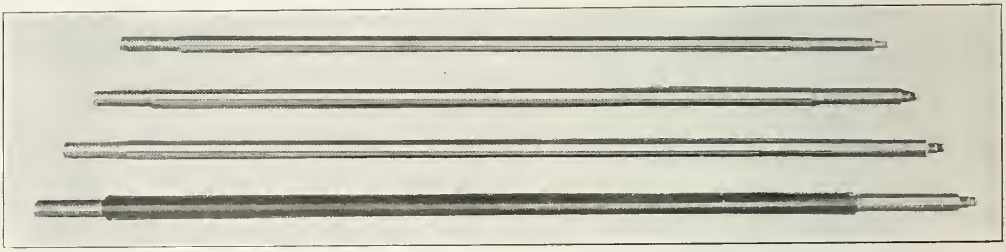

Fig. 8. Work Too Thin to be turned efficiently—finished entirely by grinding

Now note what was accomplished with the same low-power lathe and the same work, when tradition was ignored and the work made ready for grinding in the proper way. Two roughing cuts were taken, because the lathe was not powerful and the work was frail. The feed was ten per inch, cutting deep grooves; the time complete ready for grinding was nine minutes. The work was not straight, and was what many lathe men would style "a very poor job." The grinding time occupied to bring the work to exact limits was nine minutes, or three times longer than with the more careful turning, and the total time eighteen minutes, a saving of 10½ minutes on each forging. An attempt to rough this work with one cut instead of two resulted in a loss of two minutes. A modern, high-power lathe would have carried the same feed and depth of cut at a higher cutting speed, with a still further reduction of time. This shows us what may be accomplished with our weak low-power lathes. To install high-power lathes and continue to turn just as smoothly and accurately as of old, simply allowing a few thousandths for grinding, would seem the height of wastefulness. Whether high-power lathes, or old low-power lathes are used, mechanical industries are losing an enormous sum each year because of the lack of understanding of the efficient production of cylindrical work —the proper combination, in each individual case, of rough turning and grinding.

Some idea of what we are losing by not wearing our "thinking cap" is shown by the following: Some plain shafts, 1 5/16 inch in diameter and 62 inches long, were to be made to ordinary limits of size and finish. Tests were made to determine whether it was better to turn these first, or to grind direct from the rough bars. The turning required six minutes ready for finish grinding, while to grind off the same amount as was turned required nine minutes. A number of mechanics, without thinking, pronounced it cheaper to turn these shafts first. But in this case, after turning in six minutes, each shaft required straightening before grinding; this consumed ten minutes on each shaft, totaling sixteen minutes. When the roughing was done by grinding instead of turning, no straightening was necessary, and the roughing cut was taken in nine minutes. In this case, therefore, the turning was actually lost. There may be similar cases where the shafts will require some little straightening, even if roughed by grinding, so that each case should be investigated, instead of making a rule that all must or must not be turned first. Usually, however, no straightening is necessary when roughing is done by grinding.

Money is being lost because the majority of designers have not kept pace with the development along these lines. A well-known runabout motor car has a crankshaft, which, if made about one inch longer over-all, could have been produced for 50 cents less on each crank. When it is considered that about 30,000 of these cranks have been made, representing a possible saving of $15,000, we see the importance of the combination of lathe and grinding work.

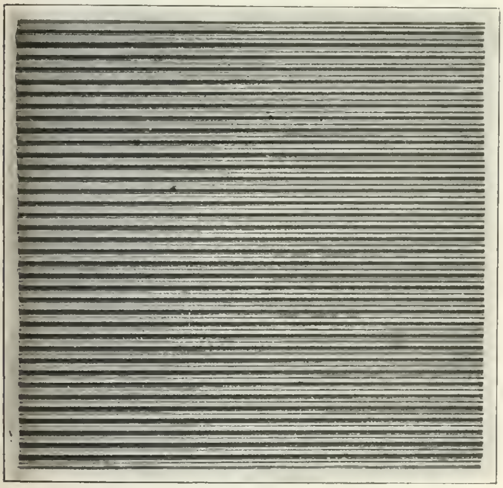
Fig. 4. Thirty-seven Slim Shafts ground direct from Rough

Fig. 1 shows a design of crankshaft that is expensive to machine, as it requires careful finished lathe work. It will be seen that this shaft has a flange that must be finished complete by the lathe. Aside from the flange, the design necessitates lathe finishing of the majority of the work. Grinding is a small part of the whole.

Fig. 2 shows a design that requires no lathe work whatever, there being clearance for the sides of the grinding wheel at all points. The illustration shows the six operations to complete the shaft after cutting off the ends and centering. These shafts are finished to the usual limits, direct from the drop-forging, by grinding. The net labor cost for cutting off ends, centering, machining complete with one keyway, and cutting the thread, so that the shaft is ready for the automobile, is 55 cents. The cost for grinding wheel is 2½ cents for each shaft, and the cost for the diamond to true and shape the wheel is 2 cents.

Another feature affecting the cost of production is the matter of shoulders. This is overlooked by many designers, and practically all draftsmen, who show sharp corners at the junction with the cylindrical portion. It is so easy to draw two sharp lines that cross each other and form a sharp corner. The fact that it costs less to provide room for the shoulder fillet on the other member than to make a sharp corner in the cylindrical member is lost sight of. This, no doubt, is the result of the experience of the past, when there were no powerful grinding machines to locate and form such shoulders cheaper than the lathe could. Shoulders made with the grinding wheel require a slight fillet.

When numbers of duplicate pieces are to be produced and a small fillet is allowed, not only can the cylindrical portion be roughed with the lathe and not at all refined, but the shoulders can also be roughed, because the grinding machine, when required, is provided with a locating bar. By the use of this bar, the exact location of all shoulders can be secured by grinding, without necessitating any measuring. At the same time, the cylindrical portion can be ground with the same grinding wheel. The roughing in the lathe can be done with the same tool that roughs the cylindrical portion because the lathe, in this case, is not required to give the shoulder any particular shape. When it is found best to locate and finish shoulders with the lathe, because there is no locating bar for the grinding machine, it should not be necessary to neck in at the shoulders for grinding. This is an old and out-of-date notion, for, with a shoulder cut sharp by the lathe tool, the grinding does not materially change the corner. A more efficient method, when no locating bar is at hand, is to rough the work in the lathe, leaving the shoulders about 1/32 inch long and of whatever angle the rough-turning tool may form. Next grind the cylindrical portion and, at the same time, cut out the angle at the shoulder with the grinding wheel. The work should then go to a lathe where a more skillful operator can locate the shoulders accurately; if a sharp corner is really necessary, it can then be made.

Fig. 3 shows work that is so slim that turning the main portion is out of the question, if it is to be produced efficiently. The main or center portion should be ground direct without turning. Fig. 4 shows thirty-seven slim shafts ground direct from the black stock. To turn them first would be a waste of time. They were 30 inches long by 11/16 inch in diameter in the rough. They were ground to 0.625 inch plus or minus 0.0005 inch; the work was handled twice and ground complete in seventeen minutes for each piece. The stock was tool steel. A lot of sixty countershafts of 35-point carbon steel, finish size 2 3/16 inches plus or minus 0.0005 inch by 66 inches long, were turned eight pitch, leaving about 1/32 inch for grinding. They were ground complete in thirty-five minutes each. The number of cubic inches of steel ground off was 278; 20.7 cubic inches of steel being removed for every cubic inch of wheel wear. The total wheel cost for sixty shafts was 38 cents, and the total cost for power, 35 cents. The type of wheel used was 24-combination grade L, alundum. The radial depth of cut when roughing was 0.001 inch and when finishing 0.0005 inch. The surface speed of work when roughing was 42 feet per minute, and finishing 35 feet per minute. The table traverse for roughing was 11¼ feet per minute and for finishing 10 feet per minute.

To produce cylindrical work efficiently we must make a study of everything that affects the problem in each individual case, instead of following tradition, which is costing us thousands of dollars every year. Lathe builders are offering some very efficient roughing lathes, but are we roughing with them? In most cases, we are not. The real roughing lathe needs a good system of multiple steadyrests to enable it to take rapid and deep coarse cuts. Will someone come forward with such a system of steadyrests? Instead of our lathe departments and grinding departments being separate, there should be one department for cylindrical work under one foreman. This would check the tendency of the lathe department to treat their work as a finished product, and the tendency of the grinding department to insist upon close careful turning in order to make a better showing on the grinding time, regardless of the real cost of production. There is much yet to be learned about the preparation of cylindrical work for grinding, as no two pieces of work require the same lathe treatment. There is also a great need for thinking men as foremen and operators. Such men can effect great savings by working out the best combination of turning and grinding for each class of cylindrical work.

NEW SHOP OF THE CINCINNATI GEAR CO.

The Cincinnati Gear Co. is now located in its new shop at 1825–1833 Reading Road, Cincinnati, Ohio. A good idea of the modern construction and equipment of this shop may be obtained from reference to Figs. 1, 2, and 3. The building has been provided with an exceptional window area which affords an ample amount of daylight, so that all machines may be operated without artificial illumination.

This company started in business in a small way, two years ago, and has grown rapidly. A specialty is made of rawhide and bevel gears, and an idea of the quantity of work turned out may be gathered from the fact that fifteen bevel gear machines are kept in operation all the time. All kinds of bevel gears—including those of fractional pitch—are cut without the use of form cutters or templets, planer generators being used exclusively.

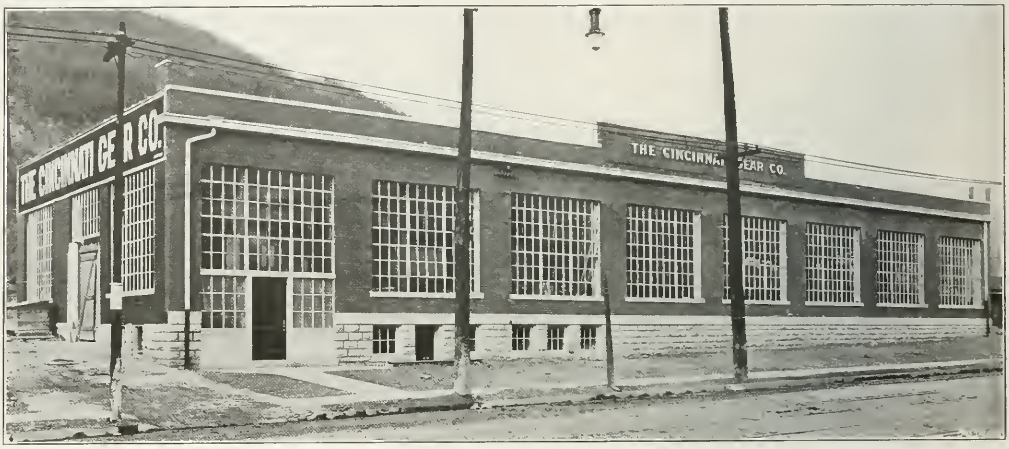

Fig. 1. New Shop of the Cincinnati Gear Co., Cincinnati, O.

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MACHINE TOOL EXHIBIT AT NATIONAL AUTOMOBILE SHOW

A new feature of much interest to the machine tool building industry will be added to the thirteenth National Automobile Show, to be held in Madison Square Garden and Grand Central Palace, New York, January 11 to 25. A machine tool exhibit is planned for the Part II period, or second week, beginning January 20, which is devoted exclusively to commercial vehicles. The proposed exhibit has received the approval of President E. P. Bullard, Jr., of the National Machine Tool Builders' Association and of its executive committee.

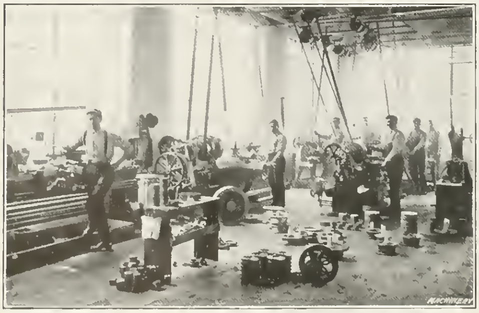


Fig. 2. Corner of the Lathe Shop showing Liberal Window Space

The members of the Society of Automobile Engineers, many of whom will attend the show for the entire two weeks, have expressed themselves as being in favor of a display of machine tools and accessories used largely in the manufacture of motor cars. The time is ideal for the machine tool builders supplying the automobile trade to meet the men personally who are vitally interested in their product. Automobile factories throughout the country are constantly increasing their machine tool equipment, and their engineers will welcome the opportunity to see the latest developments.

The exhibit of cars in the second week of the show has not attracted the general public in large crowds, but chiefly business men, manufacturers and mechanical engineers concerned with the problems of transportation and in the development of motor trucks and delivery cars. The educational value of the proposed exhibit of machine tools to these classes is of no little importance. The intention of the management is to make the display of machine tools an annual feature of future shows.

* * *

Tests made at Watertown Arsenal some time ago, which strikingly demonstrated the truth of Wöhler's law that the endurance of steel decreases rapidly with increases of stress above a certain percentage of the elastic limit, were cited in an article "The Factor of Safety" appearing in the first number of *The Travelers Standard.* Wöhler, a German railway engineer who was the first to scientifically investigate factors of safety, had observed that car axles often break after having run a certain number of miles although when new their strength was several times that required to carry the load, and from this fact was led to investigate the phenomena of fatigue of metals. The Watertown tests were made on steel specimens having the following characteristics: Carbon content, 0.55 per cent; ultimate tensile strength, 111,200 pounds per square inch; elongation, 12 per cent; reduction of area, 33 per cent; elastic limit 59,000 pounds per square inch. Under repeated alternate extension and compression stresses a specimen under maximum stress of 30,000 pounds per square inch withstood 76,326,240 repetitions without breaking; under 35,000 pounds a specimen broke at 900,720 repetitions; under 40,000 pounds, at 455,000; under 45,000 pounds, at 166,240; under 50,000 pounds, at 93,160; and under 60,000 pounds, at 12,400.

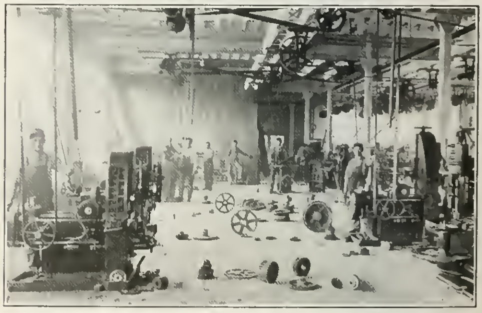
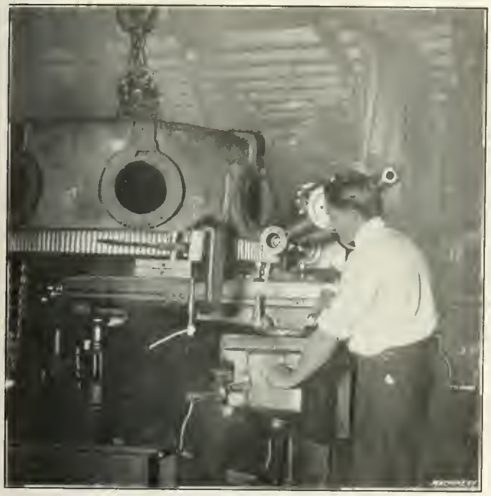


Fig. 3. The Spur Gear Shop and Some Samples of Work

AN UNUSUAL GEAR CUTTING JOB

An unusual job of gear cutting was recently performed in the shop of William Ruwell, 719-21 Noble St., Philadelphia, Pa., and is believed to be one of the largest pieces of gear cutting which has ever been done on a No. 4 milling machine. The work consisted of an iron casting 56 inches in diameter which had a four pitch gear cut on its outside circumference. The gear face was 3 inches in width, the total width of the casting 24 inches, and its weight about 2680 pounds.

This gear was cut on a No. 4 Cincinnati universal high-power milling machine. The casting was supported by a ball bearing placed in the center at the top and a triple rope and block tackle was used to raise it into position. The weight of the casting was counterbalanced, the counterweight being located at a point where it could not interfere with the work. This arrangement worked so well that it was estimated that the casting was raised by a pull not exceeding ten pounds.



An Unusual Job for a No. 4 Milling Machine

The regular universal dividing head was moved to the extreme left end of the milling machine table; the spindle of the head was then placed in a vertical position and an arbor made to fit the hole in the casting. The other end of the arbor was located in the dividing head. The casting was now lowered onto this arbor and a stocking cut taken all the way around. The casting was then examined to see that this stocking cut gave accurate results, after which the worm-wheel of the dividing head was thrown out, and with the casting still mounted on the dividing head, a pawl was attached to the table of the milling machine. This pawl was now used for indexing the work, the C clamp shown in the illustration being used to hold the casting securely in position. Although this work is considerably beyond the range usually covered by a No. 4 milling machine, the job was turned out with satisfactory results.

* * *

IMPORTANT PATENT DECISION AFFECTING TRUST AGREEMENTS

The United States Supreme Court, on November 18, affirmed the opinion of the Federal District Court of Maryland that the Standard Sanitary Mfg. Co., and forty-nine other defendants, constituting the so-called "bath-tub trust" are not, under the patent laws, warranted in making the license agreement under which they have been doing business. Under this license agreement, the various manufacturers of bath-tubs were allowed to use a patented device in their manufacturing processes, but only on condition that they abided by an attached price list, would not sell to jobbers who bought from independents, would not sell in a certain territory, and would not sell "seconds." The court held that it is illegal for the manufacturer of a patented article to fix the price at which articles manufactured by it must be sold at retail, and thus laid down the broad principle that there can be no monopoly in the unpatented product of a patented machine without the violation of the anti-trust law. Justice McKenna delivered this as the unanimous opinion of the court.

The Supreme Court in this decision refuses to extend the doctrine of the Dick mimeograph case to the unpatented product of a patented machine. The defendants in the bath-tub case owning patents on machines used in the manufacture of enameled ware attempted to fix prices and destroy competition in an unpatented product, but their conduct was held to be illegal. This decision, together with that of the Dick mimeograph case, in which it was held that the purchaser of a patented device could be compelled to buy from the patentee all the supplies used on that particular machine, are probably the two most important decisions in patent cases in a number of years.

* * *

HEAVY THIRTY-SIX-INCH LATHE JOB IN A PITTSBURG STEEL PLANT

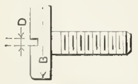
An exceptional lathe operation which was recently performed in one of the large steel plants in the Pittsburg district is illustrated herewith. The work is a 3½ per cent nickel steel shaft, which was turned from a forging 25 feet 5 inches in length by 22 inches in diameter, which weighed 33,000 pounds. When finished, the maximum diameter was 20 inches and the weight 28,000 pounds. The engine lathe used for this purpose is of the regular 36-inch triple-geared type manufactured by the Boye & Emmes Machine Tool Co., successors to Schumacher & Boye, Cincinnati, Ohio. The ability to deal with such a job, which is necessarily a most severe test, certainly speaks well for the capacity of the lathe on which the work was performed.

Turning an exceptionally Large Nickel Steel Shaft on a 36-inch Boye & Emmes Triple-geared Engine Lathe

SLOTS IN SCREW HEADS—WIDTH OF FLAT ON SHANKS OF TOOLS

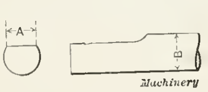
For ordinary fillister-head screws, where the diameter of the head is made in proportion to the diameter of the body of the screw, the width of the screw slot ought to be made according to the standard approved by the American Society of Mechanical Engineers in May, 1907. According to this standard, the width of the slot is figured from the formula $D = 0.173A + 0.015$ inch, in which D equals the width of the slot for the screw-driver and A equals the diameter of the body of the screw itself. When the screw heads are made especially large in proportion to the body of the screw, however, as shown in the illustration at the top of the accompanying table, this formula is not adaptable, as the screw slots would be entirely too narrow for the size of the head, and, in that case, it is better to base the width of the slot for the screw-driver on the diameter of the head rather than on the body diameter of the screw. In this case the width of the screw-driver slot is calculated from the formula $D = B \times 0.090$, in which D equals the width of the screw-driver slot and B the diameter of the head of the screw. This formula gives good proportions for average conditions, although, of course, judgment must be used in drawing the line between the conditions when the regular A. S. M. E. formula ought to be used and when the head is large enough to call for the use of the present formula. A table is given in which the width of the screw-driver slot is calculated for different diameters of head according to this formula.

TABLE OF SCREW-DRIVER SLOTS



B	D
3/16	0.017
7/32	0.019
1/4	0.022
9/32	0.025
5/16	0.028
11/32	0.031
3/8	0.034
7/16	0.039
1/2	0.045
9/16	0.050
5/8	0.056
11/16	0.062
3/4	0.067
13/16	0.073
7/8	0.079
15/16	0.084
1	0.090
1 1/16	0.095
1 1/8	0.101
1 3/16	0.107
1 1/4	0.112
1 5/16	0.118
1 3/8	0.124
1 7/16	0.129
1 1/2	0.135

TABLE OF FLATS FOR SET-SCREW ON SHANKS OF TOOLS



B	A	B	A
1/8	0.047	1 5/16	0.492
5/32	0.058	1 3/8	0.515
3/16	0.070	1 7/16	0.539
7/32	0.082	1 1/2	0.562
1/4	0.094	1 9/16	0.586
9/32	0.105	1 5/8	0.609
5/16	0.117	1 11/16	0.633
11/32	0.129	1 3/4	0.656
3/8	0.140	1 13/16	0.679
13/32	0.152	1 7/8	0.703
7/16	0.164	1 15/16	0.726
15/32	0.176	2	0.750
1/2	0.187	2 1/16	0.773
9/16	0.211	2 1/8	0.797
5/8	0.234	2 3/16	0.820
11/16	0.258	2 1/4	0.844
3/4	0.281	2 5/16	0.867
13/16	0.304	2 3/8	0.890
7/8	0.328	2 7/16	0.914
15/16	0.351	2 1/2	0.937
1	0.375	2 5/8	0.984
1 1/16	0.398	2 3/4	1.031
1 1/8	0.422	2 7/8	1.078
1 3/16	0.445	3	1.125
1 1/4	0.469	...	.....

The width of the flat for set-screws on round shanks of tools may not seem to be of great importance, but, nevertheless, it is advisable to have a standard for this. The accompanying table gives, therefore, the width of the flat A for a number of different diameters B figured from the formula $A = 3/8\,B$. If the flat is milled to this width, the appearance of the tool shanks will be satisfactory, and by using a standard, uniformity is assured.

Tools with a square milled on the shanks often present a bad looking appearance by having sharp corners. This often produces burrs on the square itself, which prevent the tools from entering the socket or wrench in conjunction with which they are used, and—what is still worse—is often the cause of bruised and cut hands. A well-proportioned square having a good round corner is obtained if the width across the flats is made 3/4 times the diameter of the shank. A.

LAUNCHING OF THE NEW YORK

The ninth U. S. dreadnaught *New York* was launched at the Brooklyn Navy Yard October 30. This battleship is a sister ship to the *Texas*, building at Newport News by the Newport News Shipbuilding & Drydock Co., and is the largest yet launched. Her keel was laid in September, 1911, and when launched the construction was about sixty per cent completed; the hull at launching weighed over 9000 tons. About 25,000 pounds of special grease was used to lubricate the launching ways. These ways consist of two wooden tracks, each about four feet wide and thirty feet apart upon which the vessel rests at launching, being supported in a cradle or sliding ways built to conform to the hull. The spectacular "sawing off" of the sliding ways to release the vessel was made obsolete by a double trigger device, located in the launching ways amidship, and operated by two hydraulic plungers. The vessel had been wedged up onto the launching ways and was held only by the triggers when the signal was given. The turn of a valve released the liquid in the cylinders, and the weight of the vessel pressed the triggers down out of the way, thus freeing her to slide into the water. The mechanism worked perfectly and will be used hereafter; it insures the safety of the men, and enables the time of release to be fixed to the fraction of a minute.

The *New York* is the largest and most formidable battleship in the world, the mean displacement being 27,000 tons; the length on water line, 565 feet; breadth at water line, 95 feet; mean drafts, 28 feet 6 inches. The propelling machinery is triple expansion reciprocating engines of 28,100 H. P. driving two propellers. The main battery comprises ten fourteen-inch rifles and four submerged twenty-one-inch torpedo tubes; and the secondary battery, twenty-one five-inch rapid fire guns, and smaller pieces. The cost of the fourteen-inch gun and mount is $62,000 for the gun and $50,000 for the mount. The life of a gun before relining is necessary is 225 rounds. The range at fifteen degrees elevation is over twelve miles, and the penetration of face-hardened armor at six miles is sixteen inches. The cost of a round of ammunition is $600. The total cost of the vessel, hull and machinery exclusive of armor and guns is about $6,000,000.

* * *

PERSONALS

Robert Cary has resigned his connection with the Gisholt Machine Co., Warren, Pa., and taken a position as superintendent of the J. N. Lapointe Co., New London, Conn.

H. S. Kartscher has left the designing department of the Pratt & Whitney Co., Hartford, Conn., to take the position of chief draftsman of the Rivett Lathe & Grinder Co., Brighton, Boston, Mass.

M. O. Frenier, mechanical engineer, formerly with the engineering department of the Knox Automobile Co. of Springfield, Mass., has opened an engineering office at 168 Bridge St., Springfield, Mass.

J. E. Brennan, who for several years held the position of assistant superintendent of the Remington Arms-Union Metallic Cartridge Co., at the works in Ilion, N. Y., has been appointed superintendent of the works.

A. J. Jones, formerly with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, has been made secretary and manager of the Acme Machine Tool Co., of Cincinnati, manufacturer of turret lathes and screw machines.

Walter G. Lamont, late with Elliott & Fisher Co., Harrisburg, Pa., manufacturer of billing machines, has taken the position of mechanical engineer with the Simplex Non-Refillable Seal & Stopper Co., at Baltimore, Md.

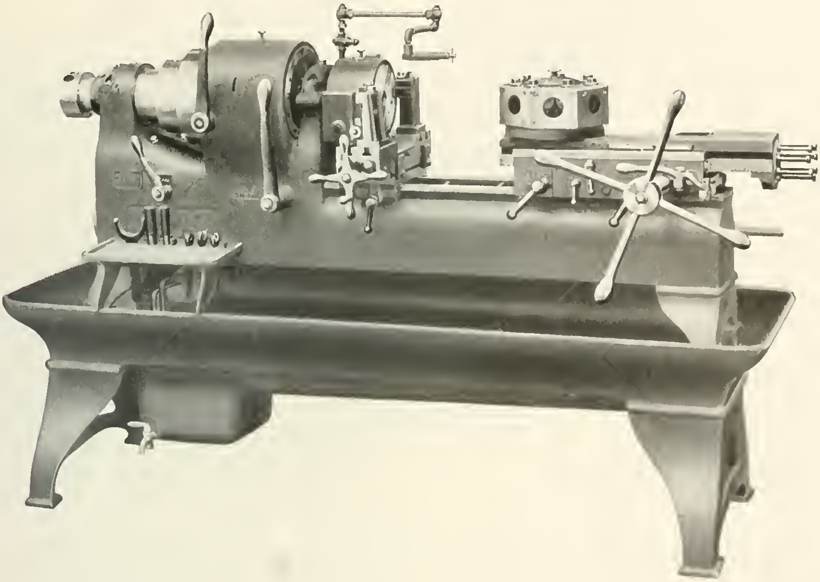
Henry K. Swinscoe has resigned the position of assistant superintendent of the South Works of the American Steel & Wire Co., Worcester, Mass., to enter the employ of the Morgan Spring Co., of Worcester, as superintendent.

Clifford F. Kern, formerly president of the Kern Machine Tool Co., Hamilton, Ohio, has disposed of his interest in that company and purchased the Von Wyck Machine Tool Co. of Cincinnati, manufacturer of 15-inch engine lathes.

Fred R. Jochmus, who for several years has been assistant foreman in the machine shop department of the Remington Arms-Union Metallic Cartridge Co., at Ilion, N. Y., has been appointed foreman of the machine shop department.

F. B. Jacobs, for several years in the employ of the Carborundum Co., Niagara Falls, N. Y., in various capacities, and

These machines are adapted for the rapid production of duplicate parts in small lots



B. & S. Wire Feed Screw Machines

Unless the volume of any one kind of work in a shop is sufficient to warrant the installation of automatic machines, the wire feed type is the most economical to employ. Because they are adapted for such work, they embody many conveniences to aid in setting up and operating.

A glance at the sizes of the machines in the line will emphasize their range. They are as follows:

No. 0 takes stock ⅜″ diameter; turns to 2¼″ length.

No. 1 takes stock ¾″ diameter; turns to 3″ length.

No. 2 takes stock ⅞″ diameter; turns to 5″ length.

No. 4 takes stock 1¼″ diameter; turns to 8″ length.

No. 6 takes stock 1½″ diameter; turns to 10″ length.

See our Catalogue for detailed descriptions. Sent on request.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

a frequent contributor to Machinery, has resigned from his position as salesman in the company's Philadelphia office.

Edward K. Hammond of Chicago, a frequent contributor to the technical press, has joined the editorial staff of Machinery. Mr. Hammond is a graduate of Armour Institute of Technology, and has had practical shop and editorial experience.

Corneil Ridderhof, formerly treasurer and manager of the Wilmarth & Morman Co., Grand Rapids, Mich., and an occasional contributor to Machinery, has taken a position as assistant manager of the Western Gas Engine Corporation, Los Angeles, Cal.

Charles A. Schaefer, formerly general foreman of Schumacher & Boye, and for fourteen years with that company, has taken a position as superintendent of the John B. Morris Machine Tool Co., Cincinnati, O., manufacturer of lathes and radial drills.

Frank J. Lapointe, secretary of the J. N. Lapointe Co., who has been acting as superintendent of the works, will now give his whole attention to the engineering department of said concern, as Mr. Robert Cary, formerly of the Gisholt Machine Co., Warren, Pa., is now the superintendent.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, has recently increased his staff by the addition of Mr. Fred R. Lufkin, formerly of the instruction staff in electrical engineering of the Massachusetts Institute of Technology, and late assistant superintendent of lighting and wires of Brookline, Mass.

Joseph Wolf, formerly of the Hisey-Wolf Machine Co., Cincinnati, Ohio, has become interested in the Cincinnati Electrical Tool Co., and has been made vice-president and general manager. The company makes portable electric drills and grinders and Mr. Wolf will take entire charge of the management of the business.

E. P. Bullard, Jr., president of the Bullard Machine Tool Co., delivered an address Tuesday evening, November 26, before the Cleveland Engineering Society in Cleveland, Ohio, on the subject, "A New Era in Machine Design," in which the basic principles of the design and construction of machines which will fully meet the new requirements of the present-day manufacturer, were discussed.

E. J. Kearney, president of the Kearney & Trecker Co., Milwaukee, Wis., who was very ill with pneumonia in Boston, at the time of the recent National Machine Tool Builders' Association's annual convention in New York, has recovered, after having been confined to the hospital for five weeks. Mr. Kearney is gradually regaining his strength, and recently passed through New York on his way home with Mrs. Kearney, traveling by easy stages.

Henry Hess has resigned as president of the Hess-Bright Mfg. Co. and has sold all of his holdings in that company. It is understood that no change in the policies of the company is contemplated. Mr. Hess became interested in ball bearings while general director of the German Niles Tool Works. The Deutsche Waffen-und Munitions Fabriken ball bearings had just become famous through their use in the German Mercedes automobile in the winter of 1901. Up to this time all the early types of ball bearings had been failures as applied to automobiles. Owing to its novel mechanical features and high efficiency, the German Mercedes car made a great sensation, and the general adoption of ball bearings in automobiles soon followed. Armed with the American rights of the DWF ball bearings, Mr. Hess came to this country and in 1904 formed the Hess-Bright Mfg. Co. The company started with a small one-room office, and grew until today it owns a new factory and thirteen acres of land at Front St. and Erie Ave., Philadelphia. The history of the company is, in part, Mr. Hess's history. At first the bearings were used only in automobiles. Since then, however, the field has broadened, and Mr. Hess has made applications of the bearings in many other types of machines in the industrial world, especially adapting them for use at points where plain bearings would not stand up, as where high speed is necessary. Mr. Hess has contributed largely to the technical literature of ball bearings and is looked upon as one of the foremost authorities in America on the subject. He was judge of the mechanical exhibit at the St. Louis Exposition; he is a member of the council of the American Society of Mechanical Engineers, a former president of the Society of Automobile Engineers, and chairman of the Philadelphia Branch, president of the Engineers Club of Philadelphia and a member of the fair practice committee of the Motor and Accessories Manufacturers Association.

COMING EVENTS

December 3-6.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St., New York.

December 5-7.—Sixth annual convention of the National Society for the Promotion of Industrial Education in Philadelphia, Pa. Headquarters, Hotel Walton. C. A. Prosser, secretary, 105 East 22d St., New York.

January 11-18.—National Association of Automobile Manufacturers show of pleasure vehicles at Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 20-25.—National Association of Automobile Manufacturers show of auto-truck and delivery cars at Grand Central Palace, New York. M. L. Downs, secretary, 7 East 42d St., New York.

NEW BOOKS AND PAMPHLETS

Road Legislation and Administration in Iowa. By John E. Brindley. 112 pages, 8⅝ by 5¾ inches. Three tables of information on road legislation and administration. Published by the Engineering Experiment Station, Iowa State College of Agriculture and Mechanical Arts, Ames, Iowa, as Bulletin No. 28.

Table of Angles Obtainable on the Dividing Head. Prepared and published by C. W. Ripsch and P. W. Hirsch, 113 Hawthorn St., Dayton, O. Price 25 cents.

These tables were prepared to meet the needs of machinists and toolmakers who are required to find angles on the dividing head of the milling machine quickly. The tables cover all the angles obtainable by simple indexing, using the plates furnished with the machine and an additional plate containing ninety holes, and are calculated to the nearest second.

The A B C of the Differential Calculus. By William Dyson Wansbrough. 148 pages, 7⅜ by 5⅛ inches. 30 illustrations. Published by D. Van Nostrand Co., New York. Price $1.50.

The object of this little book, which is clearly expressed by the title, is to present the essential details of the differential calculus in as concise and readily understandable a manner as possible. The present is the third edition, and is practically unchanged. The book can be recommended to those who wish to study the calculus at home. The subject is presented simply and progressively; the language often is unmathematical and the examples are drawn from everyday practice.

Emery and the Emery Industry. By A. Haenig. 103 pages, 7½ by 5 inches. 45 illustrations. Published by D. Van Nostrand Co., New York. Price $2.50.

The development of competition in the machinery industry has fully justified the expression that "time is money." This condition has led to the development of many forms of machinery that not only assist the workman in carrying out certain operations, but in many cases, actually do away with a large amount of hand work. Among such improvements, the substitution of emery wheels for the old type of grindstone, or for the file, has found wide application. In the present text, the author presents to both the engineer and layman, a general discussion of the subject of emery and the emery industries, treating of the raw materials, the finished wheels, and machines used to drive them, in the classes of work where they find application.

The Mechanical World Pocket Diary and Year Book for 1913. 330 pages, 6¼ by 4¼ inches. 71 illustrations. Published by Emmott & Co., Ltd., 65 King St., Manchester, England.

The latest edition of this annual contains a variety of useful information on mechanical engineering which is presented in convenient form for reference. The opening chapters deal with subjects pertaining to power installations and cover steam, gas and oil units. Following this section comes information on power transmission with useful tables on the standard dimensions of equipment used for this purpose. A considerable amount of useful information on machine shop practice is also presented chiefly in tabular form. In addition, the book contains a number of tables on the characteristics of engineering materials and also tables of mathematical constants. Considering the low publisher's price—six pence— this book is a remarkably cheap and valuable handbook.

Forging, Stamping and General Smithing. By Benjamin Saunders. 428 pages, 8¾ by 5¾ inches. 728 illustrations. Published by Spon & Chamberlain, 123 Liberty St., New York. Price $7.50, net.

The information presented in this book will be found of value to foreman-blacksmiths, engineers and managers, and others concerned with the operation of blacksmith shops. The text includes matter on forging, stamping and general smithing, the methods in each case being freely illustrated and described in a concise and readily understood manner. The author is, himself, a practical foreman-blacksmith and has drawn his information from a wide experience with the subject upon which he writes. One of the points of particular value is that the time required to complete given operations is indicated in connection with the description of the method to be followed. The time and other data presented have been carefully verified by the writer; the work, therefore, may be taken as a guide by those who are looking into the efficiency of blacksmith shop operation.

Gasoline Engines; Their Operation, Use and Care. By A. Hyatt Verrill. 275 pages, 7½ by 5¼ inches. 152 illustrations. Published by Norman W. Henley & Son, New York. Price $1.50.

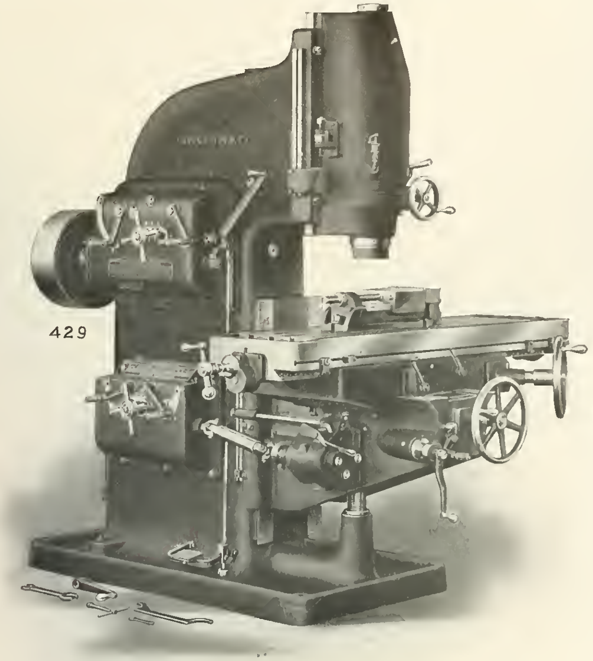
The wide application of gasoline engines to motor-driven vehicles and to a variety of classes of stationary service, has created a need for a book dealing with the methods of operating and caring for this type of equipment. The subject is one which affords an opportunity for highly technical treatment, but such a text would be of little value to the many users of gasoline engines who are non-technical men. It is for the use of such readers that the present volume has been written. The text gives all necessary information concerning the operation and care of gasoline engines in simple language, and the use of technical terms has been avoided as far as possible. There are certain cases, however, where technical terms have to be used, as for instance, in ordering new parts, but to make these clear, a glossary has been included which gives the meaning of all the technical terms used.

Soft Soldering, Hard Soldering and Brazing. By James F. Hobart. 190 pages, 7 by 4¾ inches. 62 illustrations. Published by D. Van Nostrand Co., New York. Price $1, net.

Some mechanics believe that the operations of soldering and brazing are comparatively simple, requiring no special degree of skill or experience on the part of the workman. As a matter of fact they involve a wide range of manipulations, and frequently demand experienced workmanship of a high order. At the same time, so many mechanics are accustomed to performing soldering operations with tools and appliances which might be greatly improved upon, that the author has been led to offer this book in the hope that it will serve as a practical aid to an improvement of methods. If such a purpose can be accomplished, the interests of both mechanics who seek advancement and employers who are awake to the importance of efficiency and economy, will be advanced by a careful study of this volume. The different phases of soldering and brazing are dealt with, the subject matter being based upon the author's experience in this work.

Toothed Gearing. By George T. White. 217 pages, 7⅜ by 4¾ inches. 136 illustrations. Published by D. Van Nostrand Co., New York. Price $1.25.

This book is presented by the author with the view of explaining simply the action of the principal forms of gear teeth. The two forms of tooth profile in most common use—the cycloidal and the involute—have been considered in detail, neither being strongly advocated in preference to the other. On cut gears, the involute curve is preferred to the cycloidal, and has almost entirely displaced it on such wheels. This change has gone so far that the involute form may very shortly become the generally accepted standard the world over for machine-cut teeth. The contents by chapter heads are: Kinematics: The Spur Wheel—Cycloidal Teeth: Annular Wheels—Cycloidal Teeth—: The Spur Wheel—Involute Teeth: Obliquity of Action, etc.: Pin Gearing: Non-Circular Wheels: Lobed Wheels: Helical Wheels; Bevel Wheels: Skew Bevel Wheels: Worm-Gearing: Oblique Worm and Wheel; Screw Wheels or Spiral Wheels: Strength of Teeth: Durability: Trains of Wheels: The Odontograph.



THE operator can change the direction of the table movement—longitudinal to cross and back again—by the two levers at the front of any Cincinnati Vertical Miller.

He always moves the levers in the direction he wants the table to go. There is no lever down under the table at the back of the knee for determining the direction or reversing. All levers are at the front with the operator.

It is easy to mill around the periphery of a rectangle because the changes in direction can be made without stopping. In fact, both longitudinal and cross feeds can be used in combination, when it is profitable to do so, which is the case on much work.

These things make the man's task easier, enable him to operate the machine quicker and produce more work.

And our Verticals are so rigidly constructed, that they can produce flat surfaces on such difficult pieces as the flanges of covers or gear cases, etc., and not leave an offset where the cut ends.

Send us your blueprints and we will show how this applies to your work.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

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How to Read a Drawing. By Vincent C. Getty. 64 pages, 9¾ by 6⅜ inches. 61 illustrations. Published by J. B. Lippincott Co., Philadelphia and London. Price $1, net.

There is probably no study of more general use to the practical mechanic than the reading of drawings. No matter what class of work he is engaged upon there will be constant occasion for him to use drawings in carrying on his work. This knowledge can be readily acquired by the young mechanic without being well informed on engineering or other technical matters, as it is only necessary for him to be able to read English to enable him to acquire a working knowledge of mechanical drawings. In presenting this book, the author has endeavored to explain the methods of reading a drawing without the use of technical terms, but where it has been absolutely necessary to include such terms an explanation of them has been given. The main principles of drawing are thoroughly explained and sufficient examples are given to enable anyone to clearly understand a drawing which may be placed before him. This is a book which is particularly adapted to home study and should enable any mechanic to acquire knowledge upon a subject that will be of particular value to him.

Practical Mathematics. By Claude Irwin Palmer. Part I. Arithmetic With Applications; 139 pages, 7⅛ by 4¾ inches. 20 illustrations. Part II, Geometry with Applications; 149 pages, 7⅛ by 4¾ inches. 130 illustrations. Published by McGraw-Hill Book Co., 239 West 39th St., New York. Price 75 cents, net, per volume.

The subject of mathematics is one with which many mechanics are insufficiently acquainted, and the realization of this fact causes many to attempt to remedy the deficiency by attending evening classes. During the past eight years Mr. Palmer has taught evening classes in mathematics comprising a total of over 500 men, and has prepared the text to meet the requirements of such students. In all cases, the subject matter has been made as practical as possible in order that its application to actual problems which the students will subsequently encounter in the shop, may be made as easy as possible. The series will be completed by two other volumes covering the subjects of algebra and trigonometry, and it appears that the complete text should meet a need in presenting mathematical subjects in evening classes, continuation schools, etc., which are primarily intended for the education of practical men of somewhat advanced years.

The Theory of Engineering Drawing. By Alphonse A. Adler. 312 pages, 9 by 6⅛ inches. 273 illustrations. Published by D. Van Nostrand Co., New York. Price $2.

The subject matter of this volume is largely the same as that of many other treatises on descriptive geometry but the author has given it the title "Theory of Engineering Drawing," believing that this indicates the ultimate purpose of the book in a better way. The text was written with the purpose of correcting certain weaknesses in the presentation of the subject of descriptive geometry, and emphasizes the fact that the student is concerned with the representation on a plane of objects in space or three dimensions. Although analysis is important as affecting primary purposes, the development of methods for representation and interpretation of the resulting drawings cannot be regarded as an end in itself. The number of fundamental principles treated in the text has been reduced to a minimum; indeed it will be found that the entire text is based on the problem of finding the piercing point of a given line on a given surface, together with a few additional problems. The author believes that this method of treatment has simplified the presentation of a somewhat abstract subject, so that it may be more readily grasped by the average student.

Petrol Engine Construction and Drawing. By W. E. Dommett. 55 pages, 11 by 8½ inches. 26 illustrations. Published by Longmans, Green & Co., Fourth Ave. and 30th St., New York. Price 75 cents, net.

Existing books on machine design have failed to present information to meet the requirements of draftsmen engaged in work dealing with petrol engines and to meet this requirement, a series of drawings was prepared for use at Guildford and Kingston-on-Thames Technical Institutes. These drawings have been embodied in the present book with the view of compiling a text to meet the requirements of technical students, engineers, apprentices and junior draftsmen, who are either engaged on work in connection with petrol (gasoline) engines or are otherwise interested in the subject. Some of the dimensions in these drawings are given in millimeters on account of the extensive use of this system on the continent of Europe. For purposes of reference, a very brief description has been given of the four-cycle and two-cycle engines. The purpose of so doing has been to encourage the student-draftsman to enter into the mechanical principles underlying the operation of the parts which he is drawing in addition to simply producing a view of them for the use of the engineering department. In view of the wide application of petrol engines on motor cars, marine vessels, aeroplanes and stationary engines, it is believed that this work should be one of considerable value.

The Modern Gasoline Automobile. By Victor W. Page. 693 pages, 8⅝ by 6 inches. 380 illustrations. Published by Norman W. Henley & Son, New York. Price $2.50.

In preparing this book, the author's object has been to develop a text on the modern gasoline automobile which will be readily understood by non-technical readers. The usefulness of such a book will be readily appreciated when it is remembered that a large number of the owners of automobiles are business and professional men who have very little mechanical knowledge. The present book has been written primarily for the benefit of such readers and with this purpose in view, technical terms have been eliminated from the text as far as possible. At the same time, the author has appreciated the necessity of entering into a considerable amount of detail in order to present the subject in an adequate manner. This is probably one of the most striking differences between this book and preceding books which have been written by other authors with the view of covering the same subject. It is an established fact among automobile builders and sales agencies that many persons are deterred from purchasing an automobile, not on account of lack of means for the initial investment or provision for maintenance, but owing to the somewhat general belief that the upkeep of a car requires considerable mechanical ability. While this is undeniably true, any business man should be able to acquire much of the necessary knowledge concerning the operation and maintenance of a car from Mr. Page's book.

Hygiene for the Worker. By Dr. William H. Tolman. 231 pages, 7⅜ by 5¼ inches. Profusely illustrated. Published by the American Book Co., New York. Price 59 cents, postpaid.

It has been truly said that good health is the first requisite of success in any business undertaking. This is particularly true in the case of industrial workers who are more or less dependent upon physical strength in earning their livelihood. Dr. Tolman has had unusual opportunities for studying the conditions governing the health and general welfare of industrial workers and has developed his text with the particular object of making it acceptable reading for workers who are just starting upon their business career. The fault of many books intended to teach methods of hygiene is that they have been made more or less dependent upon a knowledge of anatomy. In the present book, such scientific terms have been entirely eliminated and a simple description is given of the necessary steps for the young worker to take in order to preserve his health and vitality in the best possible working condition. The book is freely illustrated with drawings especially prepared for the purpose and should be of particular interest and value to the class of readers for which it is intended. The chapter titles are as follows: Applying for a Position; Preparing for the Day's Work; Good Habits for the Workmen; Suitable Clothing; Food and Drink; Alcohol and Tobacco; The Noon Hour; Hygiene of the Workroom; Fatigue; After Hours; Holidays and Outings; Choice of Occupation; Occupational Dangers—Accidents; Occupational Dangers—Poisons and Fumes; Fire; First Aid to the Injured; Tuberculosis, etc.

Commercial Engineering. By "A General Manager" (Alfred B. Liversedge). 369 pages, 8¾ by 6⅛ inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price $1.80.

The text presented in this book reproduces a series of articles which recently appeared in the *Mechanical World*. The primary aim of the text was to fill in the gap which exists between the information acquired from any form of technical or business education and the actual application of the knowledge so acquired in commercial or engineering fields of endeavor. Business aptitude or the ability to handle engineering work to advantage can only be acquired through years of actual experience, and such experience necessarily entails making a start in positions of minor importance. One of the objects of the matter presented in this text is to afford a means for employes holding positions of minor importance to get in touch with the work carried on by the directing officials of large corporations. It is believed that a study of such methods will prove of particular value, as a knowledge of the workings of the organization of large corporations will place the employe in a position to undertake readily the duties of a more important position, when the opportunity of so doing presents itself. In addition, this book presents information which should be of value to the man higher up in pointing out the possibilities of markets which exist for engineering products, and the best methods of conserving these markets for his company. One of the valuable features of the method of presentation of this text is that it will appeal to a wide circle of technical readers occupying positions of varying importance.

NEW CATALOGUES AND CIRCULARS

Edwin Burhorn Co., 71 Wall St., New York. Catalogue of Burhorn and "Acme" cooling towers.

American Engineering Co., Philadelphia, Pa. Report of tests made on Taylor gravity underfeed stokers.

New Jersey Foundry & Machine Co., 90 West St., New York. Circular of cranes, tracks, trolleys and hoists.

Green Fuel Economizer Co., Matteawan, N. Y. Booklet entitled "Best Proportions of Boiler and Economizer Surface."

George Nash Co., 217 Pearl St., New York. Card illustrating "Perfection" spring winder for winding springs by hand or in the lathe.

Otto Gas Engine Works, 33d and Walnut Sts., Philadelphia, Pa. Special number of the *Otto Cycle* describing the Otto horizontal crude oil engine operating on the Diesel principle.

W. S. Rockwell Co., 50 Church St., New York. Catalogue 16 on semi-automatic furnaces for annealing, hardening, tempering, and heat treating, aluminum, brass, copper, german silver, sterling silver, steel, etc.

Kern Machine Tool Co., Hamilton, Ohio. Circular of sixteen-inch ball bearing, sensitive type, drilling machines furnished in 1-, 2-, 3- and 4-spindle combinations, with and without table elevating screw.

Emmert Mfg. Co., Waynesboro, Pa. Catalogue No. 12 of Emmert vises, comprising patternmakers' and woodworkers' universal vises, toolmakers' and machinists' universal vises, machinists' plain vises and combination pipe vises.

De Laval Steam Turbine Co., Trenton, N. J. Booklet on the new De Laval steam turbines with velocity stages, built in sizes up to 600 H. P., and suitable for direct connection to centrifugal pumps, blowers, small generators, etc.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 88 on hydraulic leather belt presses, listing six distinct types of leather presses; also hydraulic pumps, accumulators, fittings, etc., generally required with hydraulic presses.

Otis Elevator Co., 11th Ave. and 26th St., New York. Catalogue of inclined elevators for quick handling of freight and merchandise, truck elevators, overhead carriers, dock elevators, ramp elevators, dumbwaiters, horizontal conveyors, etc.

George W. Richardson, 4212-16 24th Place, Chicago, Ill. Circular of the Richardson direct-reading metal slide-rule, having distinctive features; also Johnson's combination pocket rule made of german silver, forming a hook-rule, caliper-gage, protractor, triangle, or try-square.

Green Fuel Economizer Co., Matteawan, N. Y. Catalogue of standard and special fuel economizers; mechanical draft outfits; heating, ventilating and drying outfits; hot blast heaters; steel plate fans; motor- and engine-driven fans, cast-iron volume blowers, exhausters, etc.

Cincinnati Precision Lathe Co., Cincinnati, O. Catalogue of Cincinnati precision lathes which have the following features: no cone pulleys, continuous spindle bearings, absence of belt pull on spindle, variable speed and reverse without shifting of belts, permanency of alignment, etc.

Cochrane-Bly Co., Rochester, N. Y. Circular on the Cochrane-Bly universal shaper which was illustrated and described in the October number. The shaper is designed especially to meet the needs of tool- and die-makers, being adapted to produce accurate work on dies, special tools, jigs, etc.

Celfor Tool Co., Buchanan, Mich. Table of feeds and speeds for Celfor drills working in cast iron, medium and hard or very tough steel, ranging from ¼ inch to 3 inches diameter. The tables are printed on "Crystaloid," in convenient shape for hanging up in the shop for ready reference.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets on ball bearings comprising propeller shaft ball bearings, mounting for double exhaust fan, two direction thrust bearings, special bearings for automobile steering pivots, vertical shaft bearings, and classified index to titles of ball bearing data sheets.

Crocker-Wheeler Co., Ampere, N. J. Bulletins Nos. 150 and 158, superseding Bulletins Nos. 114, 133 and 123, on coupled and belt type alternating-current motors two- and three-phase 50 KVA and up; and adjustable speed motors 1/3 to 32 H. P., speed ranges 2 to 1, 2.5 to 1 and 3 to 1, made in eleven frame sizes.

Manning, Maxwell & Moore, 85-89 Liberty St., New York. Twelve page bulletin descriptive of Shaw electric monorail system with fixed tongue switch which effects an advance and improvement in monorail construction, eliminating the danger of accidents and delays incident to the use of the moving-tongue type.

Foster Machine Co., Elkart, Ind. Circular of plain head and geared head turret lathes, plain head and geared friction head screw machines, universal or set-over turret lathes, special friction head

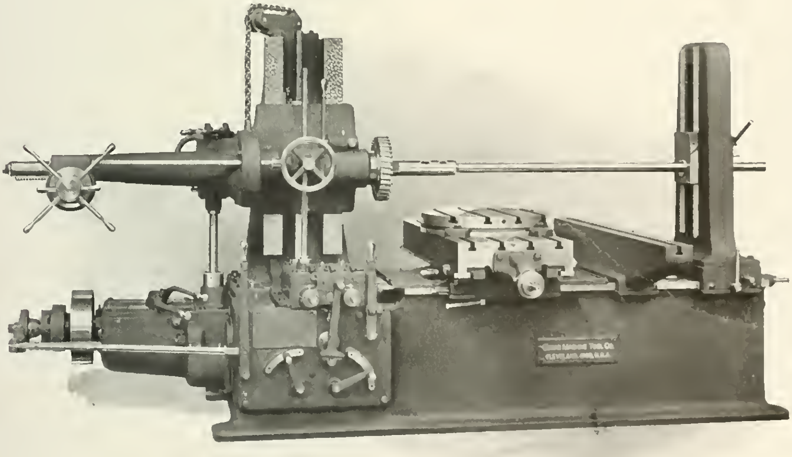
EVERYTHING WAITS BUT THE PAY-ROLL

when a machine breaks down.

One of our customers who has used several

"PRECISION"
BORING, DRILLING AND MILLING
MACHINES

for five years says: **"I DON'T KNOW WHAT IS INSIDE OF 'EM YET."**



THINK THIS OVER

Relative strength of parts is one of our closest studies.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

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screw machines, cock grinder for grinding water and gas cocks up to two inches diameter, tap holders, box tools and other accessories.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Catalogue of punches, shears, rolls, bulldozers, etc., made by the Rock River Machine Co., comprising the "Badger" single end punch and shear, "Badger" single end punch, "Badger" coping punch, "Badger" power plate bending roll and air compressors for general purposes.

Platt Iron Works Co., Dayton, Ohio. Catalogue of Platt horizontal and vertical centrifugal pumps, illustrating different forms of centrifugal pumps adapted to many kinds of service. Users of this apparatus will find interesting and valuable data on the general subject of centrifugal pumps and the conditions necessary for their economical use.

De Laval Steam Turbine Co., Trenton, N. J. Catalogue and treatise on the De Laval steam turbines, containing 120 pages, 6 by 9 inches. The relative advantages of the several fundamental types of turbines are discussed and much space is devoted to a discussion of the "speed-compromise" problem. The publication is an interesting and valuable contribution to trade literature.

Foote Bros. Gear & Machine Co., 210-220 North Carpenter St., Chicago, Ill. Price list of standard gears, comprising spur, bevel, worm gears, raw hide pinions and reducing gears. The catalogue contains 240 pages and comprises considerable data on gear elements that are required in the design and cutting of gearing; also weight tables, gages, drill sizes, thread shapes, power of belting, capacity of cisterns and tanks, etc.

Niagara Machine & Tool Works, Buffalo, N. Y. Catalogue No. 50 of tools and machines for working sheet metals, tinsmiths' and roofers' tools, etc., comprising folders, brakes, bench machines, beaders, flangers, groovers, double seamers, forming rolls, tube formers, stakes, snips, roofing tools, gutter beaders, notchers, rotary shears, foot squaring shears, lever punches and shears, power squaring shears, power rotary shears, etc.

William Cramp & Sons Ship & Engine Bldg. Co., Philadelphia, Pa. Pamphlet on gear bronzes describing six kinds, including Parsons' manganese bronze. The characteristics of each kind are given with illustrations showing application in use. The bronzes named range from the type suitable for light loads and high speeds to Parsons' manganese bronze adapted for heavy loads and slow speeds, under excessive strain and shock.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 11 on "National" pipe, and defining "spellerizing" which is a method of treating metal. The heated bloom is worked by rolls having regularly shaped projections, and then by smooth face rolls, the result being a uniform dense texture of the steel which is better adapted to resist pitting and corrosion than is the structure of common steel. A list of bulletins published by the company is also included.

National-Acme Mfg. Co., Cleveland, Ohio. Calendar for 1912-13, made in the form of a wall pocket, having two openings through which the calendar for the month and advertisements of the National-Acme automatic screw machine appear. The leaves can be removed and transposed to the back, keeping the entire calendar for the year intact, if desired. The illustrations and print appear in white on a black background, creating a very pleasing effect. A limited supply is available for distribution.

General Electric Co., Schenectady, N. Y. Bulletin A 4037 on isolated and small plant switchboards; A 4036 (superseding bulletin 4917) on direct-current exciter panels; 4974 on current limiting reactances; 4993 (superseding bulletin 4858) on type RI single-phase motors: A 4004 (superseding bulletin 4836) on the G-E steam flow meter; A 4034 on type W long-life flame arc lamps; and A 4039 on direct-current motor-starting and speed-regulating rheostats and panels, superseding bulletins 4600, 4599, 4532 on the same subject.

Pennsylvania R. R. Co., Philadelphia, Pa. Booklet on the American Land & Irrigation Exposition held in New York City November 15 to December 2 at the 71st Regiment Armory. The P. R. R. Co. in common with other progressive railroads, is educating farmers to produce more and better crops. Larger crops mean more freight and merchandise to be transported, more passengers and better dividends. The booklet is illustrated with examples of farm products and is one of a series of interesting and valuable farm publications issued by the company.

Eagle Gear & Machine Co., Wyoming and Stenton Aves., Philadelphia, Pa. Pamphlet on herringbone gears describing their characteristics and superiority to spur gearing where smooth, uniform transmission is required. Examples of herringbone gears made by the company are illustrated, ranging up to 365 H. P. capacity, in which example the pitch diameters of the gearing and pinion are 76 and 11 inches, respectively, and the face width 21 inches. The pamphlet also illustrates examples of miter and bevel gears, wormwheel balanced gears, etc.

Deane Steam Pump Co., 115 Broadway, N. Y. Catalogue D 167 on sand riddlers; D 169, on hydraulic air-charging device; D 171, on horizontal duplex piston pumps operated by direct-connected gasoline engines; D 202, on duplex steam pumps piston pattern; D 217, on duplex horizontal double-acting power pumps; D 220, on portable mine pumps, outside packed plunger pattern; D 219, on modern water works for town and city supply; supplement B to D 200, on deep well pumping machinery; D 222, on automatic pumps and receivers; D 224, on horizontal double-acting single-cylinder power pumps.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of "Universal" conductor pipe and eave-trough machinery, paint rolls, drop presses, melting outfits and dies for ceilings, sidings, cornices, etc. Circular of "Universal" garage equipment comprising turntables, jacks and floor cranes. Circular of "Canton" alligator shears made in five sizes ranging in capacity from 1½ inch square round or equivalent cross-section, soft steel or iron, to 3 inches square or equivalent section. Circular of portable floor crane and hoists for use in machine shops, factories, garages, etc. Circular of turntables for shop and factory railways.

Dodge Mfg. Co., Mishawaka, Ind. Abridged catalogue 106-A-12 on power transmission machinery, comprising price lists of steel shafting; keyseating and shouldering shafting; keyseating iron and iron center wood rim pulleys, rope sheaves, etc.; safety collars; flange couplings; compression couplings; universal joint couplings; shaft hangers and adjustable pillow blocks; adjustable ball-and-socket drop and post hangers; countershafts; step bearings; bearing metals; belt tighteners, friction clutches; cut-off couplings; adjustable mule stands; wood split pulleys; iron center wood rim pulleys; machine molded solid iron pulleys, standard iron split pulleys, etc.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Catalogue No. 3 of Hanna pneumatic standard riveters, screen shakers, revolving dumping riddles, oscillators, mold dryers, etc. The principle of the interesting toggle mechanism of the riveter is clearly shown in outline illustrations and by a view of a model furnished to salesmen. Among the advantages claimed are one blow to a rivet, saving of time and air, heavy predetermined compression, reduced wear and tear, etc. The "anatomy" of the Pedrick and Ayer hydro-pneumatic riveter, also controlled by the company, is shown with list of parts. A list of users of Hanna riveters, 1912, and testimonials from users are issued in separate pamphlets.

New Departure Mfg. Co., Bristol, Conn., manufacturer of "New Departure" ball bearings, has issued a series of data sheets devoted exclusively to the adaptability of these bearings to machine tools and shaft hangers. The data sheets cover the three types of ball bearings of "New Departure" manufacture, each of which has its peculiar qualifications. The sheets are 8½ by 11 inches, printed on one side, and have two holes punched in one edge for a loose-leaf binder. They show the design of specific mountings in a milling machine head, speed cones and driving pulley of a drilling machine, an air compressor base with layshaft and crankshaft, a high-speed grinding spindle and a grinding or polishing head. The construction of the "New Departure" shaft hanger is illustrated and described. This hanger is equipped with a ball bearing developed especially for the service. The sheets and loose-leaf binder will be sent free to any address on request, when written on the letter paper of manufacturing concerns.

TRADE NOTES

Reed Mfg. Co., Erie, Pa., manufacturer of vises, has erected a one-story brick addition 50 by 200 feet.

J. N. Lapointe Co., formerly of Marlboro, Mass., manufacturer of broaching machines and broaches, has moved to its new factory in New London, Conn.

Williams Tool Co., Erie, Pa., manufacturer of pipe tools and threading machines, has just erected a two-story brick addition for office purposes.

Oneida Steel Pulley Co., Oneida, N. Y., manufacturer of steel pulleys, has extended its plant by a one-story cement and steel addition 112 by 310 feet.

Wayo Mfg. Co., 642 Ellicott Square, Buffalo, N. Y., has placed on the market a brush-bar belt dressing, consisting, of a bar of dressing with a leather brush fixed in one end for cleaning the belt before applying the dressing.

Duff Mfg. Co., N. S. Pittsburg, Pa., manufacturer of jacks, has recently placed an order with Tate-Jones & Co. of Pittsburg for a

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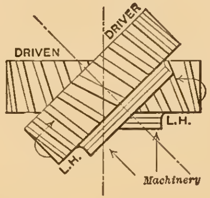
SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—I

Shafts at 45 Degrees Angle, Ratio Equal, Center Distance Approximate



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. α = angle of spiral of driving gear.
5. β = angle of spiral of driven gear.
6. N = number of teeth nearest $\dfrac{2\,C_a\,P_n \cos\alpha \cos\beta}{\cos\alpha + \cos\beta}$

To find:

a. When spiral angles are 22½ degrees.

1. D = pitch diameter $= \dfrac{N}{0.9239\,P_n}$ 2. O = outside diameter $= D + \dfrac{2}{P_n}$
3. T = number of teeth marked on cutter $= N \div 0.788$.
4. L = lead of spiral $= 7.584\,D$.
5. C = center distance $= D$.

b. When spiral angles are other than 22½ degrees.

1. D = pitch diameter of driver $= \dfrac{N}{P_n \cos\alpha}$ 2. d = pitch diameter of driven gear $= \dfrac{N}{P_n \cos\beta}$
3. O = outside diameter of driver $= D + \dfrac{2}{P_n}$.
4. o = outside diameter of driven gear $= d + \dfrac{2}{P_n}$.
5. T = number of teeth marked on cutter for driver $= N \div \cos^3\alpha$.
6. t = number of teeth marked on cutter for driven gear $= N \div \cos^3\beta$.
7. L = lead of spiral for driver $= \pi D \cot\alpha$.
8. l = lead of spiral for driven gear $= \pi d \cot\beta$.
9. C = actual center distance = sum of pitch radii.

Example

Given or assumed:

1. See illustration. 2. C_a = 4 inches. 3. P_n = 10.
4 and 5. $\alpha = \beta$ = 22½ deg. 6. N = 37.

To find:

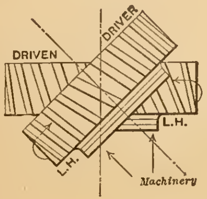
1. $D = \dfrac{N}{0.9239\,P_n} = \dfrac{37}{0.9239 \times 10} = 4.005$ inches.
2. $O = D + \dfrac{2}{P_n} = 4.005 + \dfrac{2}{10} = 4.205$ inches.
3. $T = N \div 0.788 = 37 \div 0.788 = 47$ teeth. (No. 3 cutter).
4. $L = 7.584\,D = 7.584 \times 4.005 = 30.374$ inches.

Contributed by James H. Carver

No. 161, Data Sheet, MACHINERY, December, 1912

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—II

Shafts at 45 Degrees Angle, Ratio Equal, Center Distance Exact



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. P_n = normal pitch (pitch of cutter).
3. C = center distance.
4. α_a = approximate spiral angle of one gear.
5. β_a = approximate spiral angle of the other gear.
6. N = number of teeth nearest $\dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a}$

To find:

1. α and β = exact spiral angles found by trial from $\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{N}$.
2. D = pitch diameter of one gear $= \dfrac{N}{P_n \cos\alpha}$.
3. d = pitch diameter of the other gear $= \dfrac{N}{P_n \cos\beta}$.
4. O = outside diameter of one gear $= D + \dfrac{2}{P_n}$.
5. o = outside diameter of other gear $= d + \dfrac{2}{P_n}$.
6. T = number of teeth marked on cutter for one gear $= N \div \cos^3\alpha$.
7. t = number of teeth marked on cutter for other gear $= N \div \cos^3\beta$.
8. L = lead of spiral for one gear $= \pi D \cot\alpha$.
9. l = lead of spiral for other gear $= \pi d \cot\beta$.

Example

Given or assumed:

1. See illustration. 2. $P_n = 8$. 3. C = 10 inches. 4. $\alpha_a = 15°$. 5. $\beta_a = 30°$.
6. $N = \dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a} = \dfrac{2 \times 10 \times 8 \times 0.96593 \times 0.86603}{0.96593 + 0.86603} = 73$ teeth.

To find:

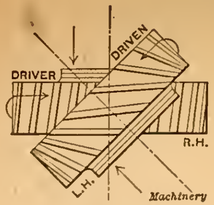
1. α and β from $\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{N} = \dfrac{2 \times 10 \times 8}{73} = 2.1918$; by trial α and β, respectively, $= 14°\,44'$ and $30°\,16'$.
2. $D = \dfrac{N}{P_n \cos\alpha} = \dfrac{73}{8 \times 0.96712} = 9.435$ inches. 3. $d = \dfrac{N}{P_n \cos\beta} = \dfrac{73}{8 \times 0.86369} = 10.665$ inches.
4. $O = D + \dfrac{2}{P_n} = 9.435 + \dfrac{2}{8} = 9.685$ inches. 5. $o = d + \dfrac{2}{P_n} = 10.565 + \dfrac{2}{8} = 10.815$ inches.
6. $T = N \div \cos^3\alpha = 73 \div 0.904 = 81$ teeth. 7. $t = N \div \cos^3\beta = 73 \div 0.645 = 113$ teeth.
8. $L = \pi D \cot\alpha = \pi \times 9.435 \times 3.803 = 112.72$ inches.
9. $l = \pi d \cot\beta = \pi \times 10.665 \times 1.714 = 56.889$ inches.

Contributed by James H. Carver

No. 161, Data Sheet, MACHINERY, December, 1912

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—IV

Shafts at 45 Degrees Angle, Ratio Unequal, Center Distance Exact



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. P_n = normal pitch (pitch of cutter).
3. R = ratio of large to small gear $= N \div n$.
4. α_a = approximate spiral angle of large gear.
5. β_a = approximate spiral angle of small gear.
6. C = center distance.
7. n = number of teeth in small gear nearest $\frac{2CP_n\cos\alpha_a\cos\beta_a}{R\cos\beta_a+\cos\alpha_a}$.
8. N = number of teeth in large gear $= Rn$.

To find:

1. α and β, exact spiral angles, by trial from $R\sec\alpha+\sec\beta=\frac{2CP_n}{n}$.
2. D = pitch diameter of large gear $=\frac{N}{P_n\cos\alpha}$. 3. d = pitch diameter of small gear $=\frac{n}{P_n\cos\beta}$.
4. O = outside diameter of large gear $= D+\frac{2}{P_n}$.
5. o = outside diameter of small gear $= d+\frac{2}{P_n}$.
6. T = number of teeth marked on cutter for large gear $= N\div\cos^3\alpha$.
7. t = number of teeth marked on cutter for small gear $= n\div\cos^3\beta$.
8. L = lead of spiral for large gear $=\pi D\cot\alpha$.
9. l = lead of spiral for small gear $=\pi d\cot\beta$.

Example

Given or assumed:

1. See illustration. 2. $P_n = 4$. 3. $R = 4$.
4. $\alpha_a = 50$ degrees. 5. $\beta_a = 5$ degrees. 6. $C = 30$ inches.
7. $n=\frac{2CP_n\cos\alpha_a\cos\beta_a}{R\cos\beta_a+\cos\alpha_a}=\frac{2\times30\times4\times0.643\times0.996}{(4\times0.996)+0.643}=33$ teeth.
8. $N = Rn = 4\times33 = 132$ teeth.

To find:

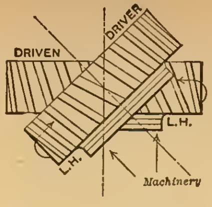
1. α and β from $R\sec\alpha+\sec\beta=\frac{2CP_n}{n}=\frac{2\times30\times4}{33}=7.273$. By trial $\alpha = 50°21'$, and $\beta = 6°21'$.
2. $D=\frac{N}{P_n\cos\alpha}=\frac{132}{4\times0.63810}=51.716$ inches. 3. $d=\frac{n}{P_n\cos\beta}=\frac{33}{4\times0.99561}=8.286$ inches.
4. $O=D+\frac{2}{P_n}=51.716+\frac{2}{4}=52.216$ inches. 5. $o=d+\frac{2}{P_n}=8.286+\frac{2}{4}=8.786$ inches.
6. $T=N\div\cos^3\alpha=132\div0.26=508$ teeth. 7. $t=n\div\cos^3\beta=33\div0.987=33$ teeth.
8. $L=\pi D\cot\alpha=\pi\times51.716\times0.82874=134.6$ inches.
9. $l=\pi d\cot\beta=\pi\times8.286\times10.678=278$ inches.

Contributed by James H. Carver

No. 161, Data Sheet, MACHINERY, December, 1912

SPIRAL GEARS WITH SHAFTS AT 45 DEGREES ANGLE—III

Shafts at 45 Degrees Angle, Ratio Unequal, C. D. Approximate



The sum of the spiral angles of the two gears equals 45 degrees, and the gears are of the same hand, if each angle is less than 45 degrees. The difference between the spiral angles equals 45 degrees, and the gears are of opposite hand, if either angle is greater than 45 degrees.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = center distance.
3. P_n = normal pitch (pitch of cutter).
4. R = ratio of gear to pinion, $N\div n$.
5. α = angle of spiral on gear.
6. β = angle of spiral on pinion.
7. n = number of teeth in pinion nearest $\frac{2C_aP_n\cos\alpha\cos\beta}{R\cos\beta+\cos\alpha}$
8. N = number of teeth in gear $= Rn$.

To find:

a. When $\alpha=\beta=22\frac{1}{2}$ degrees.

1. D = pitch diameter of gear $=\frac{N}{0.9239\,P_n}$. 2. d = pitch diameter of pinion $=\frac{n}{0.9239\,P_n}$.
3. O = outside diameter of gear $= D+\frac{2}{P_n}$. 4. o = outside diameter of pinion $= d+\frac{2}{P_n}$.
5. T = number of teeth marked on cutter for gear $= N\div0.788$.
6. t = number of teeth marked on cutter for pinion $= n\div0.788$.
7. L = lead of spiral on gear $= 7.584\,D$. 8. l = lead of spiral on pinion $= 7.584\,d$.
9. C = actual center distance $=\frac{D+d}{2}$.

b. When α and β are any angles.

1. D = pitch diameter of gear $=\frac{N}{P_n\cos\alpha}$. 2. d = pitch diameter of pinion $=\frac{n}{P_n\cos\beta}$.
3. O = outside diameter of gear $= D+\frac{2}{P_n}$. 4. o = outside diameter of pinion $= d+\frac{2}{P_n}$.
5. T = number of teeth marked on cutter for gear $= N\div\cos^3\alpha$.
6. t = number of teeth marked on cutter for pinion $= n\div\cos^3\beta$.
7. L = lead of spiral on gear $=\pi D\cot\alpha$. 8. l = lead of spiral on pinion $=\pi d\cot\beta$.
9. C = actual center distance $=\frac{D+d}{2}$.

Example

Given or assumed:

1. See illustration. 2. $C = 12$ inches. 3. $P_n = 6$. 4. $R = 3$. 5. $\alpha = 20$ deg. 6. $\beta = 25$ deg.
7. $n=\frac{2CP_n\cos\alpha\cos\beta}{R\cos\beta+\cos\alpha}=\frac{2\times12\times6\times0.93969\times0.90631}{(3\times0.90631)+0.93969}=34$ teeth approximately.
8. $N = Rn = 3\times34 = 102$ teeth.

To find:

1. $D=\frac{N}{P_n\cos\alpha}=\frac{102}{6\times0.93969}=18.091$ inches. 2. $d=\frac{n}{P_n\cos\beta}=\frac{34}{6\times0.90631}=6.252$ inches.
3. $O=D+\frac{2}{P_n}=18.091+\frac{2}{6}=18.424$ inches. 4. $o=d+\frac{2}{P_n}=6.252+\frac{2}{6}=6.585$ inches.
5. $T=N\div\cos^3\alpha=102\div0.83=123$ teeth. 6. $t=n\div\cos^3\beta=34\div0.744=46$ teeth.
7. $L=\pi D\cot\alpha=\pi\times18.091\times2.747=156.12$ inches.
8. $l=\pi d\cot\beta=\pi\times6.252\times2.145=42.13$ inches.
9. $C=\frac{D+d}{2}=\frac{18.091+6.252}{2}=12.1715$ inches.

Contributed by James H. Carver

No. 161, Data Sheet, MACHINERY, December, 1912

MACHINERY
JANUARY, 1913

VAN WAGNER MFG. CO.'S DIE-CASTING PRACTICE*—1

THE CASTING MACHINES AND DIES USED IN PRODUCING PRESSURE CASTINGS

BY CHESTER L. LUCAS†

CASTING is one of the oldest of the metal working processes. Evidences of this are handed down to us from the dark ages in cast coins, utensils and implements. From the crude cast products of those days to the high quality sand castings of the present is a long step forward, but with the exception of type-casting, it is only within the past twenty-five years that pressure casting from metal molds has been commercially successful. Owing to the general ignorance on the subject of die-casting, due no doubt in part to the secrecy which has always surrounded the process, it seems to be a common idea among the uninformed that die-casting furnishes a solution for the production of any piece difficult to make in any other way. It is the purpose of this article to set forth some of the limitations, as well as the possibilities, of this highly developed method of producing finished castings, and to give an account of some of the work incident to making the castings and the dies used in producing them. By so doing, it is believed that the mechanical public will better appreciate the effort and skill required in this line of work.

Fig. 1. Factory of the E. B. Van Wagner Mfg. Co.

In 1907, Mr. E. B. Van Wagner, of Syracuse, N. Y., established the E. B. Van Wagner Mfg. Co., for the production of die-castings. The cement and steel building shown in Fig. 1 was erected on one of the tributaries of the Limestone River in Fayetteville, a suburb of Syracuse. This stream furnishes power for operating the factory. The factory comprises the office section, the machine shop where the dies and casting machines are built, the metallurgical laboratory where the metals are alloyed, the casting department shown in Fig. 2 where the die-castings are made, and the trimming department.

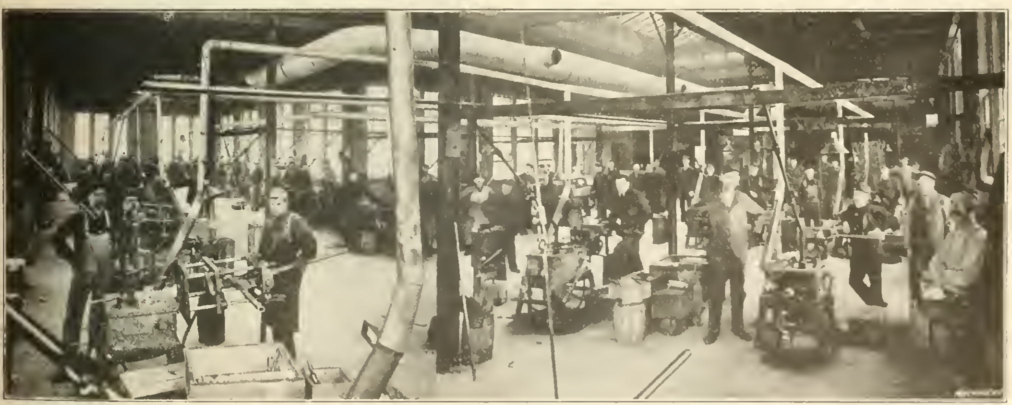


Fig. 2. View of the Casting Room

Possibilities and Limitations of Die-casting

At the outset we may say that it is possible to die-cast almost any piece, but it is not by any means practicable to do so. It must be remembered that to die-cast on a practical basis the dies must be constructed in such a manner that the cost of their operation and up-keep will be light, or there will be no profit in die-casting. It is impracticable to produce under-cut work, that is, work having no draft and which is therefore impossible to draw from the die. Such an instance is that illustrated at *A*, Fig. 3, and by the internal section of *M*, Fig. 7, and the internal groove in *O*, also shown in Fig. 7. If absolutely necessary, work of this kind can be done by the use of collapsible cores; but here, again, we meet resistance in maintaining the dies in proper condition, and, moreover, this method is commercially impracticable, owing to the difficulty of operating these cores rapidly. Hollow work, requiring curved cores, like faucets and bent piping of the character illustrated at *C* in Fig. 3 are difficult to produce. If, in designing the piece, it can be planned to have the parts of such a shape that the cores can be readily withdrawn, employing a two-piece core with a slight draft in each direction, the division coming as indicated by the core line of *C* in Fig. 3, the problem becomes simpler. Oftentimes this work can best be done by casting in a straight piece, afterward bending the die-casting. It does not pay to cast rough heavy work that can be made just as efficiently by sand casting. Generally speaking, the greatest saving can be effected by die-casting small pieces which have previously required a large amount of machining to produce. On large plain work the amount of metal required for the casting makes the cost excessive on account of the difference in cost of the metals. If, however, the large work must be finely finished by polishing, etc., it is oftentimes found of advantage to die-cast. Corners, especially those joining thick and thin sections, as at *B*, Fig. 3, should be heavily filleted as shown on one side of this piece. Regarding the casting of thin sections, it is not practicable to try to cast sections under 3/64 inch in thickness, as the metal runs with difficulty into such narrow places. A casting having walls 1/16 inch, like that shown at *X*, Fig. 10, is easily cast. Threaded sections, if the threads are fine, say, under twenty-four to the inch, should not be die-cast, because under moderate pressure they will strip. A good way to treat constructions of this kind is to enclose brass or steel bushings in the die-castings in which the threads are tapped.

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* For articles previously published on die-casting, see "Die-Casting Automobile Motor Bearings," October, 1912; "Automatic Die-Casting Machines," March, 1912, and accompanying references.

† Associate Editor of MACHINERY.

As to the accuracy with which die-castings may be produced, it is possible to keep dimensions within 0.0005 inch of standard size, but to do so requires considerable expense in keeping the dies in condition. A limit of 0.002 inch, however, is entirely practicable, and can be maintained easily. In specifying the accuracy with which die-castings are to be made, only those parts which are absolutely essential should be held to size, in order to keep the cost of the work nominal. One of the great advantages of the use of die-castings is that no finishing is required after the pieces leave the molds. Finish requirements should be plainly stated in ordering die-castings, as the alloy must be suited to these requirements.

Another great saving is effected on lettered work, either raised or sunken. One of these jobs is illustrated at *Q*, Fig. 8, which shows an example of die-cast lettering. Sunken lettering is to be preferred to raised lettering as the latter is more easily injured. Knurled work may be produced easily if straight knurls are used, and threaded sections over ¼ inch in size are entirely practicable, either internal or external. External die-cast threads are illustrated at *R* and *S*, Fig. 8. The casting of gears and segments is a familiar application of die-casting; this is illustrated by the large gear at *N*, Fig. 7, and the segment at *W*, Fig. 9, which give an idea of the general character of this class of work. The casting of pulleys, gears, and similar parts on shafts may be easily effected as shown by the gear on the shaft at *N*, in Fig. 7. The views shown in Fig. 4 are intended to convey an idea of three methods of die-casting around shafts. At *D* is shown a die-casting cast around a steel shaft. If the surface of the shaft coming within the pulley has been previously knurled, the pulley will grip it much better, but for ordinary purposes the shrinkage of the die-cast metal around the shaft is sufficient. If any heavy strain is to be imposed on the work, it is better to provide anchor holes through the shaft, like those indicated at *E*. It will be readily seen that the die-cast metal runs through these holes in the shaft, forming rivets which are integral with the casting. For locating levers upon the ends of shafts, etc., a good way is to flat opposite sides of the shaft and die-cast around them, as shown at *F*, Fig. 4. The screw seen projecting beneath the piece at *Q*, Fig. 8, was die-cast in place. Any of these methods are to be recommended, and a proper knowledge of possibilities of this kind will increase the scope of die-casting.

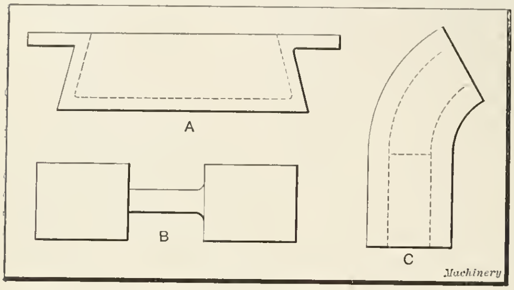


Fig. 3. Die-casting Constructions to be avoided

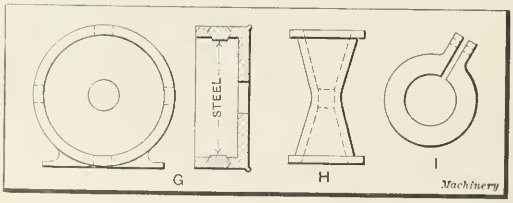


Fig. 5. A Few Possibilities of Die-casting

Another phase of die-casting which can well be borne in mind, is the possibility of inserting steel or other parts in the die-casting. Such an instance is shown at *G* in Fig. 5—a die-casting which was made by the Van Wagner Co. as a part of an electrical apparatus, the steel inserts being contact points. Oftentimes it is found advisable to include brass bearing rings to give additional durability at points where the die-cast metal would not stand up. The die-casting shown at *U*, Fig. 9, in which the brass ring at *T* has been incorporated, is typical of such cases. To die-cast pieces like those shown at *H* in Fig. 5, and similarly at *V* in Fig. 9, having inverted conical openings, might at first thought seem difficult, but this is entirely practicable. Similarly, split bushings like those shown at *I*, Fig. 5, and at *W*, Fig. 9, may be cast with projecting lugs for the reception of screws for clamping upon shafts, etc., but this construction should not be used if frequent tightening or loosening will be necessary.

The shrinkage problem manifests itself in die-casting in the same measure that it does in other casting operations. Different metals shrink in different degrees, as will be explained later on. However, one important point can be mentioned at this time: that is, the amount of shrinkage is often dependent upon the shape of the piece. For instance, pieces like those shown at *K* in Fig. 6, or at *X* in Fig. 10, will shrink very little on account of the fact that the steel mold is of such shape that the central core will prevent the die-casting from shrinking. However, pieces like those shown at *L* in Fig. 6, or at *Y* in Fig. 10, which have nothing to hold them from pulling together as they cool, will shrink to the greatest extent. All of these points must be taken into consideration when designing work for die-casting. Practically no draft is necessary on a die-casting, except on very deep sections, as indicated at *J* in Fig. 6, where a draft of 0.001 inch to the inch is desirable. Perfectly straight sections, however, can be cast, as the shrinkage of the metal is usually enough to free it from the die.

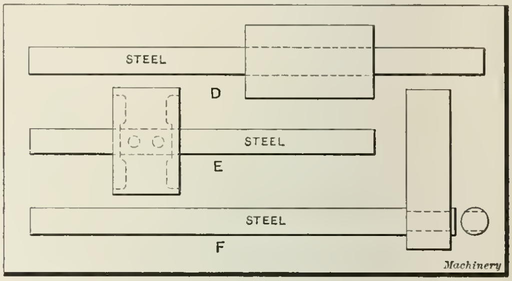


Fig. 4. Methods of attaching Die-cast Gears, etc., to Shafts

It is the opinion of the Van Wagner Co. that die-casting costs can be materially reduced if designers will bear the point in mind when bringing out new operations. Even though it is often possible to cast special pieces, incorporating several parts in one, and thereby accomplishing what seems to be a great stunt to the designer, it is sometimes more practicable to make the piece in several sections and later assemble it. Not only is this simpler for the die-caster, but it is also more economical for the customer. Such points as avoiding thin sections, including large fillets at corners, as well as taking account of the under-cut problem, are simply matters of common sense, but they can profitably be considered by the designer.

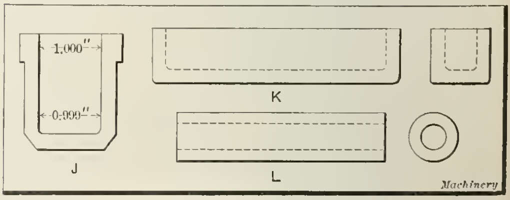


Fig. 6. Castings which illustrate Points of Shrinkage and Draft

The Van Wagner Die-casting Machine

The first essential to good die-casting is a good casting machine. Perhaps the best known types of casting machines are the familiar plunger type, of which there are several varieties, the pneumatic type and the rotary or automatic type. For descriptions of various types of die-casting machines, see articles in MACHINERY, July, 1911, and March, 1912. For the economical production of die-castings, however, the hand-operated machines are entirely too slow, and automatic machines are only applicable to a class of work which may be made in very large quantities, for the cost of the dies is prohibitive for the average die-casting job. For these reasons, therefore, the Van Wagner Co. employs the compressed air type of die-casting machine which was patented by Mr. E. B. Van Wagner in 1907. In the casting department of the Van Wagner shop, illustrated in Fig. 2, there are installed upwards of thirty machines. Fig. 13 shows a die-casting machine in the open position. Fig. 12 shows a closer view of the die-operating mechanism and Fig. 11 is presented to give a general idea of the construction of the entire machine.

By referring to the line illustration Fig. 11, which shows the Van Wagner pneumatic die-casting machine in part, and comparing this illustration with Fig. 12, which shows the general appearance of the die-operating and other mechanism of the casting machine, a good idea may be obtained of its construction and working. At *A* may be seen the base of the machine in which is located the melting pot *B*. This melting pot is heated by means of fuel oil passing through the supply pipe *C* to the burners C_1. A vent pipe *D* is provided to take away the gases incident to combustion. The pressure for "shooting" the metal into the die cavity is supplied by air through the supply pipe *E*. A valve controls this air supply. The pressure is regulated to suit the particular casting or die, the proper amount being determined by experiment. Similarly, an air exhaust pipe *F*, which may be seen directly above the supply pipe, sub-divides into two tubes which extend to the die cavity to exhaust the air before the metal is admitted. There are two methods of overcoming the presence of air in the die cavity—the exhaust method and the venting method, and it is the former that is here described.

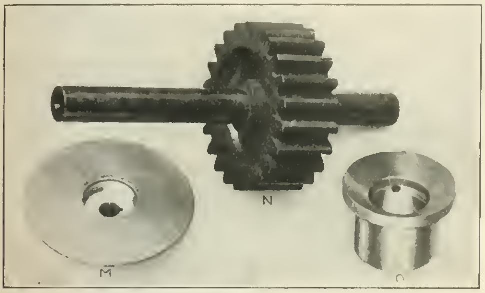


Fig. 7. Die-castings showing Impractical Under-cut Sections; also a Large Gear die-cast on Shaft

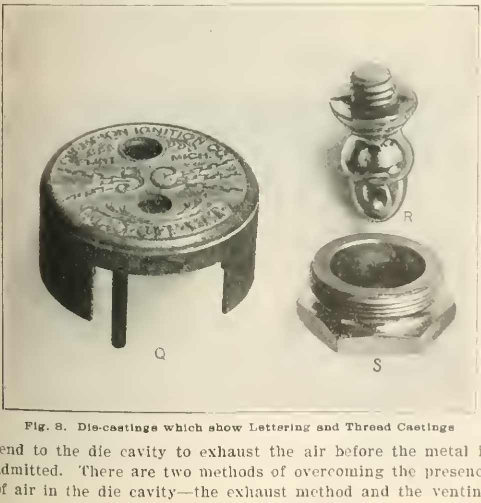


Fig. 8. Die-castings which show Lettering and Thread Castings

A "goose-neck" *G*, shown in Fig. 11, serves to contain the metal for immediate use, which is forced into the mold. An amount of metal slightly in excess of that required for one die-casting is placed in this goose-neck with a hand-ladle, previous to each operation of the machine. One end of the goose-neck is connected to the air pipe *E*, while the other end terminates in the nozzle G_1. This nozzle may best be seen by referring to the illustration of the machine shown in Fig. 13 in connection with Fig. 11. One of the advantages in using this goose-neck is that the entire air pressure is expended upon the metal in the goose-neck, and, by reason of its isolated position, the goose-neck and its contents are kept slightly hotter than the contents of the melting pot.

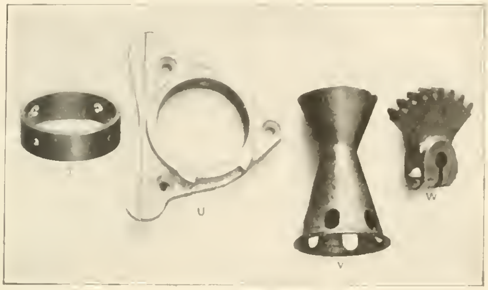


Fig. 9. Typical Die-castings illustrating Various Points

The Die-operating Mechanism

The die-operating mechanism of the machine is contained within a hinged framework, shown in position for the removal of the die-casting in Fig. 13. Referring to Fig. 12, in connection with the line illustration Fig. 11, it will be seen that the die-holding mechanism is all supported upon the lower die-holding plate *H*, which is hinged to the edge of the base of the machine. A lock *J* serves to hold the dies and operating mechanism in the upright operating position, and by means of a counterbalance, suspended from an overhead rope which connects with the top of the mechanism at *P*, the changing of the position of this mechanism is easily effected, and when thrown into the horizontal position, as indicated in Fig. 13, it rests upon a support while the dies are being opened and the castings ejected.

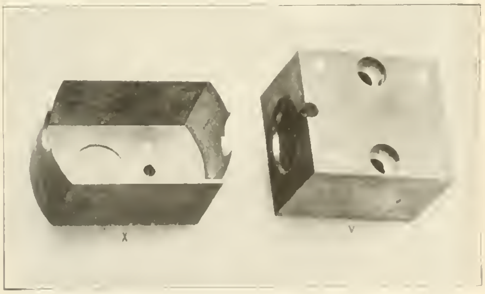


Fig. 10. Die-castings illustrating the Extremes of Shrinkage

No attempt will be made to describe the dies in detail at this time, this phase of die-casting being treated of in the second installment of this article. The lower die is shown at H_1, and the upper die K_1 is mounted upon the upper die-holding plate *K*. Four rods *L* act as guiding members for the upper die-holding plate to slide upon. These rods *L* are mounted in fixed positions at the corners of the lower die-holding plate *H*, and at their upper ends the operating shaft supporting plate *M* is located in a fixed position, serving to support the upper ends of these rods. The position of this plate *M* is adjustable upon the rods by means of check-nuts, thus providing for the accommodation of thick as well as thin dies. A shaft *O* is supported in this top plate, and by means of the operating lever *N* working through slotted levers O_1 and links O_2, the upper die-holding plate and die can thus be removed from contact with the lower die at will.

The metal enters the die cavity through the nozzle G_1, and after setting it is necessary to cut the sprue formed by the surplus metal that remains outside the die cavity. For this purpose, a sprue-cutter, operated by means of hand-lever Q_1, is employed. This is most plainly shown in the illustration Fig. 13. This sprue-cutting lever is hinged in the fulcrumed link Q_2, and is held in its casting position by means of an adjustable stop on bracket Q_3.

In many dies, it is necessary that water be circulated through the die-blocks to keep them cool during the die-casting operation. In the illustration Fig. 12, the water pipe may be seen at R, and hose pipes run from this supply to each side of the die-blocks, thus providing a cooling circulation. In this illustration, the pipes used for exhausting the air from the die cavity are apt to be confused with the cooling pipes, but by following the two pipes leading vertically down to the machine, the exhaust pipes may be seen and kept distinct from the water pipes.

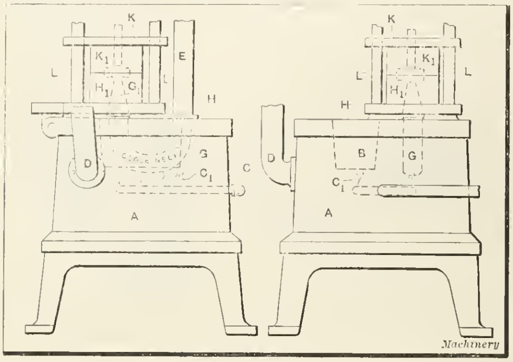


Fig. 11. Drawing illustrating Principle of Van Wagner Die-casting Machine

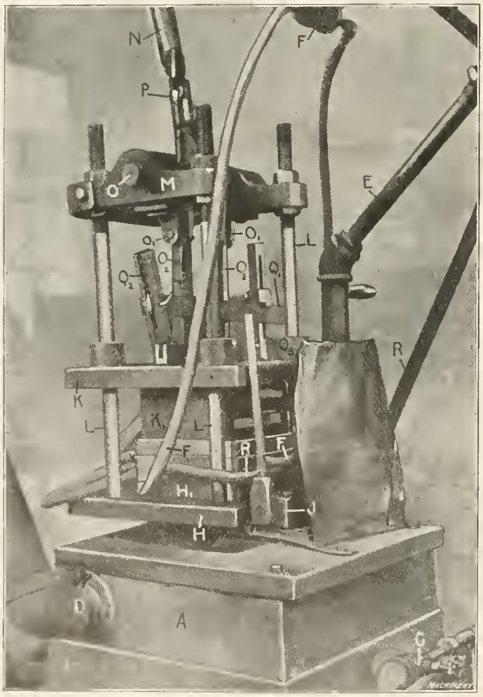


Fig. 12. View of Machine showing Die-operating Mechanism

Making a Die-casting

In order to clearly understand the operation of the die-casting machine, let us follow the sequence of events that takes place in producing a casting. Two men are required to operate the machine, and as they become almost automatic from long practice, it is easy to follow the cycle of operations. Starting with the machine shown in the position in Fig. 13, the operators may be seen in their working positions. The first step is taken by the operator at the left who, with a hand-ladle, dips enough metal for one casting from the melting pot and pours it through nozzle G_1 into the goose-neck. The second operator in the meantime is replacing the cores in the dies, adjusting the position of the sprue-cutter and closing the dies preparatory to making a casting. This being done, he elevates the dies and their operating mechanism, which are hinged and counterbalanced, as previously described, bringing them to an upright position. The die operator now mounts the box, raises the sprue-cutter to its open position to admit the metal; after which the machine operator turns the air valve with his left hand. The operation of this air valve admits the air behind the metal, forcing it into the die, and the same movement opens the exhaust valve slightly in advance. The exhaust valve is located upon the second length of piping just above the air valve, and as a link connects the two valves the single motion exhausts the air from the die cavity and immediately afterward the air is admitted behind the metal, thereby "shooting" the metal into the die. This being done, the air is shut off and the die operator cuts the sprue by means of lever Q_1, withdraws the cores in the die, throws the dies to the open position which is indicated in Fig. 13, and operates the ejecting mechanism, thus removing the casting from the die. In the meantime, the machine operator is tending to his metal supply and getting a ladle full of metal ready for the next die-casting operation. By referring to the machines shown in Fig. 2, it will be noticed that only a few are provided with exhaust piping for venting the dies. Another venting method will be described later.

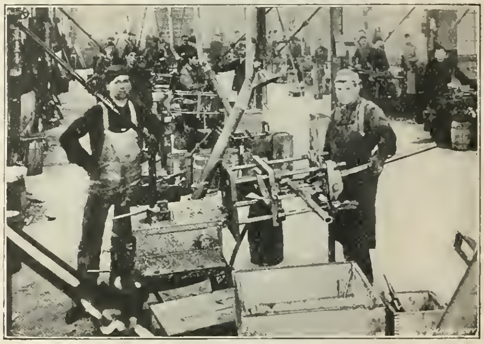


Fig. 13. Die-casting Machine in Position for Removal of Casting

Fig. 14. General View of Trimming Department

The number of die-castings which can be made on one machine per day of ten hours varies with the character of the pieces being die-cast, the number of pieces made at each operation of the machine and the ease with which the dies may be worked, which depends, of course, upon the number of cores and parts to be handled at each die-casting operation. The dies shown in the machine in Fig. 12, produce four bearings at each operation.

Trimming Die-castings

At the end of each run the operators of the machines go over their work, breaking the castings from the sprues and throwing out all that are defective. No matter how carefully the die-casting molds have been made, there is always a certain amount of trimming to be done on the finished die-castings, on account of the crevices left in the die for air vents, or which exist from improper fitting of the parts of the dies. These "fins," as they are called, are trimmed by hand operators in a special department. A general view of this trimming room is shown in Fig. 14. Usually it is sufficient to scrape these fins off with a scraping knife, but if the casting is especially difficult to produce so that a large opening is required to admit the metal, it is sometimes necessary to trim unusually thick sprue sections by filing. Fig. 15 illustrates the method of trimming such die-castings on a filing machine.

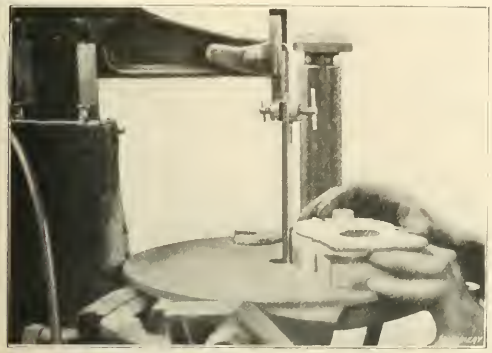


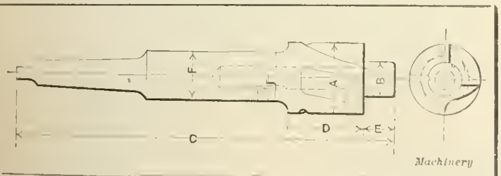
Fig. 15. Trimming Die-castings on a Filing Machine

* * *

COUNTERBORES WITH INTERCHANGEABLE CUTTERS AND GUIDES

Machinery has placed on record during the past few years the features of design and the dimensions for practically all classes of machinists' cutting tools. Dimensions for counterbores with interchangeable cutters and guides of the latest design, however, have not been published. An article on the construction and the object of the design of these tools was published over six years ago (in the November, 1906, number), but no dimensions for making these tools were included. The accompanying engraving shows an interchangeable cutter and guide counterbore of a design employed by one of the foremost tool manufacturers. The dimensions given in the accompanying table can be varied, of course, to suit conditions, but, in a general way, they are assumed to meet the requirements placed upon these tools. The range suitable for each holder or shank is based upon accepted practice, as given in the catalogue of the firm that first brought out this type of tool. As a rule, the guide or pilot was not fluted in the past, but the tendency of modern practice is to groove the pilot as indicated. The grooves in the pilot are merely small oil channels and a lodging place for chips and dirt, that may happen to be on the side of the hole to be counterbored.

COUNTERBORES WITH INTERCHANGEABLE CUTTERS AND GUIDES



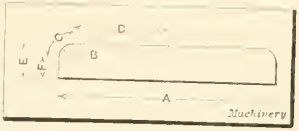
Number of Holder	Number of Morse Taper Shank	Range of Cutter Diameters A	Range of Pilot Diameters B	Total Length C	Length of Cutter Body D	Length of Pilot E	Diam. of Shank F
1	1 or 2	$\frac{3}{4}$ to $1\frac{1}{16}$	$\frac{1}{2}$ to $\frac{3}{4}$	$7\frac{1}{4}$	1	$\frac{5}{8}$	$\frac{3}{4}$
2	2 or 3	$1\frac{1}{8}$ to $1\frac{9}{16}$	$\frac{11}{16}$ to $1\frac{1}{8}$	$9\frac{1}{2}$	$1\frac{3}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$
3	3 or 4	$1\frac{5}{8}$ to $2\frac{1}{16}$	$\frac{7}{8}$ to $1\frac{5}{8}$	$12\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{5}{8}$
4	4 or 5	$2\frac{1}{8}$ to $3\frac{1}{2}$	1 to $2\frac{1}{8}$	15	$2\frac{1}{4}$	$1\frac{3}{8}$	$2\frac{1}{8}$

* * *

FLANGED HEADS

BY R. H. CREVOISIE[*]

The following formulas may be used for finding the exact diameter of the plate required for making flanged heads, as shown in the accompanying illustration. Let



Notation used in Formulas

A = outside diameter of the head;
B = radius of bend;
F = depth of flange.

For C, D and E, see illustration. Then

$$C = \frac{2\pi B}{4};\ D = \tfrac{1}{2}A - B;\ E = F - B.$$

The length of a line measured along the center line on the outside of the head then equals:

$$2D + 2C + 2E = L. \qquad (1)$$

The plate, however, gains in the flanging an amount equal to $2G$.

$$G = \frac{8\,(E + C)}{\tfrac{1}{2}AF} = 16\,\frac{E + C}{AF} \qquad (2)$$

The corrected diameter, hence, equals $L - 2G$.

Assume that in a certain case the outside diameter of a flanged head is 60 inches; that the radius B is 2 inches; and the depth of the flange F, 5 inches. Then D is found to be 28 inches, and C equals $3\frac{1}{8}$ inches. From Formula (1) we find:

$$L = 56 + 6\tfrac{1}{4} + 6 = 68\tfrac{1}{4} \text{ inches.}$$

From Formula (2) we find:

$$G = 16 \times \frac{3 + 3\frac{1}{8}}{60 \times 5} = 0.327.$$

Hence the corrected diameter equals:

$$68\tfrac{1}{4} - 2 \times 0.327 = 67\tfrac{5}{8} \text{ inches, approximately.}$$

* * *

PERPETUALLY SELF-OILING

The following story, illustrative of the dangers of technical terminology to the literal-minded, is attributed to one of the branch office managers of the Crocker-Wheeler Co.:

'One of our men sold one of our small motors to the owner of a sweatshop in a large Western city about ten years ago. The other day he met the sweatshop owner and asked him how the motor was behaving.

"'I hardly ever see it,' replied the latter. 'It is upon a shelf in the corner of the room, and I don't bother with it, only to turn it on and off.'

"'How often do you oil it?' inquired the salesman.

"'Oil it? Why I never oil it. You told me when you sold it to me that the motor was self-oiling!'"

* * *

Orders have been issued on the Illinois Central Railroad to erase the words "private car" on all the cars used by officials, and to replace them by the words "office car." It is intended to make the car a traveling office to which persons having business with the railroad company will have access at any time. Undoubtedly this move is a wise one for the roads, as the idea of a private car for railroad officials at the railroad's expense has often aroused animosity both on the part of the public and on the part of the railroad's own employes and the stockholders.

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[*] Address Wickes Boiler Co., Canton, Ohio.

THE DESIGN OF CLUTCH RELEASE SHOES

A METHOD OF DETERMINING THE PROPER DISTRIBUTION OF BEARING PRESSURE AND WEAR

BY M. TERRY[*]

A common arrangement of the clutch and releasing mechanism employed on a number of pleasure and commercial motor cars is shown in Fig. 1. The shoe *A* is generally made of phosphor-bronze and has two functions to perform: 1. To move the revolving clutch parts in an axial direction, against the full tension of the spring. 2. To stop the rotation of the clutch after it has been withdrawn from the flywheel, by acting as a brake on collar *C*.

The proper design of the shoe constitutes the only object of the present investigation. At first glance it might appear to some that "there is no design to it," and that "the thing ought to be drawn up and handed over to the shop," but this is one of those frequent instances where attention to details and the expenditure of a little extra time in the drafting-room results in an improved design and in a reduction in the cost of upkeep to the owner of the car.

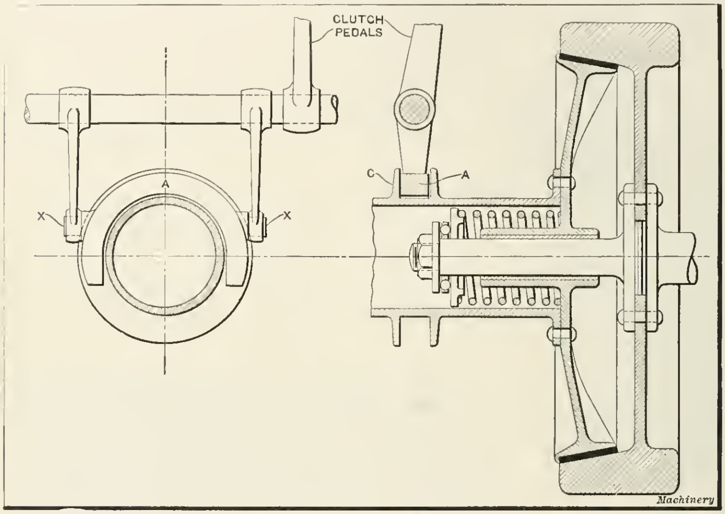

Fig. 1. The Clutch and its Releasing Mechanism

There are only two essential points to be considered in connection with the proper design of this shoe. They are: 1. A low unit bearing pressure. 2. An equal distribution of wear.

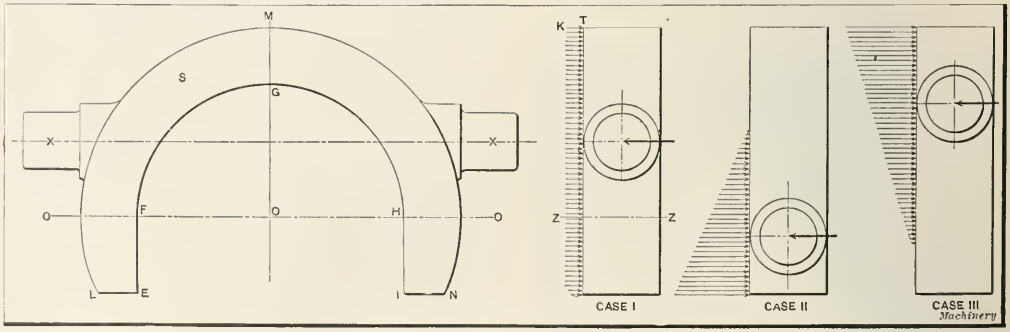

Fig. 2. Diagram showing Relation of Location of Pins to Distribution of Wear

Low unit bearing pressure depends, of course, on the spring tension and the total amount of the bearing surface, both of which are often governed by other and more important considerations. Nevertheless, their proportions in the majority of cases are such that a low pressure per square inch is secured. This is a very fortunate coincidence, since collar and shoe must run on each other dry. If any lubricant is used on the shoe, its effectiveness as a brake will be diminished and, perhaps, entirely disappear.

The equal distribution of wear depends on the location of pins *X*, which serve to transmit the pressure of the foot to the wearing surface of the shoe. Fig. 2 shows three different positions of these pins. It is evident that by locating the pins as shown in Case II, the bearing pressure would be intensified on the open ends of the shoe at the expense of that on the bend; the reverse would be true if the pins were shifted close to the bend, as shown in Case III. In either case, unequal wear will result; to obtain uniform wear, the pressure must be uniformly distributed over the face of the shoe, as shown in Case I.

Whatever the distribution of pressure on the shoe may be, however, its resultant must be equal and opposite to the applied force at the pins, or else the shoe will not remain in equilibrium. The position of the pins determines the location of the resultant, which, in its turn, governs the distribution of pressure and of the resulting wear. Hence, we may say that the distribution of wear (z) is a function of the location of the pins (y), where both z and y are variables.

Now whenever a designer locates these pins at random, without calculation, he unconsciously makes their location the independent variable, the distribution of wear, of necessity, becoming the dependent variable. If the shoe is to be properly designed, the relation of these functions should be reversed, because equal distribution of wear and, hence, of pressure, must be the starting point.

Case I, Fig. 2, shows a design where the total pressure is uniformly distributed over the whole shoe; *KT* represents the pressure in pounds per square inch. The total pressure and its distribution can be represented by a solid body of the outline *LMNIHGFE* (which we will call *S*), and of thickness *KT*.

Now, the centroid of this body with respect to the plane *ZZ* is identical with the location of the resultant of the bearing pressure and also with the position of the centroid of the plane surface *S* with respect to line *OO*. The center line of the pins *X* must, therefore, pass through the centroid of this area, and be parallel to *OO*. The problem then consists of determining the location of this centroid.

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In Fig. 3, the shaded surface is the bearing surface of the shoe. Complete the outer circle and divide the unshaded portion of it into three regular figures as shown. Now let

A = area of circle $LMNV$,
M_a = moment of this area with respect to OO,
B = area of semicircle FGH,
M_b = moment of this area with respect to OO,
C = area of rectangular figure $EFHI$,
M_c = moment of this area with respect to OO,
D = area of circular segment LNV,
M_d = moment of this area with respect to OO,
S = area of the shoe, *i. e.*, of the shaded portion of the circle,
M_s = moment of this area with respect to OO.

Then

$$A = B + C + D + S \tag{1}$$

and

$$M_a = M_b + M_c + M_d + M_s \tag{2}$$

From (1)

$$S = A - B - C - D. \tag{3}$$

Now, $A = 19.64$ square inches,
$B = 4.81$ square inches,
$C = 3.50$ square inches,
$D = 4.97$ square inches.

Substituting these values in (3) we obtain,

$$S = 6.36 \text{ square inches.} \tag{4}$$

The moment of any circle with respect to its diameter is zero; hence $M_a = 0$, and

$$M_b + M_c + M_d + M_s = 0. \tag{5}$$

$$M_s = -M_b - M_c - M_d \tag{6}$$

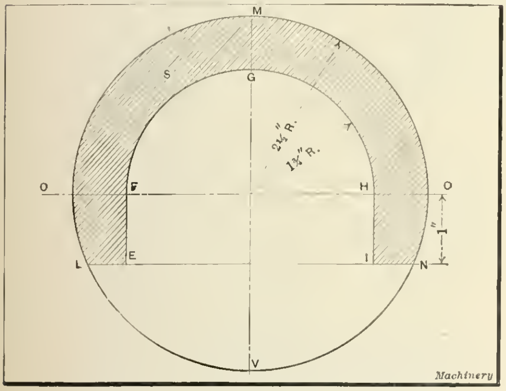


Fig. 3. Diagram showing Method of locating the Centroid

Let the moments of the figures above OO be positive, and those below OO negative.

Then

$$M_s = M_c + M_d - M_b \tag{7}$$

Now $M_c = C \times \frac{1}{2} = 3.50 \times \frac{1}{2} = 1.75$
$M_d = 8.04$
$M_b = 3.57$

(A method for calculating moments of segments of a circle will be given in the following.)

Substituting these values in (7) we obtain:

$$M_s = 6.22 \tag{8}$$

Dividing (8) by (4) gives:

$$h = \frac{M_s}{S} = \frac{6.22}{6.36} = 0.978 \text{ inch.}$$

where h is the distance of the center of gravity of S from line OO.

The center line of the pins X must, therefore, be placed 0.978 inch above OO in order to insure uniform wear on the shoe.

A practical method that is accurate enough for the purpose and which does not involve any calculations may here be given. It may also serve as a check on the preceding calculations. The method consists in reproducing to scale the bearing face of the shoe on a piece of cardboard of uniform thickness, drawing a series of lines say 1/16 inch apart, parallel to OO, and numbering them as shown in Fig. 4. Next, with a pair of shears cut out the figure S and try to balance it on a straightedge; the lines 1–1, 2–2, 3–3, etc., are merely used as guides for the straightedge, to insure having it parallel with OO. A position of balance is soon found by this method and the location of the pins X is thereby determined. The author applied this method to the problem discussed, and has found the line of balance to be between 15/16 (0.9375) inch and 1 inch from OO. The calculations gave 0.978 inch for this distance.

Moments of Segments of a Circle

A segment $STUV$ of a circle of radius r is shown in Fig. 5. To find the moment of $STUV$ about the diameter OO, parallel to ST and UV, proceed as follows:

Take a thin strip A, parallel to OO; denote its length by $2x$,

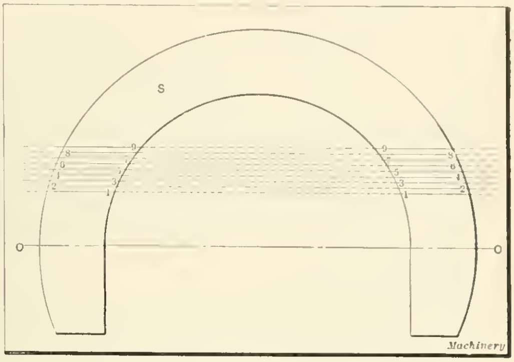


Fig. 4. Diagram illustrating Graphical Determination of Moments

its width by dy and its distance from OO by y. Its moment about OO is then equal to $2xydy$. The moment of the whole segment about OO is

$$\int_{y_2}^{y_1} 2\,xydy \tag{9}$$

Now $x^2 + y^2 = r^2$ and hence $x = \sqrt{r^2 - y^2}$.

Substituting the value of x in (9) we obtain:

$$M = \text{moment of } STUV = 2\int_{y_2}^{y_1} \sqrt{r^2 - y^2}\, ydy \tag{10}$$

and integrating (10):

$$M = -2\left[\frac{(r^2 - y^2)^{3/2}}{3}\right]_{y_2}^{y_1} \tag{11}$$

where y_1 and y_2 are the upper and lower limits of integration, respectively. Formula (11) is a general equation applicable

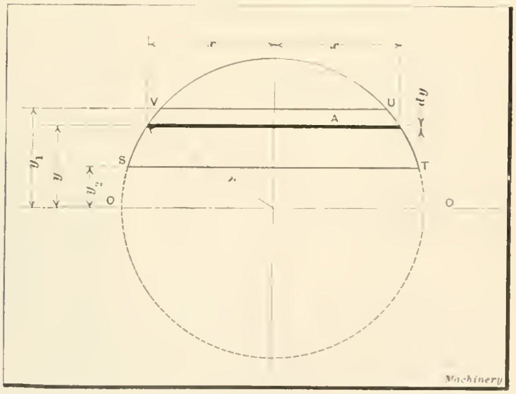


Fig. 5. Diagram for determining the Moments by Calculus

to all segments whose chords are parallel to the diameter about which the moment is to be taken.

When applied to the semicircle FGH, Fig. 3, $r = 1.75$, $y_1 = r = 1.75$, $y_2 = 0$,
and hence

$$M_b = -2\left[\frac{(1.75^2 - y^2)^{3/2}}{3}\right]_0^{1.75} \tag{12}$$

By substituting 1.75 for y, the value of (12) becomes equal to zero. From this is to be subtracted the value of (12) resulting from the substitution of zero for y. When this is done,

$$M_b = 2/3\ (1.75)^3 = 3.57 \qquad (13)$$

When applying Equation (11) to the segment LVN, $r = 2.5$, $y_1 = r = 2.5$, $y_2 = 1$.

Hence

$$M_d = -2\left[\frac{(2.5^2 - y^2)^{3/2}}{3}\right]_1^{2.5} \qquad (14)$$

When 2.5 and 1 are substituted for y, (14) will reduce to:

$$M_d = 2/3\ (6.25 - 1)^{3/2} = 2/3\sqrt{5.25^2} = 8.04 \qquad (15)$$

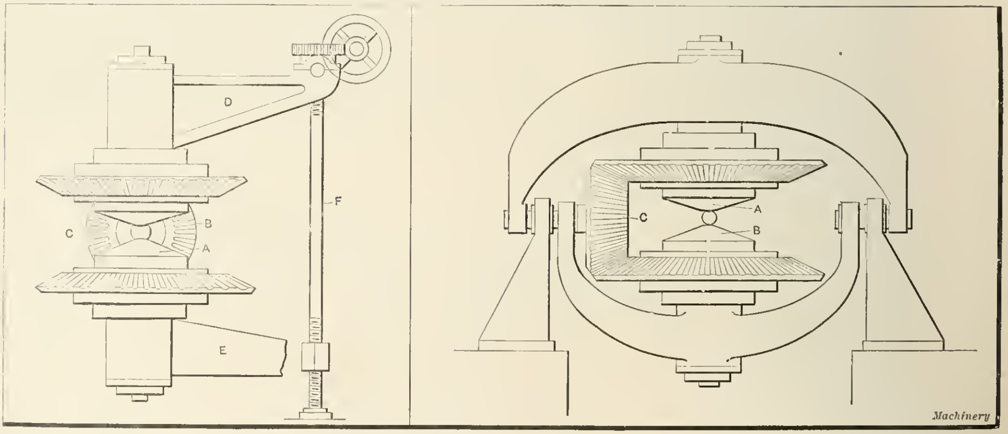
* * *

IMPROVED MANUFACTURE OF SEAMLESS TUBES

A new method of manufacturing steel tubes is described in *Le Genie Civil* of August 10. This method is derived from the Mannesmann process, but differs from it in that it does not deform the metallic fibers during the rolling and drawing of the tube.

The manufacture of the hollow ingot which is later drawn into a steel tube, constitutes the first peculiarity of this process. The ingot is obtained by the Chantrain method, which consists of casting it in a mold with a core of sand held together by oil; it is found that this does not affect the quality or composition of the metal. The hollow ingot is next rolled between the two cones A and B shown in Figs. 1 and 2. These cones are driven by a common pinion C, which turns them in opposite directions, and they can be inclined in opposite directions about the axis of the pinion by means of the brackets D and E shown in Fig. 1. These brackets are moved by nuts running on the ends of the shaft F, one end of which is threaded left-hand and the other right-hand. The rolling, which in the beginning is done without a central mandrel, is continued as long as the walls of the ingot are thick enough to resist deformation by the pressure of the cones. The result is a simple drawing of the metal without circular deformation of the fibers.

The next step is a second rolling of the tube obtained in the previous operation. A conical mandrel is introduced into the tube and the rolling is done by cones as in the first operation, but these drawing cones are constructed in such a way that all the points of the surface of the tube have the same angular velocity. This avoids the deformation of the fibers of the metal by torsion. In addition, the cones have an undulatory surface, with their projections and depressions in opposition, in order to facilitate the drawing of the metal. The advance of the tubes between the cones is not effected automatically by means of drawing tools, as in the Mannesmann process, but is produced by a hydraulic cylinder, or by a screw, driving the ingot between the rolls.



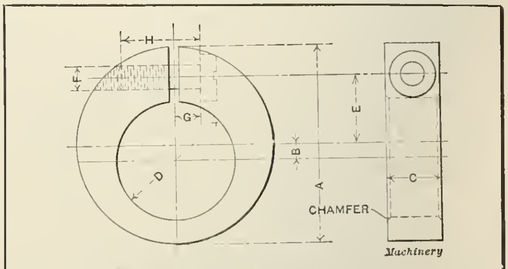
Figs. 1 and 2. Provision for adjusting Position of Rollers about Axis of Pinion and Method of driving Rollers

COLLARS FOR SPRING SCREW THREADING DIES

A number of articles treating of the best way in which to make a collar for adjusting a spring screw threading die, in which different writers were of opposite opinions, were published in MACHINERY in August, October, and November, 1906. Two of the writers claimed that the style of collar shown in the accompanying engraving would be the most suitable one for the purpose, although at that time, apparently, no one made regular use of this type of collar. The writer has been informed that this style has since been successfully used for a number of years, and found to be superior to any other kind, except the plain taper ring clamp collar. For this reason, a table of this type of clamp collars, may be of value and interest to users of spring screw threading dies. The collars are made of machine steel and need not be casehardened. The plain hole in one-half of the clamp collar for the adjusting screw should be made from 0.010 to 0.015 inch larger in diameter than the diameter of the screw. The counterbore for the screw head should also be made large enough for clearance.

E. O.

TABLE OF CLAMP COLLARS



D	A	B	C	E	F	G	H
$\frac{1}{2}$	1	$\frac{9}{64}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{3}{16}$	$\frac{11}{64}$	$\frac{13}{32}$
$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{1}{8}$	$\frac{7}{16}$	$\frac{11}{32}$	$\frac{7}{32}$	$\frac{3}{16}$	$\frac{15}{32}$
$\frac{3}{4}$	$1\frac{5}{16}$	$\frac{9}{64}$	$\frac{7}{16}$	$\frac{13}{32}$	$\frac{7}{32}$	$\frac{13}{64}$	$\frac{17}{32}$
$\frac{7}{8}$	$1\frac{1}{2}$	$\frac{5}{32}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{7}{32}$	$\frac{7}{32}$	$\frac{9}{16}$
1	$1\frac{11}{16}$	$\frac{11}{64}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{8}$
$1\frac{1}{8}$	$1\frac{13}{16}$	$\frac{11}{64}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{8}$
$1\frac{1}{4}$	$1\frac{7}{8}$	$\frac{1}{8}$	$\frac{9}{16}$	$\frac{23}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{17}{32}$
$1\frac{3}{8}$	$2\frac{3}{16}$	$\frac{5}{32}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{9}{32}$	$\frac{11}{16}$
$1\frac{1}{2}$	$2\frac{3}{8}$	$\frac{13}{64}$	$\frac{5}{8}$	$\frac{13}{16}$	$\frac{5}{16}$	$\frac{9}{32}$	$\frac{13}{16}$
$1\frac{3}{4}$	$2\frac{7}{8}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{11}{32}$	$1\frac{1}{8}$
2	$3\frac{1}{8}$	$\frac{9}{32}$	$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$1\frac{1}{8}$

* * *

It is stated in the *Brass World* that the most commonly used alloy for the extrusion process is one composed of 55 per cent of copper and 45 per cent of zinc.

THE "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE—2

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON*

In the previous article on the "Acme" multiple spindle automatic screw machine, the design, construction and operation of the cylinder, work spindles, end-working tool spindles and threading attachments, were described in detail. In the following, the side-working tool slides, top slides, speed changing mechanism, cams and cam-shafts will be dealt with. Tables of change gears, back gears, principal dimensions, capacities, etc., will also be included.

Side-working Tool Slides

The side-working tool slides are used principally as forming and cutting-off slides, carrying suitably shaped cutting tools for this purpose. As is shown in Fig. 18, the forming and cutting-off slides E_5 and F_5 are held in gibbed auxiliary slides G_5 and H_5, which are adjustable longitudinally on V-ways on the bed of the machine. This adjustment is effected by a screw I_5, illustrated in Fig. 19, which is held in the lower or auxiliary slide and threaded into a stud J_5. The threaded end of the screw is slotted, which provides a means for moving the slide along the base. Before the lower slides G_5 and H_5 can be adjusted longitudinally, it is necessary to loosen the set-screws bearing against the gibs. This makes it possible to change the positions of the forming and cutting-off tools, without changing the positions of the tools themselves in the holders.

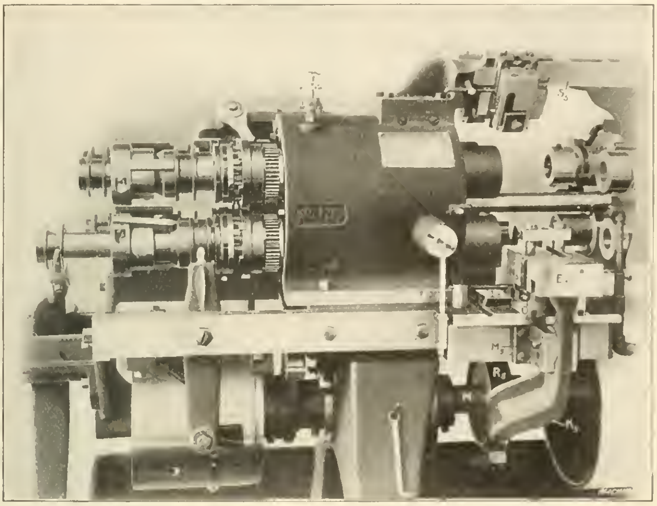


Fig. 19. View showing how the Side-working Slides are operated

The side-working slides are moved to and from the work by levers K_5 and L_5, which are fulcrumed on pins held in brackets M_5 bolted to the bed of the machine. The upper ends of these levers fit in slots cut in the under side of the slides, while the other ends, which are provided with rollers, are acted upon by the cam shoes on disk R_5 of Fig. 19. On machines Nos. 515, 52, 55 and 56, the levers K_5 and L_5, and the brackets in which they swing, are drilled in two separate places for the fulcrum pins. This makes it possible to form deeper and to cut off larger diameters of stock, when the levers are pivoted in the lower holes, without substituting shoe cams of greater throw, see Fig. 19 and Table 1.

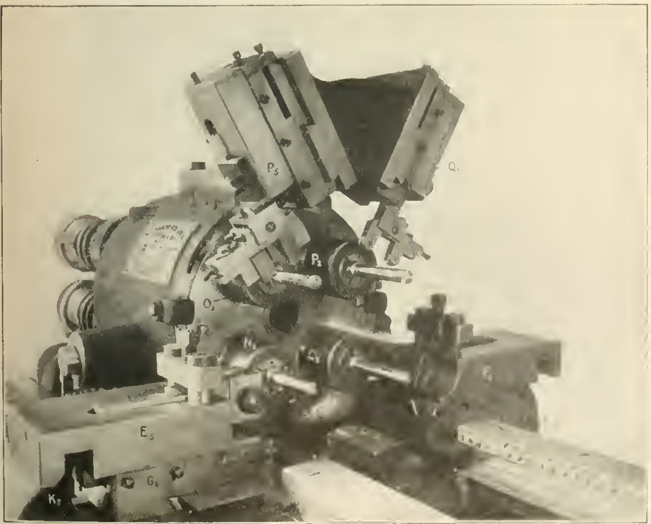


Fig. 18. Main Tool Slide removed, showing Construction of the Side-working and Top-working Slides on the "Acme" Multiple Spindle Automatic Screw Machine

As shown in Fig. 18, the tool-holders for the form and cut-off tools are held in slots in the upper face of the slides by swinging straps and set-screws. The cut-off tool, when of the blade variety, is adjusted for height by means of a set-screw in the base of the slot immediately under the holder. The forming slide is provided with a stop N_5 and an adjustable stop-screw O_5, shown in Fig. 19, to check it at the end of the cam movement and insure that the parts formed will be of an equal diameter. Set-screws are also provided for adjusting the tool-holders carrying the form and cut-off tools in towards the work. They act as locating stops for the holders, when the latter are relpaced after having been removed for the purpose of grinding the tools.

Top-working Tool Slides

The top-working tool slides P_5 and Q_5, working in the "second" and "third" positions, as shown in Figs. 18, 19 and 20, are similar in construction to the side-working slides, but are operated in a different manner. Strip cams S_5 and T_5 attached to brackets held on milled seats on the top face of the main tool slide by cap-screws as shown in Fig. 20, are used to operate the top slides. Cam T_5 moves the slides downward towards the work, while the cam S_5 moves them away from the work. These strip cams are furnished in a "blank" soft condition, when the machine is purchased without a tool equipment, and are filed to the angle required to give the desired feed to the cutting tools, after which they should be hardened on the ends to preserve the angle. When a machine is purchased with a full set of tools for making a certain part, these strip cams are furnished hardened and ready for use. The operating angles on the strip cams are governed largely by the lead of the cam operating the main tool slide. A narrow or short-rise cam on the drum operating the main tool slide, necessitates an abrupt angle on the strip cams, while a lead cam with a greater throw (wider cam), would require a flatter angle on the top-slide operating cams. Of course, the same cams can sometimes be used for a large number of different pieces; but the character of the operations and feed required govern their shape, so that, for instance, the same cam should not be used for operating a thread roll and a drill. The angle on the strip (advancing) cam and the rate of advance of the main tool slide governs the feed given to the tools held on the top slides. This subject will be more fully dealt with in a future article.

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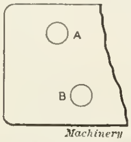
* Associate Editor of MACHINERY.

The lower or auxiliary members of the top slides, as shown in Figs. 18 and 19 are adjustable on the machined faces of the brackets; this adjustment is controlled by screws in the same manner as the side-working slides, thus enabling the tools to be set in the desired relation to the work, without shifting the holders. The shaving and knurling tool-holders, shown in Fig. 18, are held in slots in the top-slides by clamping blocks and bolts. When setting up a new job requiring the use of special strip cams, the tools in the top slides should be set and the cams filed, so that the slides will be moved out to their full capacity, in order to have the cutting tools clear the work when the cylinder is indexing.

TABLE I. TRAVEL OF FORMING AND CUTTING-OFF SLIDES WITH PINS IN HOLES A AND B



Hole *A* is top hole in bracket on forming and cut-off tool slides.

Hole *B* is bottom hole in bracket on forming and cut-off tool slides.

"Capacity" equals largest diameter of stock machine will cut off, with pin in hole designated.

Forming Slide			Cut-off Slide		
Actual Throw of Cam	"Capacity" Hole A	"Capacity" Hole B	Actual Throw of Cam	"Capacity" Hole A	"Capacity" Hole B
Machine No. 515					
$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{8}$
$\frac{5}{32}$	$\frac{5}{32}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{8}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
..	..	..	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{7}{8}$
Machine No. 52					
$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{8}$
$\frac{5}{32}$	$\frac{5}{32}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$
$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{8}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$
..	..	..	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{7}{8}$
Machine No. 55					
$\frac{1}{16}$	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$
$\frac{3}{16}$	$\frac{3}{16}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{13}{16}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{15}{16}$
$\frac{5}{16}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{16}$
$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{3}{8}$
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{11}{16}$	1	1	$1\frac{1}{2}$
..	..	..	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{5}{8}$
..	.	..	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{3}{4}$
Machine No. 56					
$\frac{1}{16}$	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$
$\frac{1}{8}$	$\frac{1}{8}$	$\frac{7}{32}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{11}{16}$
$\frac{3}{16}$	$\frac{3}{16}$	$\frac{5}{16}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{15}{16}$
$\frac{1}{4}$	$\frac{1}{4}$	$\frac{7}{16}$	$\frac{5}{8}$	$\frac{5}{8}$	$1\frac{3}{16}$
$\frac{5}{16}$	$\frac{5}{16}$	$\frac{17}{32}$	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$
$\frac{3}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{9}{16}$
$\frac{1}{2}$	$\frac{1}{2}$	$\frac{27}{32}$	1	1	$1\frac{11}{16}$
..	..	..	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{13}{16}$
..	..	..	$1\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{1}{8}$
..	..	..	$1\frac{3}{8}$	$1\frac{3}{8}$	$2\frac{1}{4}$

Machinery

Operating Positions

Before proceeding with the description of the driving and other operating mechanisms, it may be advisable to give a general idea of the character of the operations performed in the various tool positions designated by N_2, O_2, P_2 and Q_2 in Fig. 18. What is said in the following, however, is only by way of suggestion, as no set rules can be given to cover all conditions.

In operation, the cylinder indexes in the direction designated by the arrow, presenting the bars before the various tools held in the main or end-working tool slide, side-working slides and the top-working slides. On the smaller type of machines the stock is fed out while the cylinder is indexing from the "fourth" to the "first" position, while on the larger machines the stock is fed out in the "first" position, the stop swinging out of the way before the tools approach the work. The operations generally performed in the "first" position, N_2, are: Forming (with a tool held on the forming slide), and turning, drilling, facing, counterboring, countersinking, etc., with tools working from the end and held in the main tool slide.

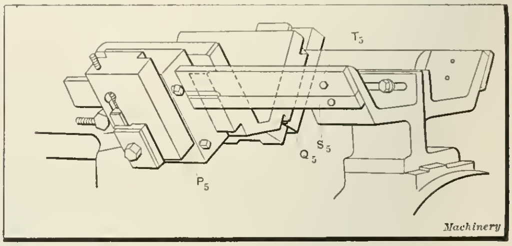


Fig. 20. View showing Top-slide Operating Cams, etc.

In the "second" position, O_2 (directly above the "first"), the operations performed from the end are: Turning with box-tools, drilling, reaming, countersinking, counterboring, facing, etc. Also such operations as shaving, light forming, knurling, and frequently thread rolling, can be performed with tools held on the slide P_5. The cylinder is then indexed to the "third" position P_2 (horizontally in line with the "second"), where such operations as threading (with dies, taps and chaser dies), drilling, reaming, counterboring, etc., and turning with a box-tool are accomplished from the end. This position also lends itself admirably to the application of special attachments for milling, cross-drilling, etc., their use being made possible because of the fact that the rotation of the work spindle can be stopped in this position for the

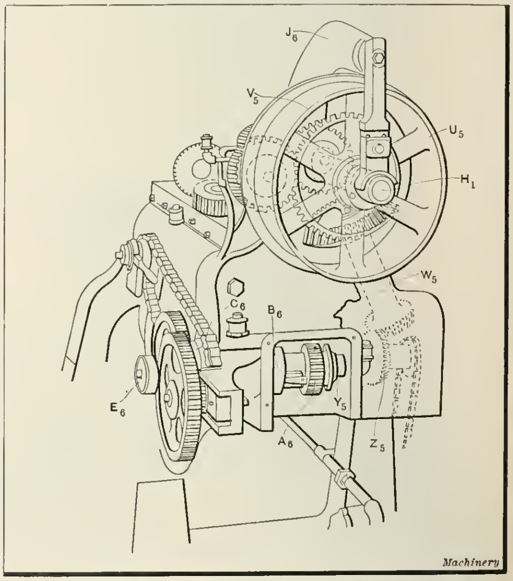


Fig. 21. End View of Machine showing Speed-changing Mechanism, Constant-speed Drive, etc.

threading operation. These special attachments are usually held on the top face of the cut-off slide, and infrequently on the top slide Q_5. Shaving, thread rolling and knurling operations are also performed on the work when in the "third" position, the tools being held on the top slide, and operating in this position.

In the "fourth" position Q_2 (vertically below the "third"), the side-working tool held on slide F_6 cuts the piece off, frequently after it has finished forming the work. The tool from the end counterbores, countersinks, reams, recesses, drills or turns with a box-tool. In many cases a variety of these operations can be combined, or made to come in practically any order desired. For instance, knurling can be accomplished in the "first" and "fourth" positions from the sides, or from any of the end positions. Threading (with taps or dies) can sometimes be done in the "second" position from the end. as provision is made for stopping the work spindle in this position when necessary. Threads can be rolled from either the "second" or "third" top positions, depending entirely on the requirements of the work in hand.

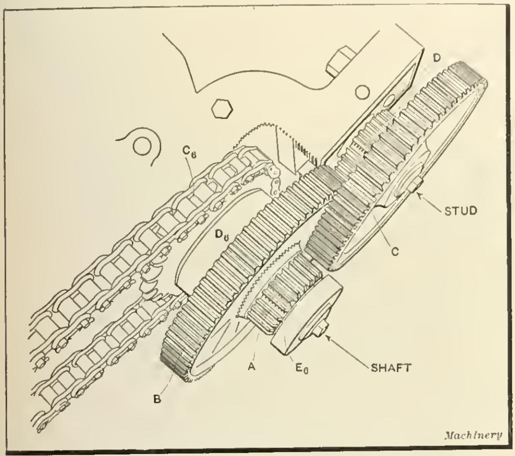


Fig. 22. Position of the Change Gears used in operating the Cam-shaft at the "Cutting Speed"

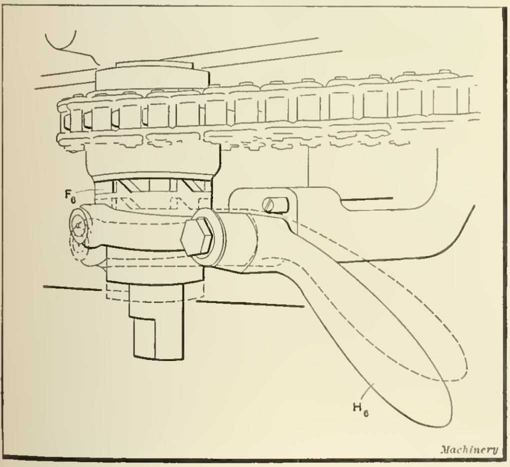


Fig. 23. Views showing the Two Positions of the Starting and Stopping Lever

Constant Speed Drive—Speed-changing Mechanisms

The driving mechanism for the "Acme" multiple spindle automatic screw machine consists of two main driving or operating shafts, the upper one H_1, Fig. 21, driving the work spindles, threading attachments, etc., through gears, while the lower shaft operates the various end, side, and top-working tool slides, stock feeding, and chuck closing and opening mechanisms through cams and levers. The drive runs from a constant-speed countershaft, equipped with tight and loose pulleys, direct to the pulley U_5 which normally runs free on the shaft H_1, but can be secured to the latter to drive direct when necessary. Fastened to the inner hub of this pulley is a large bevel gear V_5, which meshes with another bevel gear on the shaft W_5. On the lower end of this shaft is a third bevel gear meshing with the bevel gear keyed to the horizontal shaft Y_5. On machines Nos. 51, 515 and 52 spiral gears are used instead of bevel gears.

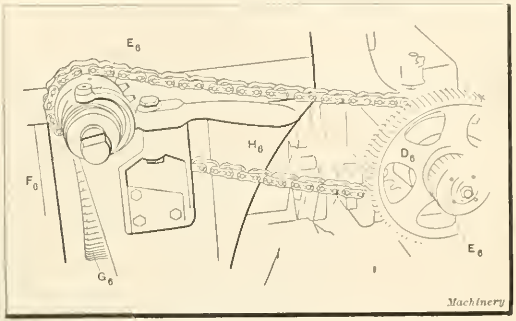


Fig. 24. Drive from the Change Gears to the Cam-shaft

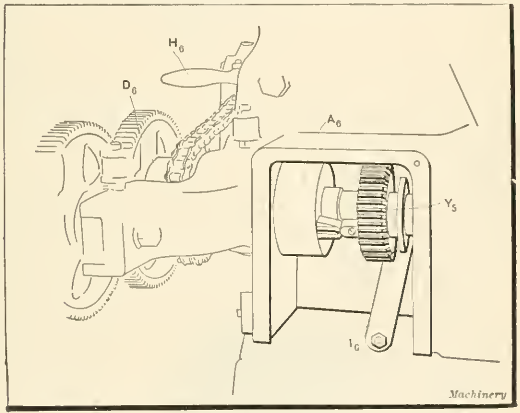


Fig. 25. View showing Position of the Johnson Friction Clutch when driving the Cam-shaft at the "Cutting Speed"

We now come to the starting, stopping and speed changing mechanisms for the cam-shaft M, Fig. 19. Starting again at the horizontal shaft Y_5, Fig. 21, the bevel gear Z_5 which receives power from the main driving pulley through the shaft and bevel gears mentioned, operates the cam-shaft through

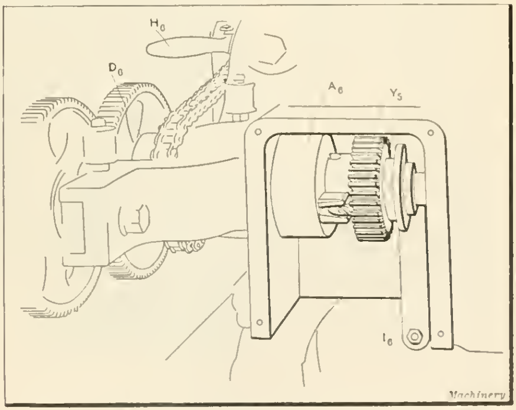


Fig. 26. View showing Position of the Johnson Friction Clutch when driving the Cam-shaft at the "Direct Speed"

the medium of a Johnson friction clutch and change gears. The sleeve A_6 of this clutch is keyed to the horizontal shaft, whereas the sleeve B_6 passes through the bearing in the frame and forms a part of the sprocket C_6 and the clutch D_6. The shaft Y_5 is also continued through the frame and has a washer E_6 keyed to its outer end. The first gear A on the shaft is, in turn, keyed to this washer, see Fig. 22, and meshes with the larger gear C on the stud. Gears C and D are pinned together and drive the second gear B on the shaft which, as previously mentioned, is pinned to the clutch D_6 of which the sprocket C_6 forms a part. The sprocket shown on the extreme right-hand end of the horizontal shaft in Fig. 21, drives the pump which supplies oil to the tools.

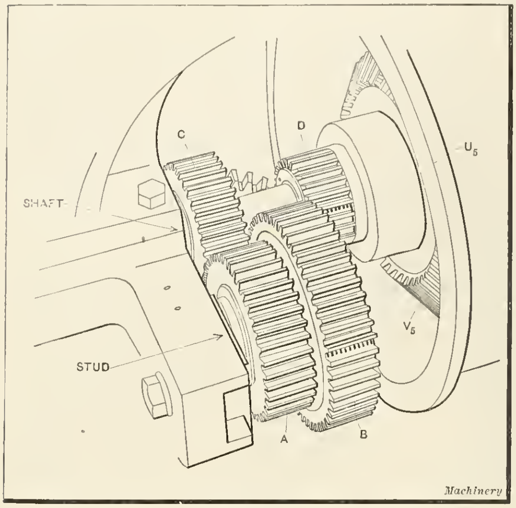


Fig. 27. Position of Back Gears used in obtaining Changes of Spindle Speeds

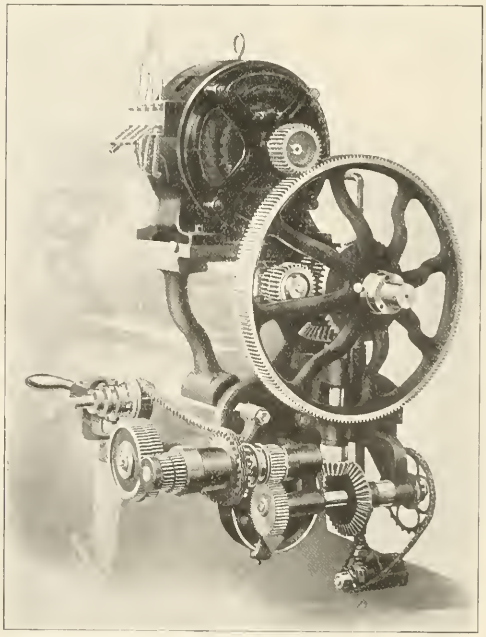


Fig. 28. Substitution of Motor for Single-pulley Drive—Alternating-current Motor shown

Power is transmitted from the change gears (for the "cutting speeds") to the cam-shaft through the clutch D_6, sprocket C_6, sprocket chain, sprocket E_6, tooth clutch F_6 and the worm on this shaft to the worm-wheel G_6 on the cam-shaft, see Figs. 23 and 24. The sprocket E_6 is free on the worm-shaft and drives the worm through the sliding member of the clutch F_6, which is brought into and out of engagement by the handle H_6. Forcing this handle in towards the machine, disengages the clutch and hence stops the rotation of the cam-shaft, while pulling it out engages the clutch and starts the machine in motion. The sprocket on the worm-shaft is provided with a safety device which consists of two fiber collars kept in frictional contact by a nut. The nut is tightened sufficiently to drive the worm when the machine is carrying the regular "cutting load," but slips in case of unusual strain, relieving the gearing, levers, tools, etc., and preventing damage to the machine.

In the latest type of "Acme" multiple spindle automatic screw machine, the operating lever or handle H_6 does not control the speed changing mechanism (changing from "direct" to "cutting speed") as was the case in the other models, but only controls the starting and stopping of the cam-shaft.

TABLES II AND III. CHANGE GEARS AND ASSUMED PRODUCT PER HOUR

(For notation, see Fig. 22)

Machine No. 51 Speed of Countershaft, 575 R. P. M.					Machine No. 515 Speed of Countershaft, 515 R. P. M.				
Number of Pieces per Hour	Gears on Shaft		Gears on Stud		Number of Pieces per Hour	Gears on Shaft		Gears on Stud	
	A	B	C	D		A	B	C	D
*1260	71	71	26	26	*1120	71	71	26	26
1097.5	50	47	38	41	975.5	50	47	38	41
1062	50	47	26	29	944	50	47	26	29
946.5	50	44	35	41	841	50	44	35	41
901	50	44	26	32	808	50	44	26	32
867	50	41	47	56	771	50	41	47	56
822	50	41	35	44	730.5	50	41	35	44
767.5	50	41	26	35	682	50	41	26	35
709	53	41	32	44	630	53	41	32	44
667	53	41	26	38	593	53	41	26	38
646	50	35	41	56	574	50	35	41	56
600.5	50	35	32	47	534	50	35	32	47
581.5	50	35	29	44	516.5	50	35	29	44
559.5	50	35	26	41	497	50	35	26	41
532.5	50	30	35	53	473.5	50	32	35	53
531.5	53	35	29	47	456.5	53	35	29	47
476.5	50	32	26	44	423.5	50	32	26	44
441	50	29	32	53	392	50	29	32	53
404	50	29	26	47	359	50	29	26	47
358.5	50	26	29	53	318.5	50	26	29	53
354	56	29	32	59	314.5	56	29	32	59
320	53	26	29	56	284.5	53	26	29	56
301.9	56	26	32	62	255.5	56	26	29	59
287.5	56	26	29	59	243	59	26	32	65
273.5	59	26	32	65	231	59	26	29	62
259.5	59	26	29	62	209.5	62	26	29	65
235.5	62	26	29	65	191	65	26	29	68
215	65	26	29	68	175	68	26	29	71
196.5	68	26	29	71	150	71	26	26	71
169	71	26	26	71	128	71	24	24	71
144	71	24	24	71	.....	..	..	..	..

Machinery

The changing of the machine from the "direct" to the "cutting speed" is now controlled entirely by dogs on drum M_4, Fig. 29, and the lever I_6, Figs. 25 and 26. Fig. 25 shows the positions that the two members Y_5 and A_6 of the Johnson clutch occupy when the cam-shaft is being driven at the "cutting speed." The drive in this case is direct to the washer which is pinned to the first gear on the shaft, so that the drive is through the change gears, sprockets, chain, etc., to the cam-shaft. In Fig. 26, the two members of this clutch are shown in engagement, when the drive is "direct" through the sprockets and chain. This is made possible by the introduction of the clutch D_6, which comes into action as it is driven in the opposite direction, allowing the pin to engage with the ratchet. This clutch works with an accelerated motion.

The idle movements of this machine are those movements which occur when the tools are not in operation on the work, such as feeding stock, indexing the cylinder, moving the tools to and from the work, etc. These movements are accomplished with the cam-shaft driven at the "direct" speed, that is, with the two members of the Johnson clutch in engagement. The "cutting speeds" are controlled by the change gears, a list of which, with the corresponding production in pieces per hour, is given in Tables II to VII inclusive.

The main driving shaft H_1 can be driven "direct" or through the back gears shown in Fig. 27. These gears are used to obtain the rapid changes in the spindle speeds and also to provide increased power. The direct speed is obtained by first sliding the gears A and B out of contact with the gear C on the shaft and the gear D which is attached to the hub of the pulley, or by removing the gears A and B entirely. Then the sleeve keyed on the end of the main driving shaft, as shown in Fig. 21, is fastened to the pulley U_5 by screws. To change from the "direct" speed to the use of the back gears, remove the screws binding the sleeve to the pulley, and place the correct gears to give the required speed, as listed in Table VIII, on the shaft and stud as illustrated in Fig. 27.

TABLE IV. CHANGE GEARS AND ASSUMED PRODUCT PER HOUR

(For notation, see Fig. 22)

Machine No. 52. Speed of Countershaft, 375 R. P. M.

Number of Pieces per Hour	Gears on Shaft		Gears on Stud		Number of Pieces per Hour	Gears on Shaft		Gears on Stud	
	A	B	C	D		A	B	C	D
*825.5	71	71	26	26	336.5	53	35	29	47
719	50	47	38	41	312	50	32	26	44
695.5	50	47	26	29	289	50	29	32	53
620	50	44	35	41	265	50	29	26	47
590	50	44	26	32	235	50	26	29	53
568	50	41	47	56	231.5	56	29	32	59
538.5	50	41	35	44	209.5	53	26	29	56
503	50	41	26	35	188.5	56	26	29	59
464.5	53	41	32	44	179	59	26	32	65
437	53	41	26	38	170	59	26	29	62
423	50	35	41	56	154.5	62	26	29	65
393.5	50	35	32	47	141	65	26	29	68
381	50	35	29	44	128	68	26	29	71
366.5	50	35	26	41	110.5	71	26	26	71
349	50	32	35	53	94.5	71	24	24	71

Machinery

To substitute the motor drive for the single-pulley drive illustrated in Fig. 21, the bracket J_6, shoe, sleeve, and pulley U_5 are removed from the machine. The large gear shown in Fig. 28 is substituted and connected to drive either direct or through the back gears as required, in the same manner as the single pulley. The bracket to hold the motor is then put in place, the motor resting on and being bolted to a plate which is fastened to the special bracket, the latter extending from the plate down to the bed of the machine to which it is securely bolted. After the motor is mounted, a pinion, usually made of rawhide, is used on the motor shaft and meshes with the large spur gear on the main driving shaft. The function of the large spur gear, in addition to receiving the power from the small pinion gear on the motor, is to transmit this power through the large bevel gear, shaft, change gears, sprockets, etc., to the cam-shaft, and by means of the back gears or sleeve on the end of the shaft, to transmit power to the main driving shaft and, through spur gears, to the work spindles.

TABLE VI. CHANGE GEARS AND ASSUMED PRODUCT PER HOUR

(For notation, see Fig. 22)

Machines Nos. 54 and 55. Speed of Countershaft, 360 R. P. M.

Number of Pieces per Hour	Gears on Shaft		Gears on Stud		Number of Pieces per Hour	Gears on Shaft		Gears on Stud	
	A	B	C	D		A	B	C	D
*585	82	82	28	28	231.5	82	60	26	48
534	82	80	30	32	199.5	82	56	26	52
500	70	66	40	44	172	82	52	26	56
486	82	78	28	32	148	82	48	26	60
450	80	74	30	36	133	82	44	28	66
426	74	66	36	44	114	82	40	28	70
390	74	66	24	32	96.5	82	36	28	74
371.5	66	56	30	40	81.5	82	32	28	78
349	82	70	28	40	68	82	28	28	82
328	80	66	30	44	58.5	82	26	26	82
307.5	74	60	26	40	50	82	24	24	82
299	82	66	28	44	45	86	24	24	86
265	78	60	26	44	42	82	22	22	82
242	78	56	30	52	38	86	22	22	86
...	..	..	..	..	25.5	86	18	18	86

Machinery

Cam-shaft, Drums and Cams

There is only one cam-shaft on the "Acme" multiple spindle automatic screw machine, and this is located under the bed, running the full length, and carries all the operating cams and shoes for the various slides, etc., and also the segment gear J for indexing the cylinder. By referring to Fig. 29, where this cam-shaft is shown, it will be seen that it also carries the two main drums W_1 and R_2. On drum W_1 are retained the cam blocks for operating the stock feeding, chuck closing and opening mechanisms, and the dogs for operating the friction clutches on the work spindles. Drum R_2 carries the cams for operating the main tool slide, which are shown at A and B in Fig. 31, and on the Nos. 51 and 52 machines, the thread starting mechanism. The grooves cut in this drum are used for locating what are known as "backing strips," which relieve the strain on the screws holding the lead or advancing cams. The cross-slots in the drum provide for the adjustment of the auxiliary cam B, Fig. 29, which controls the rapid movement of the tool slide towards the work before the cuts are started. The disk R_3 carries cams C and D, Fig. 31, for operating the side-working slides, and also the shoe cams for returning them when the cuts have been completed. The positions of these cams for different "set-ups" were clearly described in the previous article. In Fig. 31, E and F are lead return cams for the main tool slide.

TABLE V. CHANGE GEARS AND ASSUMED PRODUCT PER HOUR

(For notation, see Fig. 22)

Machine No. 53. Speed of Countershaft, 425 R. P. M.

Number of Pieces per Hour	Gears on Shaft		Gears on Stud		Number of Pieces per Hour	Gears on Shaft		Gears on Stud	
	A	B	C	D		A	B	C	D
*594.5	82	82	28	28	235.5	82	60	26	48
543.5	82	80	30	32	203	82	56	26	52
509.5	70	66	40	44	175	82	52	26	56
494.5	82	78	28	32	151	82	48	26	60
458	80	74	30	36	136	82	44	28	66
433.5	74	66	36	44	116	82	40	28	70
397.5	74	66	24	32	98.5	82	36	28	74
378	66	56	30	40	83	82	32	28	78
355	82	70	28	40	64.5	82	28	28	82
334	80	66	30	44	59	82	26	26	82
313	74	60	26	40	51	82	24	24	82
304	82	66	28	44	46	86	24	24	86
270	78	60	26	44	42.5	82	22	22	82
246	78	56	30	52	39	86	22	22	86
...	..	..	..	..	26.5	86	18	18	86

Machinery

TABLE VII. CHANGE GEARS AND ASSUMED PRODUCT PER HOUR

(For notation, see Fig. 22)

Machine No. 56. Speed of Countershaft, 240 R. P. M.

Number of Pieces per Hour	Gears on Shaft		Gears on Stud		Number of Pieces per Hour	Gears on Shaft		Gears on Stud	
	A	B	C	D		A	B	C	D
*307.5	82	82	28	28	122	82	60	26	48
281	82	80	30	32	105	82	56	26	52
263.5	70	66	40	44	90.5	82	52	26	56
256	82	78	28	32	78	82	48	26	60
237	80	74	30	36	70	82	44	28	66
224	74	66	36	44	60	82	40	28	70
205.5	74	66	24	32	51	82	36	28	74
195.5	66	56	30	40	43	82	32	28	78
184	82	70	28	40	36	82	28	28	82
173	80	66	30	44	31	82	26	26	82
162	74	60	26	40	26	82	24	24	82
157.5	82	66	28	44	23.5	86	24	24	86
139.5	78	60	26	44	22	82	22	22	82
127.5	78	56	30	52	20	86	22	22	86
...	.	..	..	..	13.5	86	18	18	86

Machinery

Cam dogs for operating the cylinder locking lever are carried on the disk K_6, Fig. 29, which is located inside the leg, to the right, on the smaller machines. The disk L_2 carries cams for operating the gage stop on machines Nos. 53 to 56. Machines Nos. 51 and 52 are supplied with a stationary stop, and disk L_2 is therefore omitted. The disk M_4 carries the cams for operating the lever controlling the change from the direct to the cutting speeds of the machine, and with the exception of machines Nos. 51 and 52, the lever for operating the thread starting mechanism. End play on the cam-shaft M is taken up by collars located inside the legs to the right; these collars seldom require adjustment.

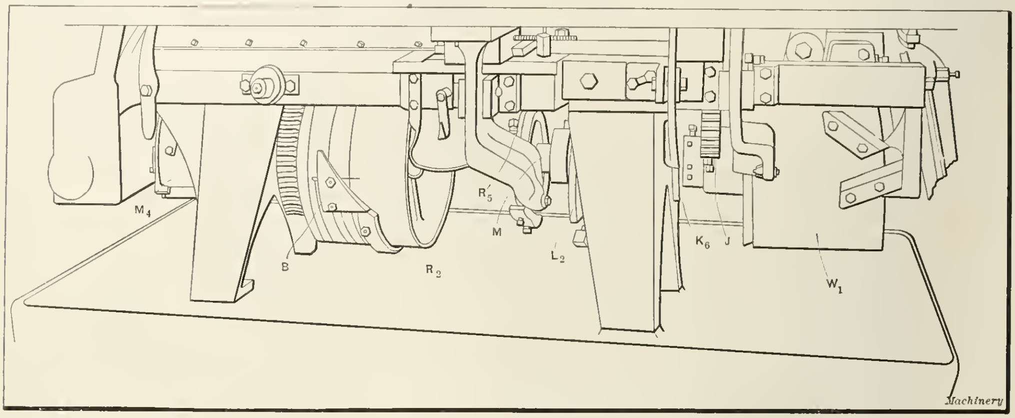
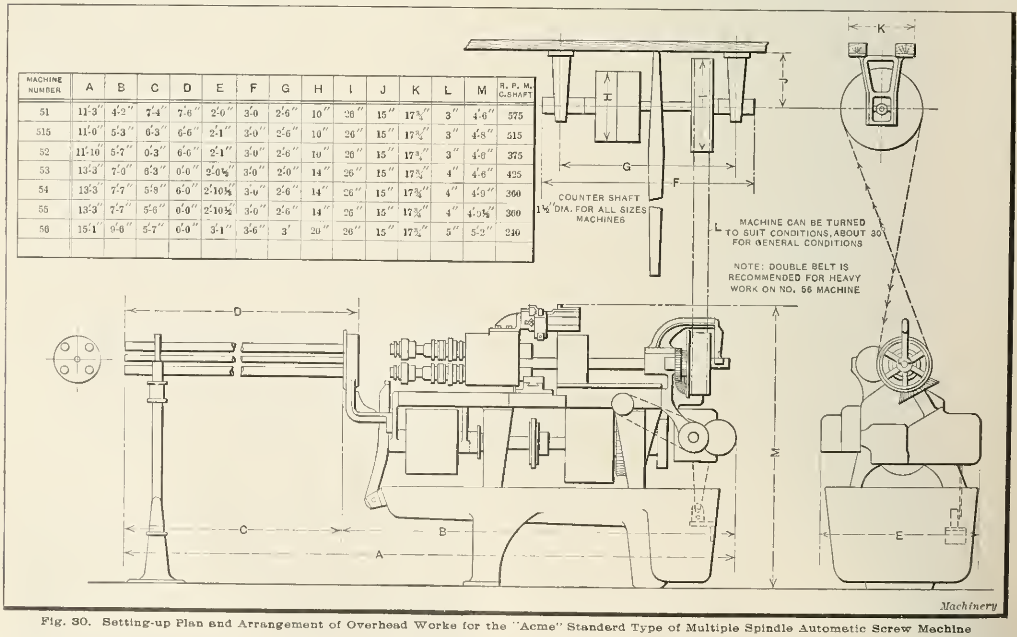


Fig. 29. Lower Section of Machine showing Cam-shaft, Drums, Cams, etc.

Tables of Change Gears

As shown in Fig. 22, change gears are provided for governing the "cutting speeds" at which the cam-shaft is rotated, and the computed product obtained by the use of these gears is listed in Tables II to VII inclusive. The computed product per hour given here is based on the assumption that these gears are used continually, that is, without shifting to the "direct" or "idle" speeds. In selecting the gears to put on the machine, allowance should be made for this by using the gears which will give the nearest speed below the one desired; this allows for the time which should be deducted for the idle or non-productive movements of the machine. Of course it is also necessary to deduct the time required for loading and grinding the tools, etc., if the actual product is desired. There are several methods for computing the product and obtaining the gears to be used; this subject will be fully dealt with in a future article on setting-up and operating this machine.


K
J
H
I
G
F
COUNTER SHAFT
1½″ DIA. FOR ALL SIZES MACHINES
L
MACHINE CAN BE TURNED TO SUIT CONDITIONS, ABOUT 30° FOR GENERAL CONDITIONS
NOTE: DOUBLE BELT IS RECOMMENDED FOR HEAVY WORK ON NO. 56 MACHINE
D
M
C
B
A
E
Machinery

MACHINE NUMBER	A	B	C	D	E	F	G	H	I	J	K	L	M	R. P. M. C. SHAFT
51	11′-3″	4′-2″	7′-4″	7′-6″	2′-0″	3′-0	2′-6″	10″	26″	15″	17¾″	3″	4′-6″	575
515	11′-0″	5′-3″	6′-3″	6′-6″	2′-1″	3′-0″	2′-6″	10″	26″	15″	17¾″	3″	4′-8″	515
52	11′-10″	5′-7″	0′-3″	6′-0″	2′-1″	3′-0″	2′-6″	10″	26″	15″	17¾″	3″	4′-6″	375
53	13′-3″	7′-0″	6′-3″	0′-0″	2′-0⅛″	3′-0″	2′-0″	14″	26″	15″	17¾″	4″	4′-6″	425
54	13′-3″	7′-7″	5′-8″	6′-0″	2′-10⅛″	3′-0″	2′-6″	14″	26″	15″	17¾″	4″	4′-9″	360
55	13′-3″	7′-7″	5′-6″	0′-0″	2′-10½″	3′-0″	2′-6″	14″	26″	15″	17¾″	4″	4′-9⅛″	360
56	15′-1″	9′-6″	5′-7″	0′-0″	3′-1″	3′-6″	3′	20″	26″	15″	17¾″	5″	5′-2″	240

Fig. 30. Setting-up Plan and Arrangement of Overhead Works for the "Acme" Standard Type of Multiple Spindle Automatic Screw Machine

By referring to Tables II to VII inclusive, it will be seen that the "computed product speed" is preceded by an asterisk; the purpose is to show that this is the highest speed obtainable and is the direct speed—that used for the idle or non-productive movements. In other words, on the No. 515 machine, for example, the cam-shaft will make 21 revolutions per minute or 1260 revolutions per hour when driven direct. This is obtained by "driving direct", as was previously explained, or by using change gears which do not change the ratio. Ordinarily the time required for the cam-shaft to make one complete revolution is the time to make one piece, but by using special combinations of tools, it is possible to turn out two or three pieces per revolution of the cam-shaft. This arrangement, as a rule, is only applicable to simple pieces requiring a few operations. The change gears are interchangeable on the Nos. 51, 515 and 52 machines, and on Nos. 53, 54, 55 and 56, as far as the dimensions of the gears are concerned.

Table of Spindle Speeds

The speed changes for the work and threading spindles, and also the tool spindle in the "second" position, are controlled by back gears, as shown in Fig. 27. Table VIII gives the speeds obtainable with the various gears supplied with the machines, and also the speed of the main driving shaft. It will be noticed that there are two speeds for the threading spindle, one direct and the other with the use of the back gears. These changes were explained in connection with Figs. 14 and 15, which appeared in the December number of MACHINERY. Those spindle speeds in Table VIII which are preceded by an asterisk are the direct speeds obtained without using the back gears, or by using gears which do not change the ratio. For the "direct" speed the drive is direct from the countershaft to the main drive shaft. The back gears are interchangeable on the Nos. 51, 515 and 52 machines, and on the Nos. 53, 54, 55 and 56 machines, as far as the dimensions of the gears are concerned.

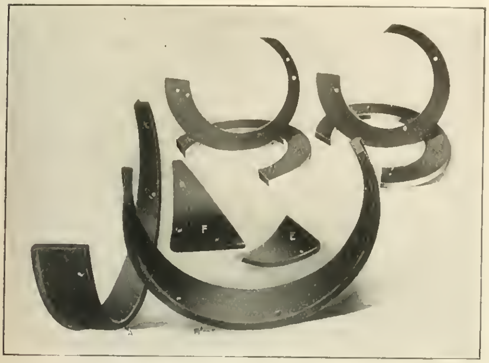


Fig. 31. Side-working Tool Slides and Main Tool Slide Operating Cams

TABLE VIII. SPINDLE SPEEDS AND BACK GEARS
(For notation, see Fig. 27)

R. P. M. of Main Drive Shaft	R. P. M. of Work Spindles	Back Gears On Shaft A	Back Gears On Shaft B	Back Gears On Stud C	Back Gears On Stud D	R. P. M. of Threading Spindle Direct	R. P. M. of Threading Spindle Back Gears	R. P. M. of Spindle Second Position
Machine No. 51—26-inch Pulley on Countershaft—575 R. P. M.								
*1495	*1605	42	42	30	30	1055	560	1495
1265	1355	42	39	30	33	890	470	1265
1130	1210	42	37	30	35	795	420	1130
1010	1085	42	35	30	37	715	375	1010
905	970	42	33	30	39	640	335	905
765	820	42	30	30	42	540	285	765
Machine No. 515—26-inch Pulley on Countershaft—515 R. P. M.								
*1330	*1230	42	42	30	30	780	305	1210
1125	1040	42	39	30	33	665	255	1025
1005	935	42	37	30	35	560	230	915
900	835	42	35	30	37	530	205	815
805	745	42	33	30	39	410	185	730
680	630	42	30	30	42	355	155	615
Machine No. 52—26-inch Pulley on Countershaft—375 R. P. M.								
*980	*980	42	42	30	30	565	225	900
825	825	42	39	30	33	475	190	760
740	740	42	37	30	35	425	170	680
665	660	42	35	30	37	385	155	605
590	590	42	33	30	39	340	135	595
500	500	42	30	30	42	290	115	460
Machine No. 53—26-inch Pulley on Countershaft—425 R. P. M.								
*790	*635	52	52	26	26	405	135	665
565	445	52	46	26	32	290	125	480
395	310	52	39	26	39	200	67	335
275	220	52	32	26	46	140	46	230
200	155	52	26	26	52	100	33	175
Machine Nos. 54 and 55—26-inch Pulley on Countershaft—360 R. P. M.								
*670	*520	52	52	26	26	315	100	480
480	375	52	46	26	32	225	71	345
335	260	52	39	26	39	155	49	240
230	180	52	32	26	46	110	34	165
165	130	52	26	26	52	78	24	120
Machine No. 56—26-inch Pulley on Countershaft—240 R. P. M.								
*390	*290	52	52	26	26	185	55	305
280	205	52	46	26	32	135	39	220
195	145	52	39	26	39	93	27	155
135	100	52	32	26	46	65	19	105
97	71	52	26	26	52	46	13	76

Machinery

Principal Dimensions, Capacities and Setting-up Plan

The principal dimensions, capacities, etc., of the standard and plain types of "Acme" multiple spindle automatic screw machines are listed in Table IX; and in Fig. 30 is shown the arrangement of the overhead works, floor spaces, etc., occupied by the standard type of machines.

TABLE IX. PRINCIPAL DIMENSIONS AND CAPACITIES OF THE "ACME" STANDARD AND PLAIN MULTIPLE SPINDLE AUTOMATIC SCREW MACHINES

Machine Numbers							
Standard......	51	515	52	53	54	55	56
Plain........	71	715	72	73	74	75	76
Capacity of Chuck in Inches							
Round.........	$\frac{1}{4}$	$\frac{9}{16}$	$\frac{3}{4}$	1	$1\frac{3}{8}$	$1\frac{3}{4}$†	$2\frac{1}{2}$†
Square.......	0.176	0.398	0.530	0.707	0.972	1.24	1.766
Hexagon......	0.216	0.487	0.649	0.866	1.190	1.51	2.19
Maximum Length—Feed and Box-tool Turning in Inches							
Feed..........	$2\frac{1}{2}$	3	3	$5\frac{1}{2}$	6	6	$10\frac{1}{2}$
Turned........	$2\frac{1}{2}$	3	3	5	5	5	8
End-working Tools							
Dia. of shank..	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{3}{8}$	$2\frac{5}{16}$
Speed of Countershaft							
R. P. M.......	575	515	375	425	360	360	240
Pulley Driving Countershaft							
Diameters.....	10	10	10	14	14	14	20
Pulleys on Countershaft							
Diameters.....	26	26	26	26	26	26	26
Speed of Horizontal Change Gear Shaft							
R. P. M........	693	616	454	502	493	493	328
Width of Driving Belts							
Countershaft .	3	3	3	4	4	4	5*
Drive shaft....	$2\frac{1}{2}$	3	3	4	4	4	5*
Normal Range of Production per Hour							
Number of pieces‡.....	144 to 1260	128 to 1120	94.5 to 825.5	26.5 to 591.5	25.5 to 585	25.5 to 585	13.5 to 307.5

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* For very heavy cuts on steel, a 4-inch double belt should be used on the No. 56 machine.

† For diameters exceeding $1\frac{5}{8}$ inch on the No. 55 machine, and $2\frac{1}{4}$ inches on the No. 56 machine, special chuck arrangements are necessary.

‡ When parts can be made two or three at a time, the production speeds will be increased in proportion.

* * *

When making sub-bases, base plates, pads, etc., for machines, generators, motors, engines, brackets or other parts, always allow from $\frac{1}{8}$ to $\frac{1}{4}$ inch of planed surface outside of the dimensions of the base of the machine or device to be attached, because castings can never be depended upon to come true to the dimensions, and it always looks best to have the base pad project outside of the object bolted to it.

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"PATENT EXPERTING"

The article by Mr. Smith in this number (engineering edition) on "Patent Experting," points to a field which deserves the attention of men of wide experience and good analytical powers. The remarkable growth of inventions in the past fifty years has brought into existence problems so numerous, varied and intricate that their solution is utterly beyond the experience or capacity of any individual, however well informed. They demand the definite, varied and extensive knowledge of many men, especially technical men of practical experience in the arts and industries. Lawyers, judges and jurors in patent cases, under the necessity of determining the rights of litigants, cannot even intelligently consider many of the cases without making use of the technical knowledge of the expert skilled in the particular branches of industry affected.

Recognized mechanical experts are well paid, but the number of men qualified for this difficult work is not equal to the demand. Besides the money to be made, there is the prestige of acknowledged authority. Moreover, the man of inventive turn engaged in this honorable and lucrative work becomes acquainted with possibilities for new inventions which he can use advantageously. The work is worthy of the attention of those who possess the qualifications for success.

* * *

NEW TOOLS THAT COMMAND A MARKET

The successful introduction of a new tool can usually be traced to one of two general causes. The manufacturer has either developed a device that will turn out more work, or work of greater accuracy than is produced by competing tools, or else he has hit upon a method of manufacture which enables him to quote a more attractive price.

In selling tools and factory supplies, the methods and "talking points" of other days will not do. The purchaser of such equipment now bases his selection upon the results of carefully conducted commercial tests and the relation of such results to the prices of competing products. He is buying units of production, and if his judgment is good the tool is selected that will produce the most work per unit of cost. As the sale of a new tool is to be based upon the number of units of work that it can produce, per unit of cost, such a tool must commend itself to the prospective purchaser either on a basis of service or of price. If the design of the new tool possesses points of merit that enable the manufacturer to offer his customers more units of work per unit of cost than his competitors can, or if he attains the same result through better manufacturing methods and correspondingly lower prices, he will be successful, provided his selling organization is efficient.

Demand favors tools of established reputation, so that the manufacturer who merely offers as much for the money as his competitors faces serious competition at the start. He may win by virtue of clever salesmanship; but what is the condition of the man who invests his money in equipment for a factory to manufacture a new tool possessing "novel features of design" but lacking the essentials of commercial success? We often see such projects launched, but are not justified in predicting their success.

The marketing of tools and supplies is coming steadily into the field of the sales engineer and the commercial test. The introduction of technically trained salesmen shows the advance which has been made in buying tools and factory supplies upon the basis of actual merit. Convincing arguments and persuasive personality still play their important part in selling—and always will—but commercial tests now make it necessary for these to rest upon actual facts. For these reasons, the manufacturer should determine whether he can offer at least an average productive capacity for the price at which he expects to sell a new tool, before investing his money in equipping a factory for its production.

* * *

THE TESTING OF SMALL TOOLS

The machine tool builder, in general, has opportunities for trying out the machines of his manufacture in his own machine shop. The types of machines built by him for the market are also used in his plant; hence, he can become familiar with the advantages and disadvantages of different designs, and can try out such improvements in their design as may be made from time to time.

The manufacturer of small machinists' tools, such as taps, dies, reamers, milling cutters, drills, etc., does not, as a rule, have this advantage, as these tools are used only to a limited extent in the making of small tools. The tap manufacturer, for example, uses taps very little, and has to depend almost entirely on his customers for such information on the construction of taps and the selection of materials for them, as will enable him to improve his product. If the progressive manufacturer of small machinists' tools is not content to depend solely on such information, which, of course, cannot be obtained from outside sources accurately or completely, he must install a testing laboratory in his plant where the various tools manufactured can be tried out and experimental tools tested. But notwithstanding the obvious need, few of the small tool manufacturers have anything like a comprehensive testing laboratory. A few concerns who give careful attention to this important matter have lately installed testing rooms which enable them to determine accurately and definitely the comparative merits of tools made in different ways. The lack of experimentation probably accounts for the fact that comparatively unimportant improvements have been made during the last ten years in the construction of small tools, while during this time great changes have been made in the design of machine tools. To be sure, great strides have been made in improving the methods of manufacture of small tools to insure rapid production and accuracy; but this, in itself, is not sufficient if the tools are still made after designs for which there are no good reasons except "that they have always been made so."

Considering taps, for example, the flutes have for many years been milled with a certain form of fluting cutter, but until lately no one has taken the pains to determine through experiment the best form of flute to produce a free-cutting tap. From experiments made by one well-known maker, it appears that the shape of the flute is one of the important factors in the production of a free-cutting tap, and of two taps, differing in no other respect than in the shape of the flutes, one will require two or three times as much power as the other to tap a given material. In fact, a tap with incorrectly shaped flutes will often break before it has passed through the test nut.

This is but one example of what can be learned by testing small tools of different designs. The testing laboratory should be of great value in determining the proper materials to use for tools, the proper methods of hardening, the best methods of manufacture, the best form of relief for the cutting edges, the shapes of flutes to insure both strength and adequate chip room, and many other features of practice which have never been scientifically determined, but merely handed down as good practice, though based on guess-work and rule-of-thumb.

* * *

THE TRAINING OF APPRENTICES

The modern conception of education takes more and more into account the necessity of arousing the interest of the child or student in the subject of study. The principle recognized by educators must be recognized by manufacturers also, in attempting to arrive at a satisfactory solution of the apprenticeship question. In the case of the apprentice, however, it is not always the character of the work alone that must provide the required stimulus. It is more, perhaps, the compensation for the work, and the possibilities of increased reward for increased efficiency. The ordinary apprenticeship contract ignores this fact. It starts a boy at, say, $4 a week, and for four years his compensation is fixed at low figures. It does not make for the best development of a boy of good mechanical ability for him to find that, after one, two or three years when he is able to perform certain work equal both in quantity and quality to that performed by average machinists, he will receive about one-half the wages paid to those who have completed their apprenticeships. Unless he is of a cheerful and optimistic temperament he is not likely to work with his full efficiency and develop his latent mechanical ability. The boy needs the stimulus of immediate reward as much as anyone. The hope that earnest effort will produce increased returns after four years—four long years to an ambitious young man—is not always bright enough to hold him.

A successful manufacturer of machine tools in the Middle West does not believe in an apprenticeship contract which binds a boy for four years and determines his pay beforehand. He employs boys, but not under contract. He gives them all the opportunities his shop affords for learning the machinist's trade, but does not consider that it is good policy either for himself as a manufacturer, or for the boys, to tie them with contracts, and to determine their pay before they have demonstrated their abilities.

Some boys are born mechanics and can produce the best work in their trade after two or three years. Others are unfitted for the machine shop. To place them all on a level may be convenient, but it is unjust and unsatisfactory both to the employer and to the boys. The manufacturer mentioned starts the boys at $4 a week. After six months he raises them, not a fixed amount, but whatever their progress merits. If a boy is not worth a raise after six months, the manufacturer advises him to try a more congenial trade—one for which he is better fitted.

This manufacturer has had no difficulty in training skilled mechanics. The men brought up in his shop usually stay for years, although it is located in a great manufacturing center affording many opportunities for change. He believes that adverse conditions in the shops are largely to blame for the difficulties met with in attracting good mechanics and in properly training apprentices. He does not pose as a philanthropist because of generous treatment of boys, but frankly states that it is done for his own advantage in developing a loyal organization, able and willing to turn out good work, not covering up mistakes to be detected by customers, or to be remedied at increased cost when the product is ready for shipment.

* * *

An aluminum alloy consisting of 92 per cent aluminum, 5 per cent copper, 2 per cent bismuth, and 1 per cent silicon, is claimed to be less corrosive than ordinary aluminum alloys, and to withstand the corrosive action of sulphuric acid, cyanide solution, etc. It is therefore well suited for castings used in mines.

PATENT EXPERTING—A NEW FIELD FOR ENGINEERS

BY DYER SMITH[*][†]

The employment of expert witnesses is one of the most characteristic features of our patent law practice. The witnesses are almost always called upon to testify in suits having to do with the infringement of patents, and their function in the litigation is usually of the utmost importance. The briefs and oral arguments of the opposing counsel in the final hearing before the judge, are largely based upon the testimony of the expert witnesses regarding the meaning and scope of the patent sued upon and of other patents and publications brought forward by the defense to anticipate or limit the patent in suit. An ill-considered answer or admission, by an expert, as to these and allied matters, may possibly prove fatal to the success of the side which called him to testify. Because of the importance of these services, the "experting of patents," as it is called, has become a profession which is well paid, and in which the supply of good men is not at present, in my belief, equal to the demand. A knowledge of technology and science is of chief importance to an expert. Many of these experts started as mechanical or electrical engineers, and at least one expert of my acquaintance, a man of deservedly high reputation, graduated from the shop and had no college or law-school training. A brief description of the part played by the expert in a patent case, would, therefore, seem of interest to the readers of MACHINERY.

Expert witnesses are employed primarily because most patents are extremely technical documents, describing complex machinery or phenomena. Without explanation, these would be difficult for a judge to understand, and still more difficult for a jury, in case the trial is held before a jury. Not only is it difficult for the layman to understand the invention itself, but the language of the patent is often incomprehensible to those not familiar with the particular subject, since the patent is addressed to those skilled in the art to which it appertains, and not to the general public. For example, an electrical patent might refer to inductance, reactance, impedance, etc., and machine patents often employ shop terms. These terms are not usually defined in the patent, and must be explained to the court by a witness who is familiar with their use.

The explanation of terms is not, however, the chief function of the expert witness, whose main duty is to testify as to the character of an invention and its apparent scope, to show the relation of one invention to others, and the equivalence of, or difference between, different structures or processes. There are really two classes of experts, scientific experts and practical or mechanical experts. The former are witnesses who have made themselves familiar, by study and experiments, with the principles of various sciences, and, therefore, are competent to explain and distinguish inventions having to do with any one of those sciences. Mechanical experts are witnesses who have had practical training in some trade or art, and so are qualified to give testimony as to the usefulness of an invention involving one of these arts, and as to whether the patent describes the invention sufficiently to enable men skilled in that line to practice it, and similar practical matters. A professional expert is usually of the scientific variety, that is, he is willing to study a case in any one of many arts, and make researches and experiments in connection with it, and as a result of this preparation testify what his opinion is in regard to such matters as the meaning of the patent specification and claims. He usually is, at the same time, a mechanical or practical expert in regard to a number of the lines in which he testifies as a scientific expert. Thus an expert might testify in a suit concerning high-speed tool steel both from the standpoint of one familiar, from previous occupation, with shop practice, and from the scientific standpoint of one familiar, from education and general training, with the questions involved in the manufacture of various special steels. The same man might testify in regard to the manufacture of phonograph records, or integrating watt-meters, without having had any practical familiarity with or training in those particular lines, solely as a scientific expert, his education and experience qualifying him to study, understand and explain the principles and operations involved.

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There are a number of experts who devote all their time to the profession, some specializing more or less in various lines, while others cover quite a broad field. There are other men who combine experting with other occupations. Thus patent solicitors, professors in technical and scientific schools, and consulting engineers often give expert testimony. If a man is a recognized scientific authority in any line—metallurgy or steel construction or what not—his services will obviously be valuable as an expert witness in a patent suit involving his special science, provided that he has the special gifts and experience required in a successful scientific witness.

The chief necessary attributes of an expert, in addition to a sound technical knowledge, are the power to analyze clearly, to express himself in simple and striking language, and to exercise what is really a creative imagination, in that he is often called upon to reconstruct the point of view which existed at the time an invention was made. After the invention has been accepted and gone into general use, it often seems such an obvious thing that it is difficult to understand why it was not always done. In this situation the defendant, usually through his expert witness, will try to make it appear that the quality of invention was not involved in the improvement at all, but merely the skill of an ordinary mechanic. It may be difficult to show that this is not the case from the testimony of witnesses who knew what was known and thought at the time of the invention, but whose powers of observation and expression are not sufficiently keen and clear to make a convincing word-picture. In this case, the complainant's expert, largely by deductive reasoning, may be able to reconstruct the situation, show the false leads and wrongly accepted standards of that prior time, and throw a realistic and truthful atmosphere of invention around the product of the successful inventor.

From the above it will be seen that a successful expert should have to some extent the attributes of a successful consulting engineer, and that he has greater need than the engineer of the power of clear, forceful statement. In addition it should be remembered that the expert and the lawyer on the other side are often engaged in a battle of wits for many days at a stretch, during cross examination, while the lawyer is questioning the expert from every possible angle in an endeavor to lure him into a false position, or trap him into a material contradiction. The expert needs, therefore, to be very watchful and mentally alert. His testimony will, of course, count for much more if it has been carefully prepared in advance, in conference with the lawyer who will question him, and the probable position of the other side analyzed; and also if he has been frank and moderate in the views he has expressed. An expert, like a lawyer, makes the best impression on a judge when he does not seek after strained constructions of language, or indulge in extravagant and biased views of the merits of his side. The opinions of the expert only count in connection with the reasoning he advances.

This latter, of course, is because the expert is, after all, only a witness, whose testimony is weighed by the judge, or in a jury case, by the judge and jury, together with the other testimony. If the expert's opinions are backed by logical reasoning, or known statements of fact, the judge may adopt them, and quote them with approval, but a bare statement of opinion, without reasons given, has small probative value.

Patent experts, in common with medical and other expert witnesses in law suits, have on occasion been subjected to a good deal of criticism from the bench and otherwise, because of the partisan and disingenuous character of the depositions of some of them. One judge took occasion to remark that it should be remembered that "such testimony is admissible to remove and not to create uncertainty". This sort of criticism, however, does not apply to the testimony of the really high class men, who pride themselves on the honesty and soundness of their opinions as set down in the record, and who have often been accorded high praise in judicial opinions.

The function of the expert is to give the court the aid of his skill and high reputation, in illuminating the technical problems to which the judge must announce the answer. It is probably not to be expected that his testimony shall be entirely disinterested, but naturally, when two eminent scientists, employed by opposite sides, maintain each that the other is utterly wrong, in his views as testified to, adverse criticism is sometimes aroused.

While it seems now to be generally agreed that the expert is not expected to be actually non-partisan in his testimony, he should not alter his convictions to suit his client's need, and if his views are not in harmony with the position which his client feels required to take, he can, of course, withdraw from the case.

A complete disagreement between opposing experts may, in many instances, arise honestly. A better impression is usually made on the judge, however, by an expert who indorses as many of the opposing expert's views as he can in good conscience. This can usually be done at the beginning of the deposition, after which other factors may be pointed out, which his adversary has failed to consider, and which may entirely change the complexion of the case. Or while a premise of the other side may be agreed to it may be that the expert can demonstrate that the conclusions drawn therefrom are, from what he considers the right point of view, quite erroneous or misleading.

In the usual patent infringement suit in equity, the lawyer for the complainant first, after preliminary matters have been disposed of, proves the acts done by the defendant which, he claims, infringe the complainant's patent. The expert retained by the complainant then takes the witness stand, first stating his experience and training to show that he is qualified to give expert testimony. He then proceeds, in answer to questions, to explain what he considers the pith of the invention in his client's patent. He then analyzes the defendant's structure or process, which the complainant considers an infringement, and by his testimony makes it clear, if possible, that the defendant's device is the same thing which is claimed in the patent, or is equivalent to it in function, and does not differ materially in structure or operation.

The defendant, in his turn, will then take testimony in which his expert will probably take a prominent part, setting forth, very likely, the points of difference between the defendant's machine and that of the patent, which points, to his mind, show clearly that the two machines are quite different in their mechanical elements and their modes of operation. or he may attack, in his testimony, the validity of the complainant's patent, and that is often done in addition to giving testimony tending to show non-infringement. The validity of the patent is attacked by setting up and explaining earlier patents and publications, which defendant's expert endeavors to show cover substantially the same invention as that of the patent in suit.

The complainant then has what is usually the last inning, and takes what is called his "rebuttal". In this his expert answers the defendant's expert, and proceeds to explain exactly wherein the inventor whose patent is in suit, made an advance over the earlier inventions which the defendant had brought forward, stating the degree or extent of that advance, as it appears to him.

A patent expert does not need to be a lawyer, but to be an efficient witness he must be quite familiar with the various fundamental doctrines of patent law relating to the equivalence of mechanism, and other points involved in the interpretation of patent claims and the question of infringement.

No one has ever endowed a chair of expert testimony. There are no text-books or correspondence or other courses open for the beginner. One qualified to enter the profession can only learn to handle his ammunition by reading the depositions of other experts, observing their methods, and by profiting by his association with lawyers and experts after he has once been retained.

DESIGNING STEEL TOWERS FOR WOOD TANKS—1

A COMPLETE ANALYSIS OF THE STRESSES IN THE TOWER STRUCTURE

BY EDMUND B. LA SALLE*

Both wooden and steel elevated tanks, for supplying water for various purposes, are so generally used that it is hardly possible to travel anywhere, in inhabited districts, without seeing them in some form or other. Their principal use in cities is for fire protection, and for this purpose they are frequently placed on the tops of the buildings, either on a short tower or directly on the walls. In such cases, they are supported by steel beams laid on steel wall plates, or on wall beams laid side by side to distribute the load over a large area of the masonry in the walls. The walls are generally designed for this purpose by the architect. Another quite common method is to install a high steel tower somewhere on the premises, which reaches above the building that is to be supplied with water; these towers are quite often put in an alley-way between two buildings. This is a good arrangement where the tank is to serve more than one building, as it allows a better layout for the piping and the water does not have to travel so far from its source. The height of these towers sometimes reaches 125 feet, but the usual heights are from 60 to 100 feet. The capacities of the tanks range from 20,000 to 100,000 gallons, it being seldom that the latter capacity is exceeded. Where the demand is very great, it is customary to install more than one tank of smaller size, as a wooden tank larger than 100,000 gallons would not be practical, owing to its cost and mechanical limitations.

In the country—on farms, summer homes, etc.—the elevated tank has become quite popular. There they are used for the storage of drinking water, as well as for fire protection, windmills or gasoline engines being used to pump the water into them. Indicators are placed on the outside of the tanks, so that the amount of water at hand can readily be ascertained at any time. These indicators are sometimes connected to electric bell systems, that ring when the tanks are either nearly empty or ready to overflow. The tanks used for this purpose are not very large, as compared with those used by industrial establishments, their capacities varying from 1000 to 15,000 gallons according to the size of the estate. The heights of the towers vary from 10 to 60 feet, 30 feet being the most common; they are generally made of galvanized steel, but a wooden tower gives very good service where the height is not too great. The wooden towers should, however, be designed, built and erected by competent persons. The steel towers are usually designed and fabricated in shops which make a specialty of this class of work, and have their own erecting crews to set up the structure. Where this is not done, the local dealer usually has men trained in that class of work.

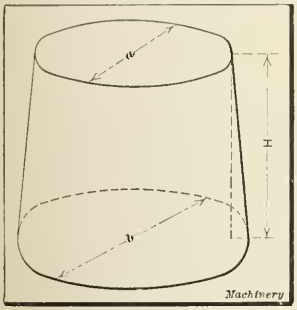

Fig. 1. Diagram showing Method of finding Volume of Tanks

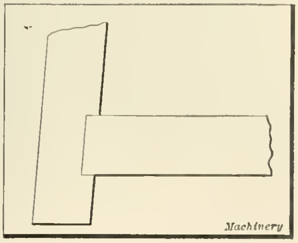

Fig. 2. Method of setting Tank Bottom into the Staves

Although a tank tower is not particularly complicated, those who are interested in the analytical and graphical determination of stresses in framed structures will find some interesting problems in studying the methods used in designing such towers, and the writer will endeavor to present these problems in the simplest possible manner. Formulas and tables that shorten or otherwise facilitate the computations will be used wherever possible. Useful information on the present methods of construction will also be included. An explanation of the various engineering terms relating to the strength of materials, which it will be necessary to use, will not be entered into, however, as it is assumed that the reader is familiar with the application of such terms as radius of gyration, section modulus, moment of inertia, etc., in engineering calculations. If not, there are many good books on strength of materials, so that one could readily take up the study of this very interesting subject.

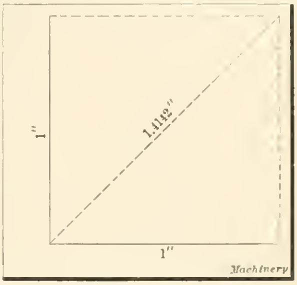

Fig. 3. Method of determining Batter of Posts on Diagonal

Weights of Various Parts

The external forces acting on a tower are gravity and the wind; the latter often becomes a serious item in high structures, and even equals the former under certain conditions. The first consideration in the design is the weight of the structure itself and the water in the tank. The weight of a gallon of water is taken at 8 1/3 pounds. After it has been decided how many gallons are required, the size of tank needed can be obtained from the catalogue of any tank manufacturer. A table giving the usual sizes of wood tanks, as well as their capacities and approximate weights, will be given later. Tanks 10 feet in diameter, and larger, are usually made of 3-inch material, although the 10- and 12-foot diameters are frequently made of 2-inch material. The sides or staves of the tanks have a slight batter inward toward the top. This amounts to about ¼ inch per foot on each side, or a total taper of ½ inch toward the upper end.

In case no table is at hand, the capacity of any taper tank can be accurately determined by the following formula:

$$\text{Capacity in gallons} = 1.9584\ H\ (a^2 + b^2 + ab)$$

in which

H = vertical height;
a = inside diameter at top;
b = inside diameter at bottom.

Referring to Fig. 1, the formula was derived from the regular formula for the frustum of a cone as follows:

$$\text{Contents in cubic feet} = 0.7854\,\frac{H}{3}\,(a^2 + b^2 + ab) =$$

$$0.2618\ H\ (a^2 + b^2 + ab)$$

As one cubic foot is equal to 7.48052 gallons, the formula for the contents in gallons becomes,

$$7.48052 \times 0.2618\ H\ (a^2 + b^2 + ab) = 1.9584\ H\ (a^2 + b^2 + ab)$$

In the case of a tank with straight sides, we can use the formula:

$$\text{Contents in gallons} = 5.8752\ D^2H$$

in which D = diameter;
H = height.

This formula is derived from the regular formula for the volume of a cylinder in cubic feet:

$$V = 0.7854\ D^2\ H$$

by multiplying by 7.48052, the number of gallons in a cubic foot.

There is one thing to be remembered in figuring the capacities of wood tanks, which is that the bottom is set up from the lower end of the staves. With 3-inch staves, this is about four inches, and this amount added to the thickness of the bottom makes about seven inches to be deducted from the total height of the stave to obtain the net depth of the tank. Fig. 2 shows the manner in which the tank bottom is set into the staves, the whole being held together by a set of steel hoops of a size calculated to safely resist the bursting pressure of the water. In a subsequent article, complete data on the method of designing tank hoops will be given.

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There are a number of items of which we must obtain or assume the weight, besides the tank and water; the complete list is as follows: water, roof, tank, railing, balcony, floor system and tower. The weights of some of these can be obtained from manufacturers' catalogues, but the others will have to be assumed by a rough method of approximation. When the sizes have been worked out from the loads, an estimate of their weight should be made more accurately, and, if a large error exists, the structure should be redesigned to suit the corrected weights.

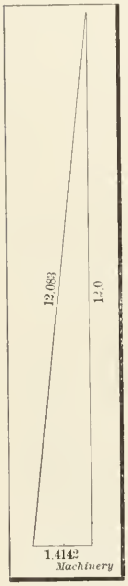

Fig. 4. Determining Column Load

Column Load due to Gravity

Having set down the weights of the different items in the order named, add them together and divide the sum by four. This gives the vertical dead load on one column in a four post tower, which is the usual type and the one we will consider at this time. Towers are often made, however, with three, six, eight, and twelve posts. After dividing by four and obtaining the vertical load, we must take into consideration the batter or inclination in order to obtain the actual load in the post. The usual batter for a four post tower is one inch per vertical foot. As the posts batter this amount in two directions, it makes a batter on the diagonal of 1.4142 inch per foot, as shown in Fig. 3. The dead load in the post will then be larger than the vertical dead load by an amount equal to the secant of the angle formed by the inclined post and the vertical; this relation is shown in Fig. 4. In the case illustrated, we have the relation for the regular one-inch batter, in which a vertical height of 12 inches, with a base of 1.4142 inch, gives a hypothenuse of 12.0830 inches; this is an increase of 1/12 inch in 12 inches, which is an increase of 1/144 of the vertical height. To change to decimals, we divide 12.0830 by 12 which gives a secant of 1.00692. This becomes larger as the inclination of the post increases, as in special cases where the tower has to span a given space of more than the usual dimensions.

Wind Force on Tank

We now have the dead load in the column due to weight of the structure and water. The next thing in order is to arrive at the live load in the column due to the wind. It creates a downward or compressive force in the leeward columns and an upward or tensile force in the windward columns in its effort to overturn the structure. It is this effect which we have to guard against, and design the anchor rods and foundations so that they will prevent such an occurrence. The usual practice is to assume the wind pressure as 30 pounds per square foot on a flat surface, and half that amount on such cylindrical surfaces as tanks, smokestacks, etc., *i. e.*, on the projected area through the diametral plane.

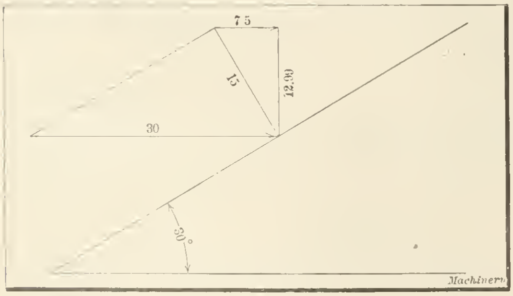

Fig. 5. Method of determining Effective Force of Wind on the Roof

In the conical roofs used on tanks, we strike still another condition. Instead of the sides being vertical, or practically so, as in a tank, they slant backwards towards the center. This still further reduces the unit pressure. On steel tanks, the roof usually has a pitch of 30 degrees with the horizontal, while in wood tanks, the roof is generally made quarter pitch or lower—seldom higher.

The pressure per square foot on flat slanting roofs, such as those used on factory buildings, is determined by the following formula:

$$P = F \times \sin a^{1.84 \text{ cosin } a}$$

in which $F =$ force of wind in pounds per square foot;

$a =$ angle that the roof makes with horizontal.

Taking a 30-degree roof as an example, and using 30 pounds per square foot as the wind pressure, we have:

$P = 30 \times 0.5^{1.84 \times 0.86609} = 9.94$ pounds per square foot, which we can call 10 pounds per square foot. Then dividing by 2, to allow for the cylindrical shape, we have a pressure of 5 pounds per square foot in the projected cross-sectional area.

In the 1903 edition of the Carnegie Steel Co.'s handbook, on page 173, there is a table calculated by this formula which is credited to Unwin, giving the wind pressure on roofs in three different directions, for various angles. Under 30-degree roofs for the pressure parallel to direction of wind, this table gives 0.33 as a constant by which F is to be multiplied. For $F = 30$ pounds per square foot we get 9.9 pounds per square foot as the value of P.

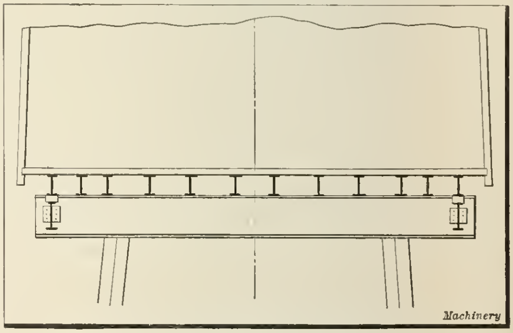

Fig. 6. Type of Floor System used to support Tanks

If no such table is at hand, it becomes quite an operation to work out the pressure for a roof having a pitch different from what you have worked out and tabulated. The writer has adopted a method which gives slightly lower values than the foregoing one, but which is far simpler to use. Taking a 30-degree roof to facilitate computations, and using the same wind force of 30 pounds per square foot, we proceed as follows: The sine of 30 degrees is 0.5 and the cosine 0.8660. Assuming the wind as acting in a horizontal direction, we resolve its force of 30 pounds per square foot into two components, one perpendicular to and the other parallel with the slant of the roof. It is assumed that when the wind strikes the roof it follows the surface to a large extent, the relation of the parallel and perpendicular components being about equal to the ratio of the cosine to the sine of the angle. In the case of the 30-degree roof angle under consideration, we shall have the normal component of the pressure equal to 15 pounds per square foot, as shown in Fig. 5. We now resolve the 15-pound force into two components, as shown in the diagram, in order to obtain the effect in a horizontal direction. This component is obtained by multiplying the normal component by the sine of 30 degrees which gives $15 \times 0.5 = 7.5$ pounds per square foot. Dividing this by 2 to allow for the effect of the conical shape gives 3.75 pounds per square foot of cross-sectional area, as against 5 pounds by the other formula. Putting it into a formula it reads:

$$P = \frac{F \times \sin^2 a}{2}$$

in which a = the roof angle.

We can eliminate the factor of ½ by saying $F = 15$ pounds.

Some specifications provide for a wind pressure on the tank roof equal to 15 pounds per square foot on the projected area taken on the diametral plane, or the same as on the tank. It can readily be seen that this would give nearly three times too high a result, when compared with the result of the second formula, and exactly three times when compared with the result of the first. Unfortunately, specifications covering tanks and towers have been "passed along" from one designer to another, each one taking it for granted that they were perfect, or perhaps "good enough." Such specifications have been receiving more attention of late.

We have now shown how to obtain the force of the wind on the roof and tank. The next thing that requires our attention is the wind acting against the steel beams supporting the tank on the tower; these beams are called the "floor system." The floor system consists of two sets of steel beams; they are the joists and the cap beams. The joists are placed close enough together to support the tank bottom properly and rest on the two cap beams, which, in turn, rest on the top of the tower posts as shown in Fig. 6. It is evident from this illustration that the cap beams offer more surface to the wind than the other sides of the floor system; consequently, only the cap beams will be considered. Their length is approximately equal to the tank diameter, and their depth varies from 4 inches to 24 inches. As they offer a flat vertical surface to the wind, the resulting force in pounds per square foot will be:

$$P = 30 \times \text{depth} \times \text{length}.$$

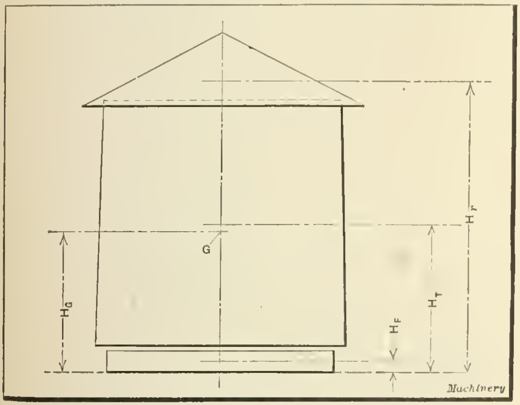

Fig. 7. Locating the Center of Gravity of the "Tank Wind"

It is evident, from the foregoing, that to get the complete wind force on the tank we must add the three items just mentioned, *viz.*:—the force on the roof, tank, and floor systems, which we will hereafter call the "tank wind."

The overturning effect due to the tank wind is found by multiplying it by the vertical distance from the tops of the concrete piers (or bottom of posts) to the center of gravity of the tank wind. This point is located near the center of the tank, and is nearly always below it. The exact position can be found by selecting some one point, say at the bottom of the cap beams, and multiplying the wind loads on the roof, tank, and floor system by the distance of their centers of gravity from this point. Then by adding these results together and dividing the sum by the total of the three loads, we get the distance of the center of gravity above the tops of the posts, which, added to the vertical height of the posts, gives the leverage of the tank wind. Fig. 7 shows the method of making the above computations more clearly; in this illustration, G is the center of gravity of all three loads. In the roof, the center of gravity is located at one third the height, as in the case of any triangle. It will also be noticed that the roof over-laps part of the tank and will slightly reduce the amount of tank surface exposed, but this can be ignored, unless great accuracy is desired. Such refinements make the calculations too laborious and are not desirable when time is money. It is, however, necessary to call attention to all such details, when treating the subject in a theoretical way. The tendency in practical work is toward short cuts, but no method should be used that brings about a result differing materially from the correct theoretical result. When we depart at all, it should be on the side of safety. On the type of tank we have under consideration, the point G does not drop more than a foot below the center of the tank, so it will be near enough for all practical purposes to assume it at the center.

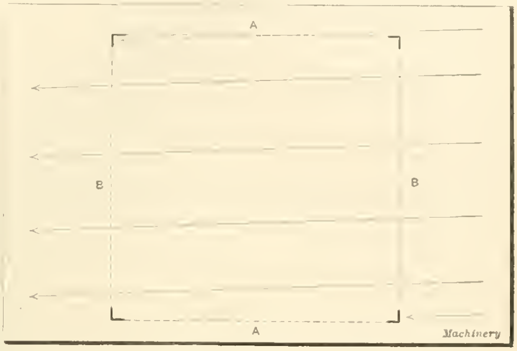

Fig. 8. Direction of Wind producing Maximum Effect on Tower

Wind Force on Tower

We will now take up the wind load on the tower. This will have considerable variation, as it depends on the size and design of the tower. Some specifications for the wind load on the tower provide for 200 pounds per foot of tower in all cases, but as the load varies from 100 to 300 pounds per foot, such a method is rather crude. There are two elements that affect the amount of the tower wind load: they are the tower frame and the wooden frost box which covers the riser pipe at the center of the tower. The frost boxes are made both square and round, the square shape being the usual one in connection with towers for wooden tanks. They are from 1½ to 3 feet square, 2 feet square being the most common size. At 30 pounds per square foot, the wind load on the 2-foot size would be 60 pounds per running foot of tower. On high towers, this load becomes considerable. When round frost boxes are used, the wind load is reduced by one-half, as previously mentioned in the case of the tanks. The wind acts on all four posts of the steel frame of the tower, but as two sides are essentially parallel with the wind, when it is acting with the maximum

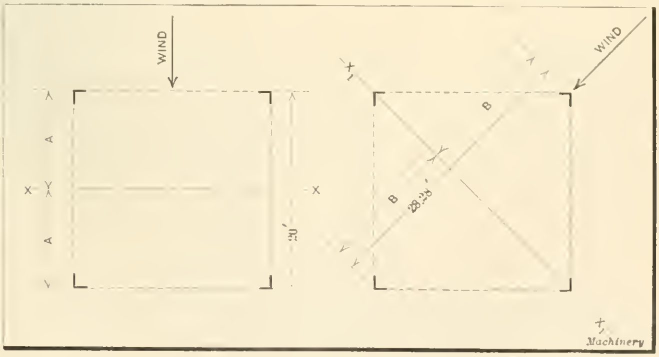

Fig. 9 Determining Effect of Tank and Tower Wind upon the Tower Columns

effect on the tower, we omit those two sides in our calculation of surfaces. Fig. 8 shows the direction of the wind in relation to the tower under these conditions, sides *A* offering practically no surface to the wind while sides *B* receive its full force. Then to get the complete tower surface exposed to the wind we proceed as follows:

1. Width of one column × 4 × length of column.
2. Length × width of all struts on two sides *B*.
3. Radius × total length of all diagonal brace-rods on two sides *B*.

These three items reduced to square feet, added together, and multiplied by 30 gives us the wind force on the tower frame. To this we add the total wind force on the frost box, which gives the full wind force on the tower. To get the wind force per foot of tower, divide the total wind force by the tower height. Then for a similar tower of different height, there is a good basis to begin with. As in the case of a tank, the center of gravity of the wind load is located half way up, which gives a leverage to the tower wind equal to half the tower height. Then we can get the complete moment of the wind tending to overturn the structure by multiplying the tank and tower winds by their lever arms and adding the results. The stress this puts into the posts is from 25 to 100 per cent of the stress due to the dead load, depending on the size of the tank and the height of the tower. This percentage is greater for small tanks than for large ones.

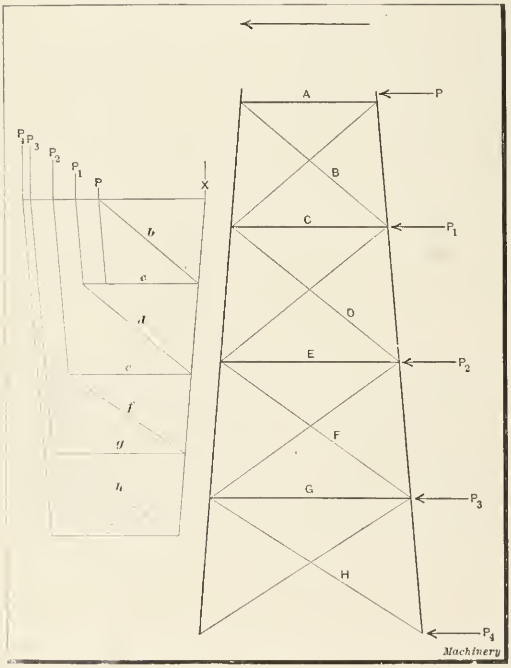

Fig. 10. Graphical Method of determining Stresses in Tower Bracing

Stress in Columns due to Wind

To obtain the stress in the posts, due to the moment of the wind tending to overturn the structure we must first decide in which direction the tower is weakest, or least able to resist the force of the wind. This is true of all structures or machines; we must determine the time or condition of maximum stress and design them accordingly. In Fig. 9, we have assumed the base of a tower 20 feet square. When the wind acts at right angles to the axis X—X, we have compression in the two leeward posts and tension in the two windward posts. Call P the load or stress in each post caused by the overturning moment M of the wind. For a tower in which $M = 1,000,000$ foot-pounds and $A = 10$ feet, we have:

$M = 4PA$

$$P = \frac{M}{4A} = \frac{1,000,000}{40} = 25,000 \text{ pounds.}$$

When we take the wind acting at right angles to axis X_1—X_1 we have:

$M = 2PB$

$$P = \frac{M}{2B} = \frac{M}{2.8284\,A} = \frac{1,000,000}{28.28} = 35,350 \text{ pounds.}$$

The two posts directly on the axis X_1—X_1 do not have any stress introduced into them by the wind and it falls on the other two posts to resist the whole wind force. This proves that the tower is weaker, or receives a heavier load, when the wind acts diagonally across it, that is, as far as the posts are concerned. To get the maximum live load in the posts due to the wind, divide the total overturning moment by the diagonal centers of columns. Combining the stresses in the columns due to both the dead and live loads we have the total compression.

Loads in Tower Bracing

The loads in the tower bracing, with the exception of the top struts, are caused entirely by the wind. In the determination of these loads, we will use the graphical method in preference to the analytical, as it is much shorter, accurate enough for all practical purposes, and not as liable to have any gross errors. The method is as follows: First draw a frame diagram of the side of the tower, or one truss, as it might be called, similar to Fig. 10. A scale of ⅛ inch to the foot works out well for most cases, except very small towers. Then with the frame diagram as a guide for the inclination of the lines, we proceed to draw the stress diagram, using some convenient scale as 5000 pounds per inch. As there are two trusses parallel with the wind—sides *A* in Fig. 8—we divide the tank and tower winds by 2, as each truss takes half the load. The initial load in the diagram, represented by line P—X, is equal to one half the full tank wind plus half of the full wind on the upper half of the top panel of the tower. For instance, if the top panel is 10 feet high and we are using a tower wind of 200 pounds per foot, we have 5 × 100 = 500 pounds. With a tank wind of 9000 pounds, we then have an initial load of 4500 + 500 = 5000 pounds.

Draw a line parallel with the left hand post in the frame diagram, and from the top of this line at X, draw a horizontal line of indefinite length. On it, lay off the initial load X—P. Next draw the line b parallel with the top panel diagonal B, starting at P and intersecting the column line. At this intersection, start and draw the line c parallel with the horizontal strut C, making it long enough to meet the slanting line to be drawn from P_1 to intersect it. On the initial load line, measure off from P the length of P—P_1, equal to the amount of wind considered as concentrated at P_1 in the frame diagram; this is half the wind in the two panels adjacent to strut C. Each strut takes half the wind of the panels next above and below it. From P_1, draw a line parallel with the right-hand column in the frame diagram to intersect line c. From this intersection, draw line d parallel with diagonal D, intersecting the column line as before. From this intersection, draw line e parallel with strut E. From P_1, measure off the new load for strut E; this load is equal to P_1—P_2. Continue in this way until all the strut loads have been added, and all the diagonal lines drawn. The last load to add is the one represented in the diagram by P_3—P_4, which is the wind load on the lower half of the bottom panel at P_4. If we now scale the last line drawn—shown on stress diagram from P_4 to line j—and multiply the amount by 1.4142, we can check the calculated value of stress in the column, due to the wind, by adding to it the load applied at the top of the post by the tank tending to overturn on its supports. For instance, if the tank wind is 4500 pounds and the center of gravity of this load is 10 feet from the top of the posts, then 4500 multiplied by 10 and divided by the diagonal distance across the top of the posts is the load required. This added to the scaled column load multiplied by 1.4142, as mentioned, ought to check very closely with the computed amount. We can now scale the diagram and get the loads in all the rods and struts, except the top strut, which requires special treatment. However, the scaled amounts for the other struts are not exact. To get the exact stress, we must deduct half the loads we added for each strut on the initial load line, as $P-P_1$, P_1-P_2, etc. The strut only gets half of this amount, due to the fact that the wind acts on both ends of it, one half on the windward end which creates compression in the strut, and the other half at the leeward end which is transferred directly to the next lower diagonal rod. Through this rod, however, the stress is carried to the strut below, with the exception of that taken by the posts because of their slant. It is impossible to take care of this deduction in the diagram, however, as the rod does not receive the full load in each case.

We also deduct the same proportion of the tower wind from the top strut, after calculating its full load, in the following way. Besides the wind load that falls to its share, the top strut has to take part of the dead load, due to the inward thrust at the top of the posts. This thrust increases or decreases with the batter of the posts. We will take as an example the usual one inch per foot batter. Divide the total dead load—not including the tower—by 4; then we have the vertical dead load at the top of one post. As the post batters 1.4142 inches diagonally, we determine the horizontal component in that direction by dividing 1.4142 by 12 and call the result *T*.

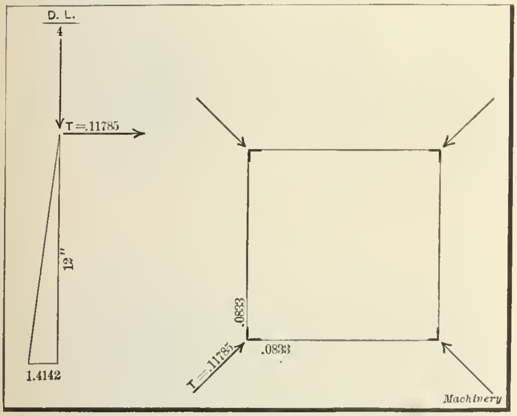

Fig. 11. Diagram used in determining Thrust in Top Struts

$$T = \frac{1.4142}{12.0} = 0.11785.$$

This will be better understood by referring to Fig. 11, where it will also be seen that each post divides its thrust between two top struts. By dividing 0.11785 by 2, we have 0.058925 as the part of the thrust affecting one strut, and as it is inclined at 45 degrees to the direction of the thrust, the load is increased to 1.4142 of its former amount and becomes 0.0833, which is 1/12. Thus each of the top struts takes 1/12 of the dead load on one post, or 1/4 of 1/12 = 1/48 of the total dead load. Adding to this the initial load of the stress diagram, $P-X$, we have the total load on each top strut.

We can also solve this in another and simpler way by saying that the post batters in the direction of the top strut one inch to the foot, and that the horizontal component of this is 0.0833 or 1/12 as before.

Stress in Anchor Rods

We have now shown how to arrive at the loads in all the members of the tower frame. It only remains to determine the size of the anchor rods and foundation piers. The anchor rods are required to prevent the wind from overturning the structure, and the amount of this overturning force is equal to the wind load—or live load—in the column, previously determined. The two elements resisting this force are the weight of the structure and the anchor rods. The most critical time is when the tank is empty, and we must therefore proportion the anchor rods for such a condition. The total dead load on a post, less one fourth the weight of the water in the tank, gives us the weight that the structure offers as resistance to overturning. This resisting weight, subtracted from the column live load, leaves the net uplift or pull which the anchor rod or rods, as the case may be, have to safely sustain.

Load on Concrete Piers

The uplift of the post must also be resisted by the weight of the piers, as it is transmitted to them by means of the anchor rods. As the stability of the whole structure depends on the foundations, they must be properly designed. If the weight of the piers is not sufficient to resist the uplift, after they have been proportioned to sustain the compression load, they should be increased in size until sufficient weight is secured. The downward pressure in the piers is equal to the maximum compression in the column, plus the weight of the piers themselves, plus the weight of the earth which partly covers them. The base must then be made of such a size that it will not overload the soil on which it is to be placed. This is a matter that will depend upon the location in which the tower is erected.

Towers for Steel Tanks

The type of steel tower under consideration is primarily for use in supporting flat-bottom wooden tanks. This is the most usual design, but the same towers can be used for flat-bottom steel tanks, provided the supporting steel beams in the floor system are spaced according to the table published in connection with the writer's article entitled "Maximum Centers of Beams for Steel Tank Bottoms," which was published in the issue of MACHINERY for July, 1911. Towers for steel tanks with hemispherical bottoms would require different treatment in many respects.

* * *

THE LIFE OF A LATHE TOOL

BY GEORGE W. BURLEY*

In an article on "Relation of Price of Tool Steel to Manufacturing Costs" in the November, 1912, issue of MACHINERY, reference is made to the life of a lathe cutting tool, or the length of time for which such a tool should be allowed to cut between two consecutive sharpenings. In the article referred to, it is stated that a tool should receive five or six grindings per diem which, based on a day of eight hours, gives eighty minutes as the life of the tool; and that if the tool were to be run so that it cut all day, that is, for eight hours without regrinding, it would be cutting considerably below its capacity.

This is a questionable point on which there is by no means a unanimity of opinion. In many up-to-date works in Great Britain, it is the general practice to run lathe tools at speeds which will allow them to cut for five or six hours without regrinding. The writer has found, experimentally, that under any conditions of depth of cut, feed per revolution, and chemical and physical properties of the metal being machined, the speed which corresponds to a life of six hours is not very much less than that which corresponds to a life of one hour. The difference between the two in the extreme case probably does not exceed five per cent, the average difference being about two per cent. Hence, it cannot be said that the capacity of a lathe tool which is allowed to run at a speed which corresponds to a life of a number of hours is considerably less than the capacity of the same tool which is run at such a speed that it lasts for only one hour.

* * *

Accuracy is a term frequently misused in technical descriptions and advertisements. To refer to an "accurate" surface gage is an example. A surface gage is simply a tool for transferring measurements with reference to a plane surface, and consists essentially of a flat base and an upright carrying an indicating needle. One make of surface gage may be more convenient to use than another, but one cannot be more accurate than another inasmuch as the accuracy of use depends entirely on the care and skill of the user. The case of a micrometer is different. Skill is required to set a micrometer accurately to a piece of work, but accurate graduations and an accurate thread are also absolutely necessary for a reliable tool, no matter how skillful the user may be.

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MACHINING GASOLINE ENGINE PARTS

METHODS EMPLOYED BY THE ROCKWELL MFG. CO. IN MAKING THE KEYSTONE GASOLINE ENGINE

BY F. B. JACOBS*

The Keystone gasoline engine, a model of which is illustrated in Fig. 1, is a product of the Rockwell Mfg. Co., West Chester, Pa. This engine is of the two-cycle type, and as all accessories are mounted with the engine on a substantial base, it is essentially self-contained. This arrangement facilitates ready removal from place to place as occasion requires. Especial attention has been given to the design of jigs and fixtures which are employed in machining the various engine parts. The factory is also provided with a machine tool equipment that is modern in every respect, and in this article a few of the more important machining operations will be described.

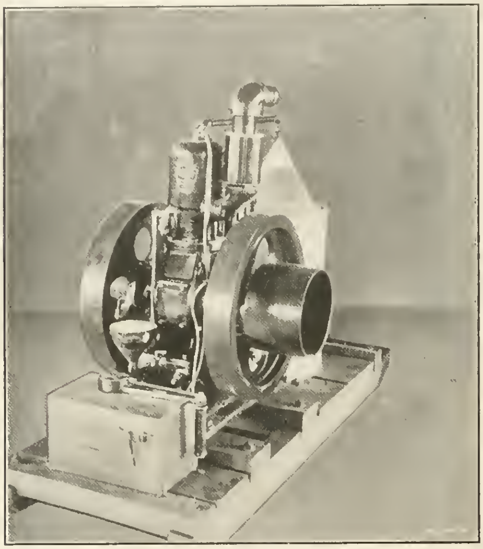

Fig. 1. The Keystone Gasoline Engine

The crank-case which forms the base of the engine is shown in Fig. 2. These parts are first machined on the surfaces marked *A* and *B*, this operation being done on a heavy milling machine equipped with inserted tooth cutters; the surface *A* is used in locating the piece for subsequent operations. The surface *C* is finished by locating the piece on an angle-iron in the boring mill. This surface is then used in locating the piece while finishing the opposite surface *D*. The top *E* of the crank-case is next faced and bored to fit the end of the cylinder. To insure a free running engine, it is quite necessary that the different finished surfaces, with the exception of the surface *B*, which is for a hand-hole cover, shall stand square and parallel with each other. The small holes are drilled and tapped in a jig.

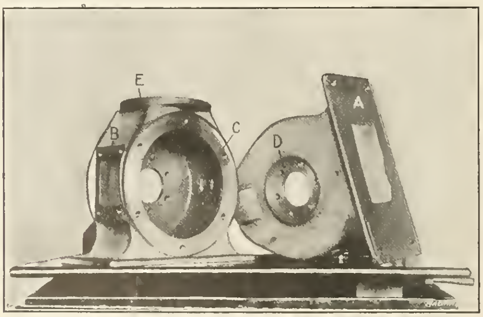

Fig. 2. Crank-case showing Order in which Machining Operations are performed

The first setting for machining the flywheels is illustrated in Fig. 3. The machine used for this purpose is a boring mill equipped with a turret head. Here the periphery and one side are finished, and the hole is roughed out. The remaining operations, consisting of finishing the other side, boring and reaming the hole, and turning the hub, are done at one setting in a Gisholt lathe as shown in Fig. 4, the work being held in a four-jaw chuck.

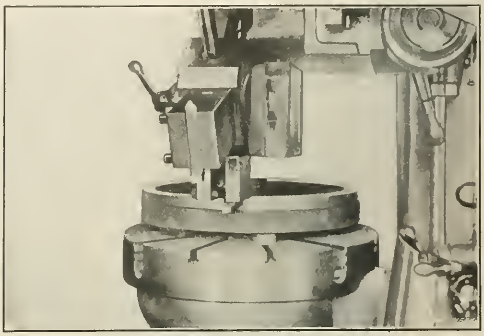

Fig. 3. First Setting for machining the Flywheels

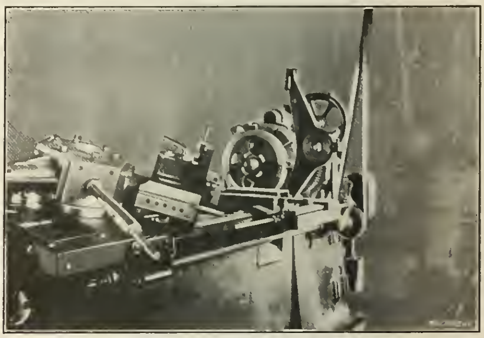

Fig. 4. Finishing a Flywheel in a Gisholt Turret Lathe

The cylinders illustrated in Fig. 5 call for special care and attention in machining, for the smooth and economical running of the engine depends, to a great extent, upon the accuracy of the cylinder. In machining the cylinders, the work is held in a cradle fixture that is strapped to the faceplate of a Gisholt lathe, where boring is carried to within 0.015 inch of the desired size, and the finishing of the end that fits the

Fig. 5. A Group of Engine Cylinder Castings

crank-case is completed at one setting, as shown in Fig. 6. This method of machining makes it reasonable to assume that the boring and facing stand square with each other, which is necessary if time is to be saved that would otherwise be consumed in the finishing operation on a Heald cylinder grinder.

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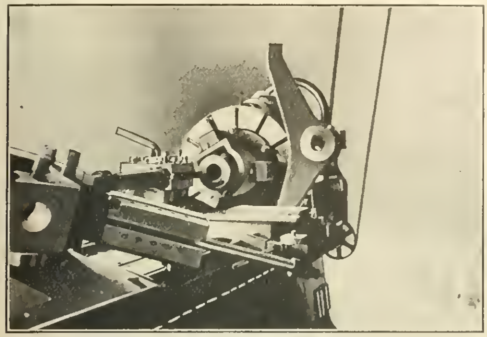
Fig. 6. Roughing Cylinder and facing Connection for Crank-case

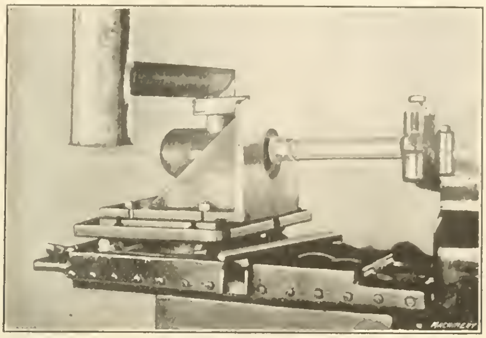

Fig 7. Grinding Cylinder to a Final Finish on Heald Grinder

In the finish-grinding operation, the cylinder is fastened to an angle-iron as shown in Fig. 7, where it will be seen that the dust is carried away by suction through a pipe fastened to the exhaust port of the cylinder. The grinding wheel used is carborundum: 303 grit, P grade, O F bond. As previously stated, the cylinders are only rough-bored in the first operation; this is considered good practice as the comparatively rough surface of the work tends to keep the wheel sharp and free-cutting while removing the greater amount of the stock, thus eliminating the necessity of frequent truing. A coarse feed is used during the first part of the grinding; the average feed is ¼ inch advance for each planetary revolution of the wheel spindle. For the final finishing, where the last two or three thousandths are removed, a feed of about 1/16 inch advance per revolution is used. During some efficiency experiments where 0.008 inch was left for finishing, it was possible to grind the cylinders in much quicker time than is done at present, where 0.015 inch is removed. However, no actual saving in the whole production time was accomplished as it was necessary to take an extra finishing cut in the lathe.

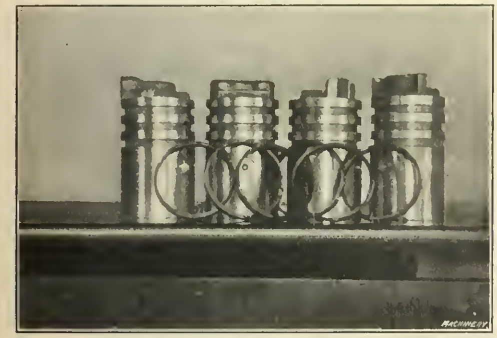

Fig. 8. A Group of Pistons and Piston Rings

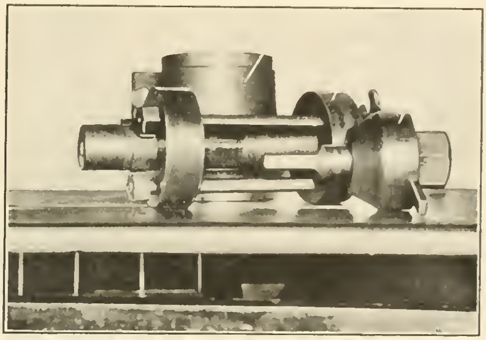
Fig. 9. Fixtures used for finishing Pistons and Piston Rings

The pistons and rings illustrated in Fig. 8 are roughed out in the turret lathe and finished by grinding. The pistons are held with the fixture shown at *A* in Fig. 9 and ground on a Landis plain grinder, as illustrated in Fig. 10. A carborundum wheel of 303 grit, N grade and O D bond is used for this work; it is run at a peripheral speed of 5500 feet per minute. In finishing the rings, a number of pieces are centrally located on the fixture shown at *B* in Fig. 9 by means of the collar *C*. These are ground with the same wheel that was used for finishing the pistons.

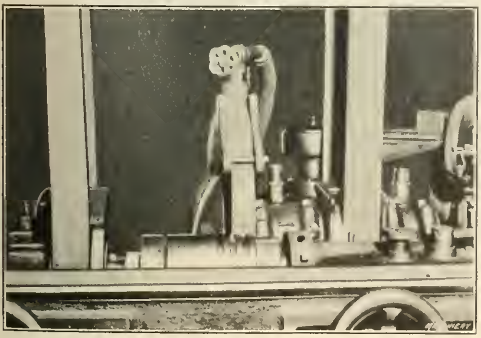
Fig. 10. Grinding a Piston on a Landis Grinder

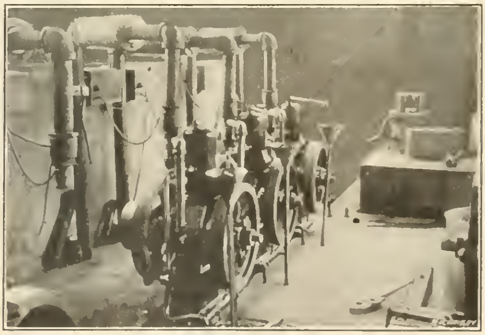
Fig. 11. The Testing Department

After assembling, the engines go to the testing department, part of which is shown in Fig. 11, where they are "tuned up," adjusted and subjected to an actual running test of several days to make sure that no imperfections exist. This work is in charge of gas engine experts who quickly detect any defects that may develop, and who see to it that none but perfect engines find their way to the shipping department. This is of particular importance, as these portable engines are sometimes used miles away from civilization.

DEVELOPMENTS IN MACHINE SHOP PRACTICE*

A REVIEW OF THE MOST IMPORTANT IMPROVEMENTS DURING THE LAST TEN YEARS

In this report the principal improvements in machine shop practice developed approximately during the last ten years are reviewed. The reason for presenting an extended review now is that the sub-committee on machine shop practice should record the advances made each year, but in the present case the committee having been only recently organized, there exists in the society's proceedings no consecutive account of progress. To carry the record back to a logical date, that of the report made by Mr. Fred J. Miller to the Bureau of the Census, in 1905, is mentioned, but, of course, the actual date is somewhat indefinite.

The review is incomplete because of the limitation of time to prepare it, and because of a natural diversity of opinion as to the limitations of what should properly be considered machine shop practice. If this review has included matters generally regarded outside of the limitations, it may be considered that the larger field was included because of practical difficulties in drawing a well defined line between machine shop practice as such and machine design, administration, heat treatment of steel and other factors affecting production. To ignore them is impossible. The operation of metal-working tools and their productive capacity are as much matters of machine design, arrangement and management as of individual skill. In fact, productive capacity in the past depended very largely on the skill and initiative of the workman, but now the rate of production is, in many branches of manufacture, almost entirely governed by construction of machines, so that the designer, when viewed in this light, is closely allied with shop practice. "The transference of skill" by the machine designer from the operators to the machines has embodied in them much of the accumulated experience of many mechanics working on simpler and more primitive tools. So it may be asserted that a large amount of the improvement in machine shop practice has appeared in the improvement of machine tools themselves in one way or another.

Variety of Machine Shop Practice.—When it is considered that machine shop practice embraces a very wide variety of work, ranging from the smallest to the largest manufactured products, and all kinds of repair work, the difficulty of classifying and differentiating it can be appreciated. Locomotive repair work, for example, is in a class by itself in which peculiar methods have been developed, differing radically from those followed in doing similar work in other lines. The slotter, for example, is a machine tool in high favor in railroad shops and, outside of shipyards, has been little used elsewhere. It is, however, slowly coming into use in manufacturing works. The milling machine until a few years ago had not gained a foothold in railroad repair shops, largely because it was and still is not as well adapted to handle the general run of plane finishing required in these shops as the planer and shaper. The latter are adaptable machines peculiarly suited to non-repetitive operations while the milling machine excels in manufacturing.

Increased Weight of Machines.—One of the noticeable changes in machine shop equipment during the past ten years is the increased weight and power of machine tools, which was made necessary through the general application of high-speed steel cutting tools. While the increased capacity of machines which followed in the wake of the application of high-speed steel was directly instrumental in bringing about such increases in the weight of machines, the result has been beneficial not only in increased production, but in accuracy of product, because of greater rigidity and consequent better preservation of alignment.

Foundations.—Progress has also been made in the methods of erecting machinery. With large size machines the foundation plays a most important part in the accuracy of the work produced. For instance, the provision of a massive, well-built foundation for large planers is imperative. When not provided, the weight of the machine and work must inevitably cause settling and springing out of shape. Every mechanic knows that such a disturbance of the foundation affects the alignment, which means that the work produced on the planer will be inaccurate. The elimination of defective action due to want of support, and the increased mass and rigidity have in the case of planers resulted in the production of plane surfaces closely approaching theoretical planes when the work itself affords the necessary rigidity and uniformity of section. Hence, hand scraping to perfect alignment, is not as necessary as it was a few years ago, and it may be said that on some classes of work scraping is now largely more of an ornamental than a corrective process. On high grade machines, however, scraping or grinding probably continues to be necessary to correct inaccuracies of surface and alignment.

Electric Motor Drive.—The subject of electric motor drives was given much prominence in discussions of machine shop practice a few years ago, the bias being generally in favor of individual motor drive. While subsequent experience has shown that the direct-connected electric motor has certain limitations and disadvantages for some classes of work, it has also shown that the same results and efficiency cannot be obtained with the group system of driving modern designs of machine tools. The investment in motors is less with the group system, but the flexibility of the independent drive is lost. When a machine driven by an independent motor is properly equipped for easy handling, increase of production over that of the same machine in a group system is practically insured. One machine tool builder has found it a good rule to apply independent motors wherever the power requirement is five horsepower or more. Hardened steel gears in the driving train reduce gear troubles to a minimum. When the character of work is constantly changing and new groupings of machines are required from time to time, the individual drive is at great advantage. The machines can then be placed "like men on a checker board."

Improvements have been made in the characteristics of variable speed and reversible motors. Automatic controllers have been introduced which make the stopping and starting of machines simply the matter of pushing a button. These devices protect the motors, save time and protect the machines from shocks.

Automatic Machines.—Progress has been made in the development of automatic and semi-automatic machines for the production of duplicate parts from bar stock, iron and brass castings. Many special fixtures have been designed for automatic screw machines which have widened their scope to include a great variety of small parts on which a number of operations must be performed before cutting off from the bar, such as small spiral gears, capstan screws, etc. The cost of production is so greatly reduced that these machines are generally applied where the quantity of work to be produced warrants the cost of installation and tool maintenance. The scope of other types of automatic machine tools is wide and constantly increasing. Certain examples will be mentioned later. Many pages could be devoted to the improvements in these machines alone without exhausting the topic; but attention is called here to the simplification of equipment required for the manufacture of highly developed specialties because of the possibility of buying the bulk of the parts from screw machine product specialists. A manufacturer of a specialty can, if he chooses, organize on an assembling basis, confining his actual manufacture to the making of a few principal parts. This development is having a marked influence on our export trade.

Training Mechanics.—Modern methods of manufacturing are responsible for limiting the employment of men to specific operations only, and pursuit of the plan is making it hard to secure all-around machinists. Young men come into a factory and soon acquire the necessary skill to become proficient drill press operators or milling machine operators. They are able to earn fairly good wages in a shorter space of time than if they served the necessary term of apprenticeship to become competent all-around machinists. The endeavor has been made in the larger manufacturing cities to offset the narrowing effect of specialized training by the introduction of training schools in which young mechanics are given instruction in the theoretical side of their work. The results obtained by this training are beneficial. Men are acquiring both theoretical and practical knowledge, so that to a limited extent at least they are obtaining the benefits of a technical education coupled with practical training.

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*Report of the sub-committee on machine shop practice, submitted at the December meeting of the American Society of Mechanical Engineers. Fred. E. Rogers, editor of MACHINERY, chairman.

Scientific Management.—One of the noteworthy improvements in modern shop practice is the application of *the principle* of scientific management. While the details and elements that make up the complete system advocated by Mr. Taylor are not widely used in full, undoubtedly the fundamental principles are coming to be more thoroughly understood and are being quite generally applied. Some of the more specific improvements referred to in the following may not be strictly modern, but doubtless most of them can be so classified because they are now common, whereas ten years ago they were found in comparatively few shops.

Standardization of Tool Grinding.—The turning and planing tools in many shops are now ground to standard shapes in the tool-room on special tool grinding machines. This method not only saves the time of the machine tool operator, but insures the grinding of all tools to the correct form, and it also saves what is of greater value—the loss of the productive time of the machine tool. The stock of tools required for a shop is also much smaller.

Checking System for Small Tools.—Most shops at the present time keep all small tools in the store-room, except those in actual use. In this way the tools are kept in good condition and a much smaller stock is required. Not many years ago it was quite common for each workman to have his own stock of tools. Consequently there were good tools and poor tools just in proportion as there are good workmen and bad workmen. For instance, a lathe operator had his own stock of mandrels which were made to suit each particular job, and when necessary one man borrowed from another. The result was that the workmen wasted a great deal of time wandering around looking for mandrels and other auxiliary equipment. It might seem somewhat out of place to refer to this well-known method of handling small tools in a paper on modern improvements, because it is an old feature of many shops. This system was not generally employed ten years ago in many of the small and medium sized shops.

In some shops in which scientific management has been applied, and where the work in connection with each operation is planned in advance, it is the practice to make up at the time the work is planned, a list of the tools that will be required for the performance of each operation, this list being sent to the tool-room in advance of the time that the tools will be required, and the tools delivered to the workman by a tool carrier, thus saving the time of the workman as well as that of his machine.

Speeds and Feeds.—The important questions of speed and feed in connection with machining operations have, during recent years, been carefully studied by many superintendents and foremen who formerly relied entirely on the judgment of the workmen, which was sometimes good and sometimes bad. Speeds and feeds are fixed in the planning department and are based on the power of the machine and character of the metal.

Tool Selection.—More thought is now given to the selection of machine tools for various classes of work. A few years ago many shop foremen used a certain type of machine for a given class of work, because that type had always been used for that purpose. It seems that there is much less conservatism to-day and precedent does not count for as much as it did a few years ago. The tendency is to design the machine for the work instead of adapting the work to the machine equipment.

Inspection of Finished Parts.—Machined parts are now carefully inspected in many shops by an independent inspection department, whereas formerly the only check on the accuracy of machined work was in the erecting department—if everything could be assembled the work was considered satisfactory. The more exacting requirements of recent years, however, made necessary the general adoption of a rigorous system of inspection. Thorough inspection and testing are necessary features of interchangeable manufacturing methods; tools and systems have become highly specialized. In the manufacture of fire-arms and other high-grade products from fifty to one hundred separate tests or gagings on a single part are not uncommon.

In some shops doing work of a miscellaneous character it is the practice to have an inspector go to the machine at the time a job is started to make sure that the workman understands all of the requirements with reference to the quality required in the work that he is to do, instructing the workman as to the degree of accuracy required, the kind of finish, etc., and seeing that he does not make a mistake in reading his drawing, setting his measuring tools, etc. The inspector inspects the work done in the operation in question upon the first piece where there are several pieces to be done, thus avoiding the danger of an error on the first piece being repeated on all subsequent pieces. An inspection is also made upon the completion of each operation of the work done on all pieces in the lot for the purpose of detecting any error that may have been made, so that steps may be taken for its correction without delay.

Cooling Lubricants.—Another improvement in shop practice worthy of mention is the more generous use of cooling mediums on cutting tools, and the provision of distribution systems from a central reservoir.

Use of Multiple Tools.—The increasing use of tools in multiple is a feature that is noticeable in connection with the modern machine shop. Milling machines are now quite extensively used having several spindles, making possible the finishing of three or even five sides of a casting at one setting, many holes are drilled simultaneously and in practically the same time formerly required for drilling one hole, and so on.

Better Facilities for Setting Up Work.—The up-to-date foreman or superintendent has come to realize that the efficiency of his shop depends largely on the amount of attention given to the little things. The furnishing of proper clamps and bolts to machine tool operators is a case in point. Poor bolts and warped clamps around a machine often double the time required for setting up work. At the present, most shops are equipped with proper clamping facilities and, in many cases, clamps of the right shape and bolts of the right length are furnished for each particular job, along with the other tools, such as cutters, reamers, etc.

These tools are being kept in the tool-room instead of being kept at the machines, as formerly; thus the responsibility for their maintenance in first class condition is concentrated in the tool-room, where they are inspected upon being returned after their use in connection with each job, and any necessary repairs promptly made. The difficulty of holding a large number of men responsible for the upkeep of these tools is thus avoided, and each workman has a larger variety of bolts, clamps, blocks, etc., to draw upon than he can possibly have where each man has his own supply.

Location of Tools and Lighting.—More attention is given to the relative location of tools in the shop, in order that all machining operations can be performed with no unnecessary handling of the work, the aim being to finish parts by advancing them from one tool to another in a direct line without any see-sawing or useless movements. Shops are constructed so that the light will be properly diffused, which makes it easier for the machinist to do accurate work and reduces the amount of spoiled work. The physical comfort of the workmen is also receiving more and more attention.

Drilling Machines.—High-speed steel has been substituted for carbon steel in the manufacture of twist and flat twist drills with marked improvement in capacity. The speed of drilling has been increased two or three times, if not more. The drilling machine, the most common machine tool, has been redesigned to meet the new requirements, and so rapid are some of the most highly developed machines on the market that holes can be drilled in boiler plate quicker than they can be punched.

The claim is made by engineers who have carefully investigated the matter that eighty per cent of all the holes drilled in general manufacturing are three-quarters inch in diameter or less. The fact is pointed out that general purpose drills with a capacity of from one-eighth inch to three inches are not efficient except within a narrow zone somewhere between the two extremes cited, desirable as they are when on deep drilling or on large diameters requiring a geared drive; hence the general recognition of the importance of comparatively small capacity drilling machines in the equipment of efficient plants.

Multiple drilling machines with from two to fifty or more drills in operation simultaneously have been developed. Inverted drilling machines in which the capacity of drills is increased largely because of the rapid clearing of chips from the holes are being used with satisfaction, also multiple drilling machines working in several planes simultaneously, making feasible the drilling and reaming of all holes in machine parts such as automobile cylinders at one operation. Another development is the rotary table semi-automatic drilling machines which relieve the operator of lifting and lowering the spindle and engaging and disengaging the feed.

A minor improvement of machine shop equipment which has increased the productive capacity of single-spindle drilling machines is the so-called roller grip drill chuck which enables the operator to insert and remove drills, reamers, counterbores and other tools without stopping the spindle. These chucks are useful for certain kinds of work requiring drilling, reaming and counterboring operations. In the same connection, mention should be made of tapping attachments, stud setting chucks, drill speeders, and similar attachments which improve the working range of drilling machines.

The need of the old style reversing countershaft has been eliminated from drilling machines by automatically reversing tapping attachments, automatically opening stud-setters; and many screw-threading operations are now performed on drill-presses with special forms of automatically opening dies, at a great saving over the former method of chucking the work on a turret lathe.

Lathes.—The improvements in lathes have been chiefly in matters of strength, power, and details of construction. Spindles are made larger and are supported in longer bearings, improvements have been made in carriages, tailstocks, tool-rests, apron mechanism, stops, ways, spindle noses, gear boxes, change gear and feed mechanisms, etc. Three-step cone pulley and double back gear headstocks have been widely adopted for high-power rapid reduction lathes, this construction providing a wide range of speeds with simple and efficient mechanism. Quick change gear mechanisms which enable the selection of gear combinations for screw thread cutting to be made practically instantaneously, have been generally provided by lathe builders. The demand for simple lathes, that is lathes without change gears, lead-screws and other standard features of complete engine lathes, has not been insistent. Hence we still have the anomaly of thousands of lathes in manufacturing plants that are never used for thread cutting, but which have the change gears, lead-screws and other parts required for screw cutting.

The reason ascribed by one prominent lathe builder is that the application of the simpler mechanism required for feeding only makes comparatively little difference in the cost of a lathe. The elimination of the change gears reduces the number of available feeds. But the chief objection is the loss of inventory value when regarded as second-hand tools.

Wheel Lathes.—A remarkable increase of efficiency has been made in locomotive driving wheel and car wheel lathes. Ten years ago, turning the tires of two pairs of drivers was a good day's work, and most railway shops did much less. High-speed steel has worked perhaps one of its greatest triumphs in this field. Tire turning lathes have been developed to equal the capacity of the best steels and the productive capacity has been increased to eight or ten pairs of drivers a day. The increase of capacity of steel tire car wheel lathes is even more marked, having been raised from five or six pairs to eighteen or twenty pairs a day.

Planer Drives.—A weak feature of planers and a serious limitation to the power of large planers is the common shifting belt reversing mechanism. On small planers even the shifting belts are objectionable because of slipping and the characteristic squeaking noise, but on large planers their fault is of more serious nature. Wide belts necessary to transmit the required power at practical speeds cannot be shifted from the tight to the loose pulleys and *vice versa* quickly. Clutches of various designs are used with varying degrees of success. The reversing electric motor direct connected to the planer drive has been developed to the point that makes its success assured. Probably this change of drive is the most marked improvement in planers made in recent years. Many details have been improved and the greater strength and rigidity of the modern planer coupled with excellent workmanship insures accurate work.

Milling Machines.—A change in the machines for producing plane surfaces has been going on gradually but surely. Planers, shapers and slotting machines are being displaced by various types of milling machines in manufacturing plants. As plants change from a building to a manufacturing basis, the superiority of the milling machine as a manufacturing machine gives it the preference. The developments of coarse-pitch teeth milling cutters and of face milling machines, are two of the marked improvements.

Single pulley drive with which the maximum power capacity of a given width belt can be transmitted to the machine irrespective of the work spindle speed, and geared speed boxes giving a wide range of poisitive speeds are other important changes in design. The vertical spindle milling machine has been developed to a high plane of efficiency, especially for small work. Rotary table machines with quick action clamping devices revolving continually while the operator places the work in position and removes the finished parts are coming into extensive use.

Characteristics of modern milling machines also common to other modern machine tools are convenience and ease of operation, starting and stopping levers being placed where the operator can grasp them without leaving his normal position; speed and feed levers so placed as to permit the operator to control the rate of cutting while watching the work; power traverse of slides on heavy machines, etc.

Boring Mills and Boring Machines.—The boring mill has taken a commanding place as a machine tool for both light and heavy work. When equipped with turret heads and a proper complement of tools its productive capacity has been made second to none. Convenience of operation, economy of floor space, compactness of design, adaptability to use of lubricants on cutting tools, are some of the advantages of this machine which have been emphasized in the new designs brought out in recent years. The builders have studied to find the best order of operations and equip with chucks and tools that produce an output far in advance of that possible ten years ago.

The horizontal boring machine of the bed and carriage type which has been developed practically within the past ten years partakes of the characteristics of the lathe, milling machine and boring mill, and in the improved designs is superior to any one for certain classes of work. One of many uses to which it is devoted is that of boring jigs and fixtures for interchangeable production. But not only is it useful for jig making, but it is peculiarly well suited for manufacturing machine parts interchangeably without the use of jigs. This important fact enables machine tools and similar high-grade machines to be economically produced on the interchangeable plan during the very active period of developing the design.

Magnetic Chucks.—Magnetism for holding steel and iron parts for grinding, planing and turning operations has been made useful, especially for thin parts that are easily sprung out of shape by ordinary clamping means. Magnetic grinding, planing and lathe chucks have come into common use in plants having up-to-date equipment.

Grinding Machines.—The surface grinder, especially the vertical spindle type, has made great strides during the last few years. The improvements in cylindrical grinding methods are also worthy of mention, especially the use of the heavy-duty grinder for removing stock formerly removed by a second or finishing cut in a lathe. Grinding stock from the rough, as in the finishing of drop-forged crankshafts is also a good example of modern practice. The stage has been reached in cylindrical grinding practice which places the cylindrical grinding machine on a coordinate basis with the lathe as a tool for finishing cylindrical work. A feature of cylindrical grinding machines which has greatly increased productive capacity in multiple diameter work is the stop bar or semi-automatic measuring attachment which enables shouldered shafts, etc., to be duplicated without measurement. Machines for internal grinding of non-revolving work with planetary spindles provides for the economical and accurate sizing of engine cylinders and other parts difficult to rotate. Vertical grinding machines and rotary work-tables utilizing magnetic chucks or other quick-action clamping means for quickly securing and releasing the parts to be ground have come into extensive use for high-grade interchangeable manufacturing. The development of the disk grinder from a mere smoothing machine to a powerful machine tool of great capacity for finishing plane and curved castings from the rough is one of the most interesting phases of modern practice.

Jigs and Fixtures.—The development of jigs and fixtures for interchangeable manufacturing has been remarkable. The expansion of automobile manufacture has been enormous and most of the leading concerns employ jigs and fixtures exclusively, thus insuring interchangeability, low production cost and systematic production. Many improvements have been made in the way of clamping devices, standardization of bushings, handles, levers, frames, etc., too numerous to mention specifically. Toolmaking has been developed on manufacturing lines, and in fact several concerns specialize on the making of tools, jigs, fixtures, punches and dies, and produce them exclusively for manufacturing plants.

Gear Making.—The demands of automobile users for quiet running gears have imposed on gear makers conditions very difficult to meet. The limits of error in shape and spacing of teeth have been greatly reduced, and coupled with the necessity of making highly accurate gears often has been that of producing them from tough alloy steels, heat treated after cutting the teeth. Hardened and casehardened gears are also demanded with minimum limits of error.

The planing process has been generally substituted for milling in the manufacture of high grade bevel gears, thus producing theoretically correct tooth shapes instead of the approximation possible only by the formed milling cutter process.

Gear hobbing machines have been widely adopted for cutting spur and spiral gears, because of the greatly increased capacity and simplicity of operation. Machines and methods for cutting the teeth of integral herringbone gears cheaply, have been developed, thus making this form of gear available for machinery generally in which it has not been commonly used because of high cost of the two-part type. The demands of automobile users for noiseless gears have led to grinding the teeth of gears after hardening to correct form, and form grinding generally, including splined shafts for automobile change gears and similar parts. Progress has been effected in the making of gears by the hot rolling process, producing them thus with a minimum waste of material and of exceptional physical characteristics.

Small Tools.—The design and manufacture of small tools have been improved principally in details. There has been a tendency to decrease the number of teeth in milling cutters, making possible heavier roughing cuts with proportionately less expenditure of power. While the extreme coarse spacing of the teeth advocated by some leading engineers has not been generally adopted, all manufacturers of milling cutters have, to some extent, modified the tooth spacing of their cutters. Several special milling cutters with inserted teeth have also been proposed and, to some extent, adopted. The tendency has been towards the design of easily adjusted removable blade type reamers, and several satisfactory designs have been brought out. The flat twisted high-speed steel drill has been commercially developed, and several modifications of it have been placed on the market. The main progress in tap making, perhaps, has been towards a more satisfactory shape of the flute, and several tap makers have made experiments in this direction.

In general, there has been an attempt to design inserted cutter tools to a greater extent than formerly. This activity has been prompted largely by the high price of high-speed steel which has made it necessary to make the cutters only from this material, while the body and shanks of the tools are made of machine steel. Many experiments have been made to find the steels best adapted for a given service and the best heat treatment for the selected steels. Improvements have been made in the tangs of twist and flat drills, adding strength sufficient to enable them to stand up to the requirements of high-speed drilling and drilling machines.

Micrometers and Gages.—During the past ten years the micrometer has become a measuring tool of general use. Almost every mechanic employed in up-to-date shops who owns a kit of tools regards a "mike" as necessary as calipers. Many shops also supply them from the tool-rooms on the workman's checks. As the result of the general use of the micrometer, one-thousandth inch has become the unit of measurement for fixing limits, and a limit of one-quarter thousandth is not uncommon in grinding operations. Not only is there a great advantage in the matter of accuracy in the use of micrometers over the old style of calipers set to a scale, but there is a considerable saving in time through their use, both in the matter of setting to size and in eliminating the element of uncertainty, permitting the workman to proceed with his work with greater confidence.

So general has the use of this unit become, and so convenient is it for small dimensions, that a strong movement is under way to make it the standard for measuring wire, sheet metals, etc., in place of the irrational and arbitrary wire and sheet metal gages. One of the largest electrical concerns abandoned the wire and sheet metal gage systems in 1904 and adopted the decimal system in which one thousandth inch is the limit for use in all specifications of wire, sheet metal, fiber, etc.

Standard length gages have been improved. The so-called Swedish gages are furnished under guarantee of error being not more than one one-hundred thousandth inch, per inch length, the limit of error being proportional to the length. Thus a gage one-tenth inch long has an error limit of one-millionth inch, and so on. Hence a stack of these gages presents an over-all length accurate to limit of one one-hundred-thousandth inch per inch of length.

Screw Threads.—The so-called United States or Sellers standard screw threads have come into general use for machine construction during the past twenty or twenty-five years and have proved generally satisfactory for locomotives, cars, steam engines, and other typical heavy machinery, but the automobile brought a new condition for which the standard threads were not well fitted. It was found that the jar and vibration to which motor cars are subjected speedily loosened the comparatively coarse thread screws and nuts threaded to these pitches, and the need of finer pitches was soon recognized. We now have the finer screw pitches established by the Society of Automobile Engineers, and the merits of these pitches have won them recognition in other lines of machinery where, for constructive reasons, pitches finer than the United States standard were desirable.

The A. S. M. E. standards for machine screws, which were adopted after a thorough investigation of the problem, should be mentioned also in this connection. No work that this society has done is of greater importance than that of fixing on standards of screw threads to be recommended to the engineering profession.

Portable Tools.—An important factor in shop work is the portable electric motor drilling and reaming machine which has been developed in several efficient forms during the last decade. These portable machines, supplemented with the pneumatic riveting, chipping and calking hammers, have virtually revolutionized shipbuilding, bridge-building, and structural steel work, and in the erection shop have wrought great changes, making possible rapid and efficient machine work on the parts as erected and thus saving labor and time through the elimination of transport to and from stationary machines.

Power Hacksaws.—The first power hacksaw machine was put on the market about twenty-five years ago. During the past few years the range and capacity of these machines has been greatly extended. They are furnished with quick return stroke, relief action for back stroke, means for using the full length of the blade, angle chucks and other improvements that have made this humble machine a real machine tool of high efficiency and low operating cost. Blades of great durability are furnished at low cost.

Brass Working.—The changes in brass working are principally in the development of automatic and semi-automatic machines for machining standard parts made in large quantities. Some of the machines have effected great reductions in cost, in some cases reducing the labor cost to one-fifth, or less, of that before the change was made. Carbon steel tools still have the call in some plants in preference to high-speed steel tools; carbon steel holds a keener edge and is generally more satisfactory for working the brass used in the manufacture of globe valves, cocks, etc. It is claimed, however, that much of the difficulty experienced in using high-speed steel on work of this character is due to improper heat treatment of the high-speed steel, and this contention seems to be borne out in practice, as certain shops doing brass work of this character are using high-speed steel exclusively.

Chucks operated by compressed air have made a great improvement in the operating efficiency of brass lathes. The work can be chucked and removed without stopping the work spindle, thus saving the time and strength of the operator. The development of the air chuck has taken place chiefly within the past few years, and it is one of the principal improvements made in hand operated turret lathes.

Manufacture of Guns and Pistols.—The methods of making guns, pistols and similar high grade products have been revolutionized. A representative of one of the largest machine tool building concerns estimates that the efficiency of workmen in these lines has been doubled by the introduction of improved machinery and methods. When the fact is considered that high grade gun parts are made interchangeable, the limits of error allowed being very small indeed, and that gun making is one of the oldest industries, the importance of the improvements made can be better appreciated.

Press Working.—Press working machines, punches, dies and other tools have developed to an extent not generally realized by engineers in lines not affected. Here again the development of highly specialized methods of manufacturing automobiles has had a marked influence. Crank presses of one thousand tons capacity are in use. Pressed metal forms of large size are commonplace. But not only has the development been remarkable in point of size, but also in detail of manipulation. Parts requiring several operations, for example, are turned out by multiple plunger presses, one finished piece being formed at every stroke. An interesting feature of press work is that shapes are produced impossible to duplicate by any other known process. In this respect, press work differs from most other machining processes; it is possible to duplicate, for example, lathe or planer work by hand tools, but not so many drawing and forming operations in daily use. A branch of presswork little known is the extrusion of shells, tubes, collapsible tubes, etc., of copper, brass and alloys. Extrusion of bars in many shapes used in manufacturing locks, small machines, etc., has become a large industry which has been largely developed in recent years. The possibilities of extrusion are practically unlimited, and this process in common with other metal working methods extensively used has an important effect on the practice of shops using the shapes in their products.

Heat Treatment.—The advent of the high-speed steels and the alloy steels used in automobile gears, shafts and other high grade machinery subjected to shocks has necessitated the development of furnaces and equipment for the scientific heat treatment of steel. Accurate determinations of quenching and annealing temperatures are absolutely necessary, and th pyrometer has become an indispensable instrument in the furnace room. Gas and oil furnaces have been greatly improved in the matter of efficient use of fuel and control of temperatures.

Die Casting.—The production of alloy castings in metal dies has grown to large proportions. Gears, bushings, bearings, type wheels, machine parts, covers, etc., are produced accurate to pattern and free from fins. This phase of manufacturing machine parts has a decided bearing on machine design. The extension of die casting to include not only the low melting alloys but also brass and cast iron, promises to make decided changes in some lines. Cast-iron gears true to pattern, on which machine work is reduced to the boring of the hub for the shaft, may become common in agricultural and similar grades of machinery.

Ball Burnishing.—Finishing processes are important in giving attractiveness to manufactured goods. Hand methods are slow and costly and the natural tendency is to use automatic mechanical methods for finishing as well as for making. One process of considerable interest because of its simplicity and effectiveness is the steel ball burnishing method, consisting essentially of a tumbling barrel partly filled with the articles to be finished and a mass of hardened steel balls of various sizes.

Thermit Welding.—An effective process has been introduced extensively during the period covered, for welding heavy sections of steel and iron. The thermit process is being successfully used for welding broken locomotive frames, cylinders, crankshafts, propeller shafts up to any thickness and diameter. The fractures are soundly united by a steel bond applied *in situ* at a fraction of the cost of removing the parts, welding them in the smith shop, finishing in the machine shop and replacing. Hundreds of locomotive frames have been welded by this process with almost uniform satisfaction and at a saving of thousands of dollars for labor and loss of service.

Autogenous Flame Welding and Cutting.—The development of oxy-acetylene and oxy-hydrogen welding and cutting torches has given the industrial world truly remarkable tools for building up or cutting apart. The welding of sheet metals is accomplished with speed and evenness hardly possible by any other process, and the cutting of steel or wrought iron is done close to the line and with such rapidity as to equal or exceed the performance of any machine tool adapted for the same work. Recent improvements make possible the cutting of all manner of shapes from steel plates up to six inches thickness so close to the outline of the pattern that a light finishing cut suffices to transform the piece into a finished die.

Cranes, Hoists and Trolleys.—The general provision of traveling cranes, jib cranes, hoists and trolleys in modern shops have made a great change in the manner of handling work and the attitude of mechanics to big jobs. When a casting weighing many tons had to be machined in the old-time shop it was a herculean job to transport it from one machine to another and fix it in position. So general has the power traveling crane become in the past few years that it is a commonplace sight to see machine parts weighing many tons being transported through shops and placed on machines with no fuss and requiring the help of only one or two men besides the crane operator.

Accident Prevention.—The prevention of industrial accidents has received wide attention in industrial establishments. In machine shops accident prevention is a relatively simple matter, but there are a few points of danger which have become generally appreciated, and all of the better types of machines are equipped with guards to cover gearing, set-screws, flywheels and all moving parts not necessarily exposed. There are also certain general sources of danger which exist in practically all manufacturing plants and the general rules to prevent accidents from slipping ladders, piles of castings, elevators, etc., are being applied.

Time and space will not permit giving much more, and the following are enumerated without elaboration:

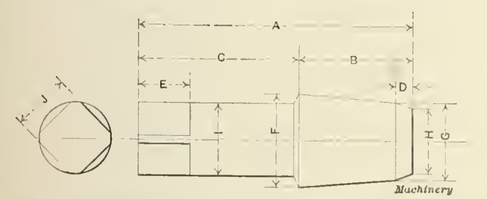
Introduction of ball bearings in the construction of machine tools, effecting a saving of power, increasing the efficiency of operation and capacity through reduction of bearing widths; development of cam grinding machinery and attachments, making possible the rapid and economical production of camshafts having cams integral with the shaft; development of the dynamic balancing machine and the general recognition of the need of dynamic balancing for high-speed revolving parts; artificial production of highly efficient abrasives or cutting particles for grinding wheels, and improvements in grinding wheel manufacture; development of improved lubricating systems for machine tool bearings; development of machine tools to their utmost capacity by providing means for working the tools all the time, employing extra men to prepare work and also by tooling the machines to bring them up to their highest productive capacity; development of spline milling machines for cutting keyways, key slots, drift holes, cam grooves, recesses, etc.; finishing square, hexagon and other shaped holes by the broaching process, insuring interchangeability and rapid production at low cost; general improvement in sanitary conditions of shops, improved lighting facilities both by day and by night through the use of saw-tooth roofs, large windows fitted with metal window frames, improved electric lights and means of distribution; provision of lockers; and the establishment of shop restaurants in localities that formerly had nothing better than the corner saloon.

* * *

NEW STANDARD DIMENSIONS FOR TAPS

Up to a short time ago, different tap manufacturers had no commonly accepted standard for pipe taps. The length of the threaded part on taps made by some manufacturers was a great deal longer than the threaded part of those made by others, and, in fact, the threaded part on all these taps was longer than necessary. In some cases, it was found impossible to properly thread a short elbow fitting, because the tap would bottom against the wall of the fitting before the correct size of thread had been obtained. Therefore, four prominent tap manufacturers, the S. W. Card Mfg. Co., Mansfield, Mass., the Pratt & Whitney Co., Hartford, Conn., the J. M. Carpenter Tap & Die Co., Pawtucket, R. I., and the Standard Tool Co., Cleveland, Ohio, agreed upon standard dimensions for pipe taps, as given in the accompanying table. It is understood that most manufacturers of taps have now adopted this standard. In the table, the dimension *G* is the diameter at the point before chamfering the end.

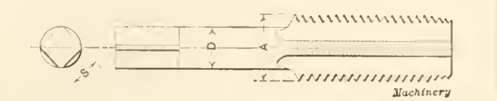
TABLE I. STANDARD DIMENSIONS FOR PIPE TAPS



Nominal Size	No. of Threads per inch	A	B	C	D	E	F	G	H	I	J
1/8	27	2 1/8	3/4	1 3/8	3/32	3/8	0.420	0.373	0.309	5/16	0.234
1/4	18	2 7/16	1 1/16	1 3/8	3/16	7/16	0.559	0.493	0.397	7/16	0.328
3/8	18	2 9/16	1 1/16	1 1/2	3/16	1/2	0.694	0.628	0.532	9/16	0.421
1/2	14	3 1/8	1 3/8	1 3/4	7/32	5/8	0.865	0.779	0.656	11/16	0.515
3/4	14	3 1/4	1 3/8	1 7/8	7/32	11/16	1.075	0.989	0.866	29/32	0.679
1	11 1/2	3 3/4	1 3/4	2	1/4	13/16	1.350	1.240	1.091	1 1/8	0.843
1 1/4	11 1/2	4	1 3/4	2 1/4	1/4	15/16	1.693	1.584	1.434	1 5/16	0.984
1 1/2	11 1/2	4 1/4	1 3/4	2 1/2	1/4	1	1.932	1.822	1.672	1 1/2	1.125
2	11 1/2	4 1/2	1 3/4	2 3/4	1/4	1 1/8	2.405	2.297	2.147	1 7/8	1.406
2 1/2	8	5 1/2	2 9/16	2 15/16	3/8	1 1/4	2.921	2.761	2.545	2 1/4	1.687
3	8	6	2 5/8	3 3/8	3/8	1 3/8	3.547	3.383	3.167	2 5/8	1.968
3 1/2	8	6 1/2	2 11/16	3 13/16	3/8	1 1/2	4.047	3.879	3.663	2 13/16	2.109
4	8	6 3/4	2 3/4	4	3/8	1 5/8	4.547	4.375	4.159	3	2.250

Up to a few years ago, it was quite frequent to hear complaints that the manufacturers of taps and reamers had no standard for the squares on the shanks of their tools. Some of the tap manufacturers, therefore, agreed upon a uniform standard for the squares on taps, adopting also a standard for the diameter of the shank. According to this standard, the diameter of the shank is equal to the diameter of the tap minus 1.6 times the standard pitch for a V-thread tap or screw of the diameter of the tap. Hence, if a 1-inch tap was made with, say twelve threads per inch, the diameter of shank would still be figured from the standard number of threads per inch of a 1-inch tap, which is eight threads, and the shanks and squares on all 1-inch taps, therefore, would be alike, irrespective of the number of threads per inch. It was further agreed that the size of the square across flats should be made 3/4 times the diameter of the shank. The accompanying table gives the diameter of shank and size of square as figured from these formulas.

TABLE II. DIMENSIONS OF TAP SHANKS AND SQUARES



Size of Tap A	Diam. of Shank D	Size of Square S	Size of Tap A	Diam. of Shank D	Size of Square S	Size of Tap A	Diam. of Shank D	Size of Square S
1/4	0.170	0.127	27/32	0.684	0.513	1 7/8	1.519	1.140
17/64	0.186	0.139	55/64	0.699	0.524	1 29/32	1.551	1.163
9/32	0.201	0.151	7/8	0.697	0.523	1 15/16	1.582	1.186
19/64	0.217	0.163	57/64	0.713	0.535	1 31/32	1.613	1.210
5/16	0.224	0.168	29/32	0.728	0.546	2	1.644	1.233
21/64	0.239	0.179	59/64	0.744	0.558	2 1/16	1.707	1.280
11/32	0.255	0.191	15/16	0.760	0.570	2 1/8	1.769	1.327
23/64	0.270	0.203	61/64	0.775	0.581	2 3/16	1.832	1.374
3/8	0.275	0.206	31/32	0.791	0.593	2 1/4	1.894	1.421
25/64	0.291	0.218	63/64	0.807	0.605	2 5/16	1.957	1.468
13/32	0.306	0.230	1	0.800	0.600	2 3/8	2.019	1.515
27/64	0.322	0.241	1 1/32	0.831	0.623	2 7/16	2.082	1.561
7/16	0.323	0.242	1 1/16	0.862	0.647	2 1/2	2.100	1.575
29/64	0.339	0.254	1 3/32	0.894	0.670	2 9/16	2.162	1.622
15/32	0.354	0.266	1 1/8	0.896	0.672	2 5/8	2.225	1.669
31/64	0.370	0.277	1 5/32	0.928	0.696	2 11/16	2.287	1.716
1/2	0.367	0.275	1 3/16	0.959	0.719	2 3/4	2.350	1.762
33/64	0.382	0.287	1 7/32	0.990	0.743	2 13/16	2.412	1.809
17/32	0.398	0.298	1 1/4	1.021	0.766	2 7/8	2.475	1.856
35/64	0.413	0.310	1 9/32	1.053	0.789	2 15/16	2.537	1.903
9/16	0.429	0.322	1 5/16	1.084	0.813	3	2.543	1.907
37/64	0.445	0.334	1 11/32	1.115	0.836	3 1/16	2.605	1.954
19/32	0.460	0.345	1 3/8	1.108	0.831	3 1/8	2.668	2.001
39/64	0.476	0.357	1 13/32	1.139	0.855	3 3/16	2.730	2.048
5/8	0.480	0.360	1 7/16	1.171	0.878	3 1/4	2.793	2.095
41/64	0.495	0.371	1 15/32	1.202	0.901	3 5/16	2.855	2.141
21/32	0.511	0.383	1 1/2	1.233	0.925	3 3/8	2.883	2.162
43/64	0.526	0.395	1 17/32	1.264	0.948	3 7/16	2.945	2.209
11/16	0.542	0.407	1 9/16	1.296	0.972	3 1/2	3.008	2.256
45/64	0.558	0.418	1 19/32	1.327	0.995	3 9/16	3.070	2.303
23/32	0.573	0.430	1 5/8	1.305	0.979	3 5/8	3.133	2.349
47/64	0.589	0.442	1 21/32	1.336	1.002	3 11/16	3.195	2.396
3/4	0.590	0.442	1 11/16	1.367	1.026	3 3/4	3.217	2.412
49/64	0.606	0.454	1 23/32	1.399	1.049	3 13/16	3.279	2.459
25/32	0.621	0.466	1 3/4	1.430	1.072	3 7/8	3.342	2.506
51/64	0.637	0.478	1 25/32	1.461	1.096	3 15/16	3.404	2.553
13/16	0.652	0.489	1 13/16	1.492	1.119	4	3.467	2.600
53/64	0.668	0.501	1 27/32	1.524	1.143	...	.....	.....

Should the pitch be coarser than that of a standard V-thread for a given diameter, so that the depth of the thread would be greater than that of the standard V-thread, then the diameter of the shank is generally made equal to the diameter of the tap minus 1.6 times the actual pitch required in each specific case, and the square is made 3/4 times the diameter of the shank.

* * *

A street sprinkler of interesting design has recently been brought out by the International Motor Co., New York, for the street cleaning department of St. Louis, Mo. The sprinkling apparatus is mounted on a 6½-ton Saurer chassis of standard construction. It is provided with a double-acting force pump driven by the motor, which forces the water through the nozzles by power instead of by the gravity of the water itself, as is the case in ordinary street sprinklers. The nozzles are located about a foot in advance of the truck proper, and hence sprinkle the street in advance of the wheels, so that the sprinkler does not raise a cloud of dust. It is claimed that a roadway from 70 to 80 feet wide can be sprinkled at one passage of this sprinkler at a rate of more than ten miles an hour.

SOME FIXTURES USED IN MAKING EDGEMONT FRICTION CLUTCHES

BY DOUGLAS T. HAMILTON*

The accompanying illustrations show some of the interesting fixtures and devices used by the Edgemont Machine Co., Dayton, Ohio, in the manufacture of its friction clutches. These fixtures are of very simple design, but as they have some interesting features, a description of them may prove of value.

Clutch Cam Forming Attachment

Fig. 2 shows a special forming tool arrangement, which is used for forming, to exact diameter and shape, the friction clutch cam of the Edgemont self-oiling type friction clutch. This cam *A* is made from an iron casting, and is bored and reamed before it is ready for the forming operation. It is then driven onto arbor *B*, which is held on the lathe centers of a 15-inch Von Wyck engine lathe. A roughing cut is first taken from the straight portion of the cam with a tool held in holder *C*. Then the wide forming tool is brought into operation. This consists of three cutters *D*, *E* and *F* which are clamped in the holder *G* by set-screws *H* in block *I*. The holder *G* is fastened to a machined seat on the tool-slide.

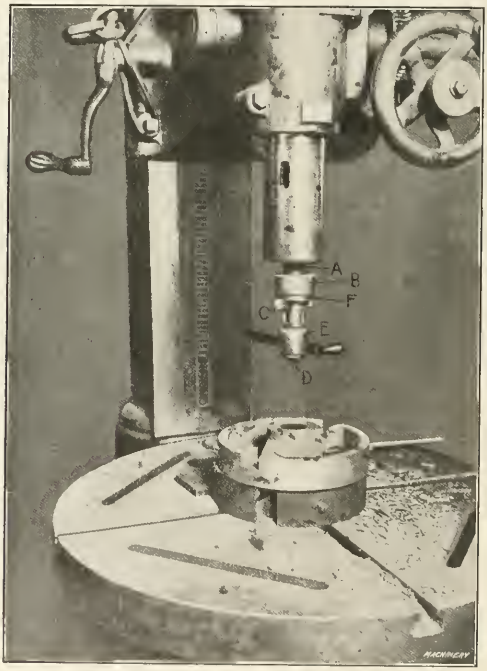


Fig. 1. Interesting Facing Tool for Expanding Clutch Ringe

The outer ends of the forming blades *D* and *F* are so made that they face the cam to the desired length as well as turn the outside and round the ends. The center or groove forming blade *E* is called upon to perform the hardest service—that of removing the hard scale—and consequently requires more frequent grinding than the two outer tools. Provision is made for adjusting the tools by set-screws located at the rear of the fixture.

The old method of machining these clutch cams was to turn them to the desired shape by single cutting tools, which operation took 13 minutes for each cam. With the arrangement shown in Fig. 2, this time has been cut down to 7 minutes, with an increase in the accuracy and an improvement in the appearance of the finished work. A finished cam is shown at *J*.

Facing Tool with Interesting Clamping Device

A simple and efficient facing tool is shown in Fig. 1, located in the spindle of a Hamilton upright drill press. This facing tool consists of a spindle *A* provided with a tapered shank to fit the taper in the drill press spindle, and threaded on the body for the knurled collar *B*. The lower end of the spindle *A* is provided with a slot to hold the high-speed steel facing cutter *C*, which is held down on the adjusting screw *D* projecting up through the slot. A bushing *E*, which is made to fit the hole in the work to be faced, is held on the reduced end of the spindle by screw *D* and a washer.

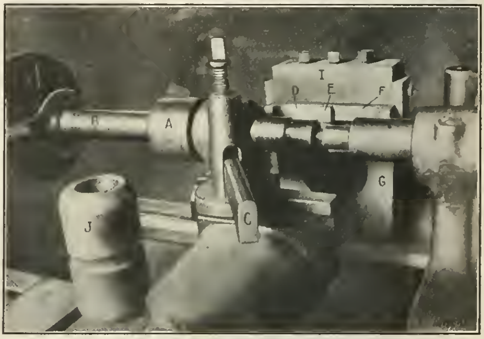


Fig. 2. Lathe Forming Device for Machining Clutch Came

The most interesting feature about this facing tool is the cam-faced washer *F*. This rests upon the top face of the tool, and is acted upon by the knurled collar *B*. This cam-faced washer is used to set the facing tool *C* "square" after grinding, and fills this function with entire satisfaction. By turning it around, the ends of the tool are raised or lowered as desired, thus obviating the necessity of grinding the tool to an equal height or thickness for its entire length. The part being faced in the illustration is the boss of the friction member of the Edgemont self-oiling friction clutch, held on a circular block located on the drill press table.

Clutch Pulley Reaming Fixture

Fig. 3 shows a special reaming attachment applied to a John B. Morris 20-inch engine lathe for reaming the clutch ring of a 14-inch diameter by 4-inch face self-oiling friction clutch pulley. This clutch ring must be concentric with both the bore and the outside of the clutch, and as it was found very difficult to accomplish the desired results in the turret lathe, the fixture shown was designed and made. It consists principally of a bracket *A* machined to fit the top face of the lathe carriage, to which it is held by screws, the feed-screw for operating the tool-slide not being connected. Held to the front face of bracket *A* by four cap-screws, is a tool-holder *B* in which are held two high-speed steel blades *C*. These blades are held rigidly in place by headless screws which press upon "leaf" portions of the fixture, formed by cutting a 1/16 inch saw slot about $\frac{3}{4}$ inch deep. This provides a clamping medium that does not distort the blades, and holds them perfectly flat.

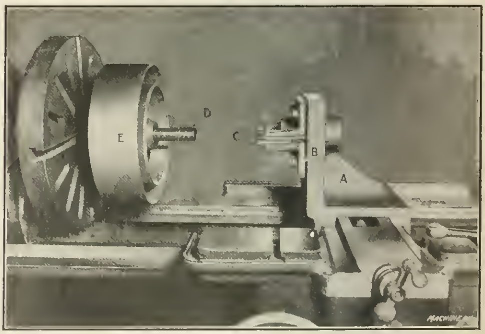


Fig. 3. Special Reaming Attachment for Friction Clutch Pulleys

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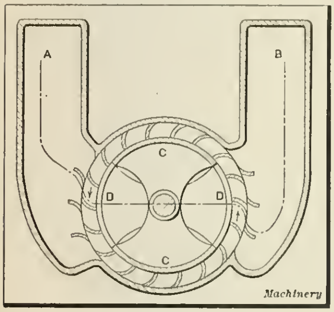
* Associate Editor of Machinery.

The holes in the tool-holder *B* for the clamping screws are enlarged, allowing the fixture, which is provided with a hardened steel bushing, to be set concentric with the hardened and ground arbor *D* held in the spindle of the lathe. The pulley *E* is held on a hardened and ground bushing located on the arbor, and is driven from the arms by a dog clamped to the faceplate. The hole to be reamed is 9¾ inches in diameter and is finish-reamed in four minutes. The bore is rough-turned in the lathe before coming to this reaming device, which only takes a light finishing cut. Bushings and tool-holders are provided for the different sizes of friction clutches, so that it is possible to use the same arbor and bracket for all sizes, which is important as it would be practically impossible to get the arbor to run true again, were it removed from the lathe spindle. The reaming blades are not removed except for grinding, which occurs at very infrequent intervals.

* * *

GAS-PROPELLED WATER TURBINE

A novel type of gas-propelled water turbine is proposed and shown in diagrammatical form by Mr. James Dunlap, of Glasgow, in a recent number of *Engineering*. The turbine casing and the explosion chambers *A* and *B* are filled with water to about one-half their volume. By permitting gas to explode in each chamber alternately, the water is caused to pass through the turbine and, in doing so, maintains the turbine wheel in continuous rotation. The dotted lines indicate the path of the water. By having two wheels, one for forward and one for reverse motion, and two sector shields *C* and *D*, the arrangement can be made suitable for marine propulsion, the shields being moved in and out of position as required—that is, when the discharge through the forward wheel is blocked, that through the reverse wheel is open. When both are half open, the wheels will be stationary and the equivalent of a releasing clutch would be obtained. The water velocity in the chambers *A* and *B* may be as high as 10 feet per second. For a given number of impulses any desired speed of revolution may be obtained by varying the diameter of the wheels. It would be interesting if practical experiments were conducted along these lines to ascertain whether the method would prove to possess the theoretical advantages indicated.



Gas-propelled Water Turbine

* * *

The number of accidents per annum per thousand Pennsylvania R. R. employes, has decreased from 11 in 1902 to 8.3 in 1911. Accidental deaths per thousand employes have decreased from 4.9 to 1.9—more than 60 per cent. Cases of illness have dropped from 35.4 per thousand employes in 1902 to 29.2 per thousand in 1911, and deaths from sickness which were 8.5 per thousand employes in 1902, were 7.5 in 1911. The Pennsylvania R. R. has more than two thousand active employes who have been on the payroll more than forty years, and over fifteen hundred men who have served forty years or more and are now on the pension list. There are on the pay roll or pension list, nearly five hundred men who have been in the service over fifty years.

* * *

When the jaw clutch is put into a machine for reversing the motion, or for changing the speed, the maximum hand force required for operating the clutch lever should not exceed 50 pounds, when the clutch is to be operated at long intervals; when the clutch is to be operated at short intervals, the operating force should not exceed 15 pounds. The clutch should be put on the shaft having the greatest speed, when possible.

JIG FOR MILLING AN IRREGULAR SHAPED GUIDE

BY CHRISTIAN F. MEYER[*]

The roller guide *A* shown in Fig. 1 is part of the mechanism of an automatic machine. When in operation, this guide rotates about the axis *e* of the central hole. Corresponding sides *a*, *b*, *c*, and *d* of different guides must be at exactly the same distance from *e*; these sides are shown by dotted lines in Fig. 1.

The side *d* is inclined to the plane of the guide and has a depression of radius *r* milled in it. The angle of inclination of this side, and the depth to which the depression is milled, also the angles which are formed by the side *c* with the sides *a* and *b* must be accurate. It will be seen that this is a difficult job since the distance of the different sides from *e* is not the same.

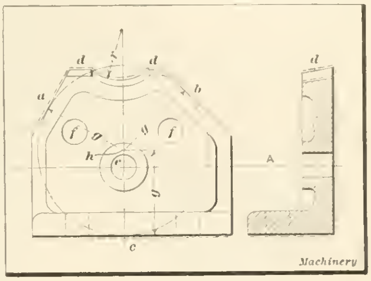


Fig. 1. Guide to be milled

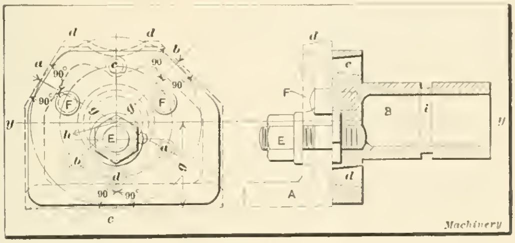


Fig. 2. Revolving Jig Faceplate for locating the Work

It appears that the performance of so many exact operations will require the use of a number of fixtures and much handling, which will decrease the degree of accuracy for each piece as well as for all pieces in relation to each other. For this reason, and since the guide *A* is manufactured in large quantities, I constructed a jig to perform all of these operations with absolute accuracy and without taking out the work before it is finished. It works rapidly and can be operated by an unskilled man.

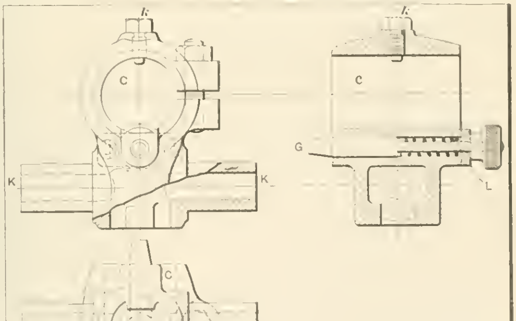


Fig. 3 Swinging Bracket for locating Side d

The guide *A* was first laid out and the point *h* located as shown in Fig. 1. This point is located in such a way that it is at the same distance g from the three sides a, b and c; or, in other words, these sides are tangents to a circle of radius g described about the center h.

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[*] Address: Garfield Ave., Burks Co., Wyomissing, Pa.

The piece A is next fastened upon the revolving table B by means of stud E, as shown in Fig. 2; A is indicated by dotted lines in this illustration. Two guide holes f, Fig. 1, are drilled in A to receive the pins F of the table, thus locating the point h on the axis y–y of table B. These guide holes are always drilled in the same relative position to e. The hole e is drilled first and a simple jig is then used to locate the guide holes f. The table B is made of cast iron and has a round extension which is provided with a square groove i running all around its circumference. Tapered holes a, b, c, and d are located with their centers upon the circumference of the same circle, in such a way that a line connecting the center of this circle with the center of one of these holes will be at right angles to the side of A which its prolongation beyond h will intersect. Each hole is marked to correspond with the respective side that is intersected by such a construction.

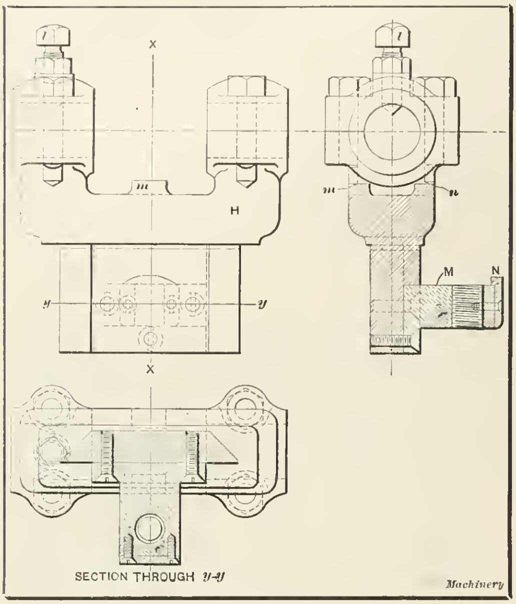


Fig. 4. Sliding Bracket that feeds Work to Cutter

The round extension of B fits into the bore of a swinging bracket C which is shown in Fig. 3. The latter is split at the one side and may be tightened or loosened by a stud and nut, thus holding or releasing the table B. Any sideway movement of the table is prevented by a set-screw k, the hardened point of which fits into the groove i. A tapered pin G is arranged in such a way that its center line coincides with the centers of the corresponding tapered index holes a, b, c and d as they pass by; this arrangement will be readily understood by referring to Fig. 6. A suitable spring, held in place by a steel cover L, serves to press the pin into the respective holes, while a knurled nut is provided to draw it out during the indexing. The lower extension of C is made with two journals K, which are turned to have a good fit in the bearings of the sliding bracket H as shown in Fig. 4. These bearings are made with a removable cap to allow the bracket C to be put into place. A pointed set-screw l holds the bracket C in its proper position. This point will be taken up later on. Two extensions m and n are provided to limit the swing of the bracket C; the use of these stops is explained in connection with Fig. 7. The lower part of H is finished to a dovetail slide which provides for sufficient tool clearance, and its rear side is cut away to receive the brass nut M, as shown. This nut has a hardened steel stop plate N fastened to it.

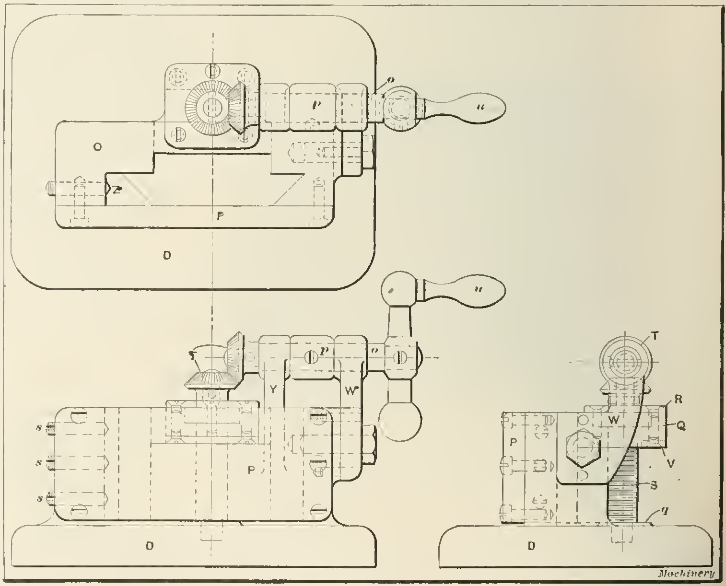


Fig. 5. Base upon which the Jig is mounted

The dovetail of the bracket H fits exactly into a corresponding bed in base D as shown in Fig. 5. By means of the screws s and a suitable gib Z, it is possible to adjust the sliding of bracket H; the steel cover P is provided to hold the slide and gib as shown. The baseplate of D has a vertical projection cast to it and the rear of this projection has a large enough opening to allow the brass nut M to move easily in it. Right above this opening, the projection is provided with a small extension Q which provides a bearing for the spindle S. This spindle is held in place by a suitable steel cover R. The lower side of Q has a hardened steel stop plate V screwed to it.

A pair of bevel gears T transmit the motion of shaft o to the spindle S. The shaft o is held in position by a collar p which is secured to it by a set-screw and fits between the two finished sides of the supporting brackets Y and W; the bracket W is independent and is fastened to D by a screw and dowel pins as shown. The spindle S is threaded to fit the brass nut M, and the crank is provided to turn shaft o and with it the bevel gears and the spindle S.

Fig. 6 shows a general drawing of the assembled jig with the revolving table in position for milling the side c. To get this position, the operator loosens the nut of the split bearing that holds the table B and revolves the latter until the tapered hole c (corresponding to side c as explained) is opposite the pin G. This pin has to be withdrawn before the table can be revolved. When the side c has been brought into position, the pin G is allowed to slip into hole c, thus locating the table as desired. The table B is clamped by the stud and bolt provided for this purpose. The cutter is then set to the correct height and the jig is ready for milling the side c. Sides a and b are finished in the same manner, but no resetting of the cutter is necessary because the table B revolves around the axis *h* and these sides are at the same distance from this point.

For the inclined side *d*, the table is first set in the same way as for the other sides. Position I of Fig. 7 shows that *d* will come below the cutting line. The set-screw *l* is now loosened and swinging bracket *C* is moved over into position II. Here it will be seen that the extensions *m* and *n* are provided as stops for the respective positions. It will be seen that in swinging, the bracket *C* carries the guide *A* with it over to the desired angle. The work is raised, at the same time, to the height of the cutting line. After the set-screw *l* is tightened, the jig is again ready for operation without resetting the cutter. When the side *d* is milled, the work is brought underneath the cutter in such a way that the vertical center line of the cut-out is in line with the center of the cutter. This may be done by bringing the table of the milling machine against a removable stop pin which may be taken out while milling the sides. The cutter, however, must have the same radius which the finished cut-out should have.

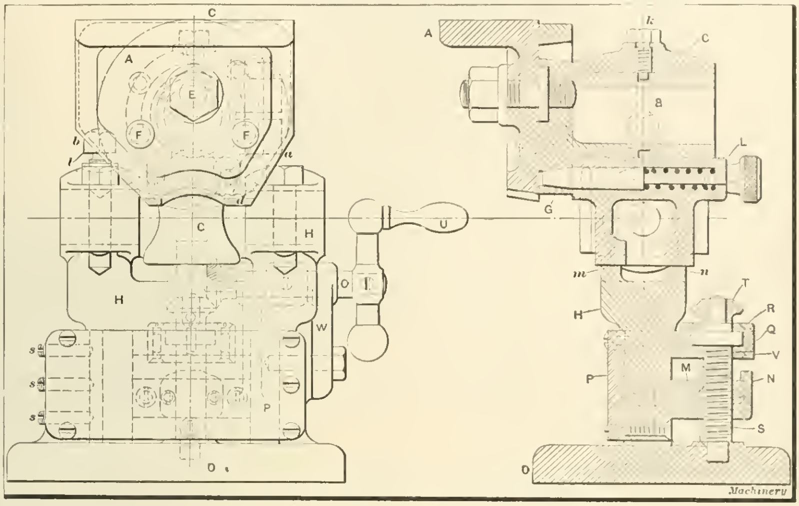


Fig. 6. General View of the Assembled Jig

The work is now fed against the cutter by turning the handle *U*. This raises the sliding bracket *H* through the action of the spindle o, the bevel gears *T* and the screw *S*. The feed is stopped at the desired point through the contact of the steel stop *N* with the stop plate *V*. This stop is so adjusted that the upward motion of the jig and work is stopped as soon as the cut-out has the desired depth.

It can be clearly seen that, as no resetting of the cutter has to be done, the guides can be rapidly and accurately produced. The operation of this jig is so simple that it can be easily understood by any unskilled man.

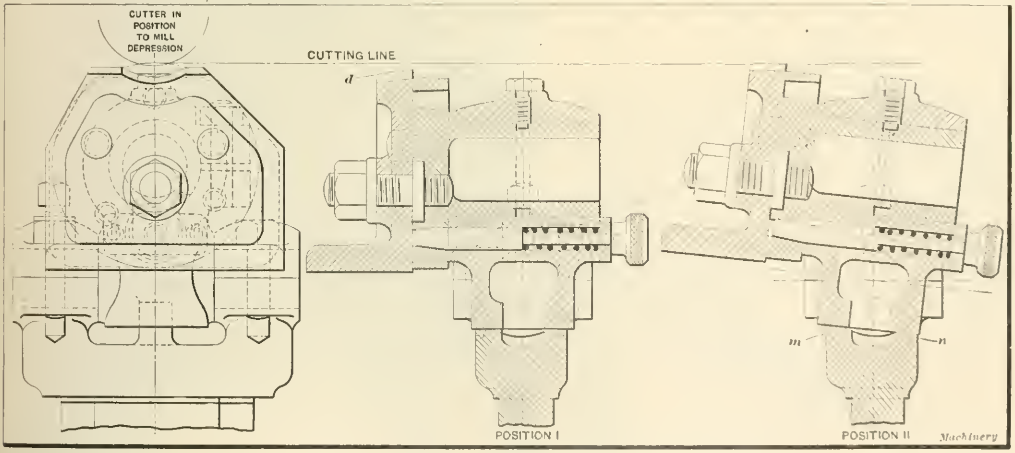


Fig. 7. Diagram showing Method of locating Side d

* * *

A peculiar use of electricity in clay working has recently been developed, according to *The Woodworker*. A direct current of electricity, flowing from a positive to a negative contact through clay, will carry with it moisture from the clay. This property of electricity is being made use of as a means of lubricating the dies of brick machines, cutting knives, etc., with moisture.

STANDARDIZATION IN THE MOTOR CAR INDUSTRY

In an article in *Motor*, dealing with the subject of standardization, Mr. Henry Sturmey calls attention to the great value of the standardization which has already been reached in the American motor car industry as compared with that of Great Britain or Europe in general. This standardization has made it possible for makers of parts of motor cars to manufacture these in greater quantities, as these parts will fit into the designs of a great number of different makes of cars. As an illustration of the price advantage which this gives to the builders of automobiles, Mr. Sturmey mentions that American manufacturers can purchase their engines at from 50 to 65 per cent less than what would be paid for similar engines of equal power in England. These advantages, of course, are reflected in the ultimate price of the finished motor car.

* * *

Zinc and spelter are synonymous terms and designate the same metal, but the term "spelter" is frequently employed to indicate the common grades of commercial zinc, while "zinc" is used to designate the refined or pure metal. Ordinary brazing spelter, however, is a compound of zinc and copper generally in the proportion of 1 to 1. Hence "spelter" means both commercial zinc and the alloys used for brazing.

BILL JONES, ONE-TIME "TRAMP MECHANIC"

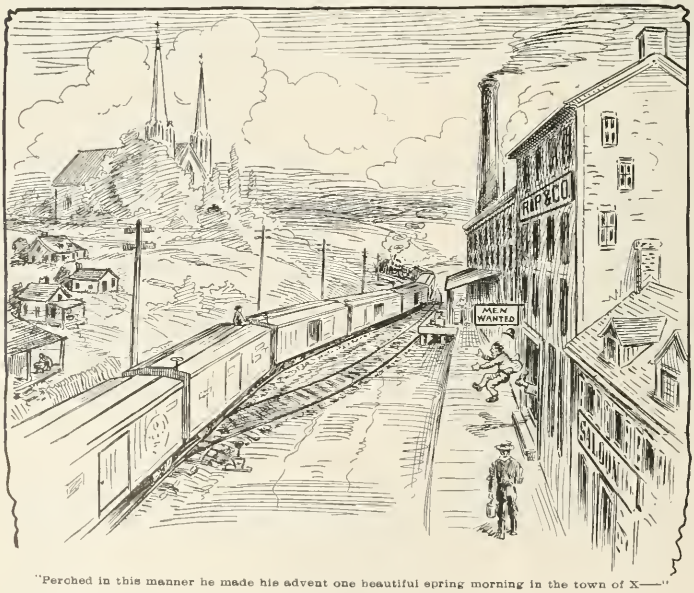
BY J. S. M.

Bill Jones didn't ride the brake beams, but he did ride free—simply because he objected to paying out his hard-earned coin to over-capitalized railroads. Some of his acquaintances were uncharitable enough to call Bill a "tramp mechanic," yet such was not the case. Bill had the wanderlust plus a knack of getting in right with a freight crew. This knack enabled him to sit boldly on top of a box car and view the scenery while en route between jobs.

Perched in this manner, he made his advent, one beautiful spring morning, in the town of X———. What first caught his eye was the glitter of the gilded crosses on the church with the twin spires upon the hill, but the chimes were all but drowned by the coughing of the locomotive ahead. Next he observed some ramshackle cottages, a woman at a wash-tub, and a man leaving a saloon with a "growler." Bill vaguely wondered why the growler at this early hour, and altogether was unfavorably impressed by the place. But there are no cushions on the top of a box car, and when he saw a sign "Men Wanted" hanging out at the works of Rip & Co., Ltd., he knew he was "elected." After hunting up a barber shop and making himself generally presentable, he interviewed the foreman and was put to work.

Such is the story of how Bill Jones landed with Rip & Co. Ltd. How he fought his way to the top and became general manager, we will let Bill tell:

"When I landed in X——— I had a dollar-and-a-quarter in my pocket, red blood in my veins, but not much sense in my head. Six hours in the shop convinced me it was rightly named. It was a regular 'old rip' of a place. Everyone was scrapping and the owner was an old reprobate, even if he did belong to the church on the hill. He drank too much at night and raised the merry devil in the morning. Many a good mechanic have I seen fired just because 'Old Man Rip' got tired 'seeing 'em around.' The foremen knew who did their work right and who did not, yet they were dominated by Rip and, by association, became like him. The superintendent and the machine shop foreman were at loggerheads. The office boy whistled 'Oh, I Don't Know,' the apprentices held indignation meetings in the yard at noon hour, and even the storeroom cat would arch her back and hiss if you even crooked your finger at her. I'd always been some fighter myself but this place disgusted me—in fact it got on my nerves, and I decided to pull out the first pay-day. I found, however, that they held back a week's pay and that I could not get the hold-back without appearing in person on the fifth of the month.



"Perched in this manner he made his advent one beautiful spring morning in the town of X——"

"That night I slept badly and towards morning had the 'night-horse'. I dreamed my brain was lying on the operating table at the hospital, that it was much larger than my body and that I was standing on the table with a patternmaker's gouge in my hand. I could see in the brain before me, a deep groove leading from the perceptive faculties straight towards the bump of self-esteem, and from there towards the bump of combativeness, from which location the marking led to the general location of the selfish propensities. I felt very much shocked and seizing the gouge with both hands proceeded to make a new thought groove, deeper than the rest, leading from the perceptive faculties to the region of reflective thought and reason. It developed next morning that this new groove was only a dream, but I determined that it should exist in reality. I saw the immense amount of energy being wasted about me by combative tendencies where there was really no principle at stake to be fought for, or any logical direction to the fight. It was simply a fight because there seemed nothing better to do—a woeful waste of good energy.

". . . the apprentices held indignation meetings in the yard at noon hour"

"I concluded that if I could manage a freight crew so that they permitted me to ride on top of a box car I could manage men, and immediately took steps towards getting the technical training necessary to fit me for a leading position. What with night schools, correspondence courses, etc., it was a long, hard fight, but now my energy was directed toward a definite goal and I landed. The apprentice who used to lead the noontime indignation meetings now gives that energy to the study of a course in mechanical engineering. He's now foreman of the small tool department, and he is certainly making good. The concern is still called Rip & Co., Ltd., but now we rip into the work instead of into each other and the balance sheets show twice the profits that they did under 'Old Man Rip's' management.

"A man who's a fighter generally is so because he has energy plus and doesn't know what to do with it. Give me a man like that, with something to direct his energy into proper channels, and I'll bank on his amounting to something."

INTERMEDIATE SUPPORTS FOR LONG SHAFTS

CONSIDERATIONS GOVERNING THE PRACTICAL METHODS OF DESIGN

BY W. G. DUNKLEY[*]

The increased speed at which machine tools are now being operated, makes the question of providing intermediate supports for long shafts a matter of much greater importance than was formerly the case. If a shaft is deflected when running at a high speed, the action of centrifugal force tends to throw it still further out of alignment. In addition to causing vibration in the shaft, it is obvious that such a state of affairs exerts a very detrimental action upon the end bearings, having a tendency to wear them somewhat conical. The deflection of a shaft under such conditions may be determined by the same method as that employed for continuous beams where the load is uniformly distributed. The load in this case will be the weight of the shaft, and the supports will be the bearings at each end. Denoting the total weight of the shaft in pounds as W, the modulus of elasticity by $E = 29{,}000{,}000$ pounds, and the length between bearings as L, we have the deflection d given by the formula:

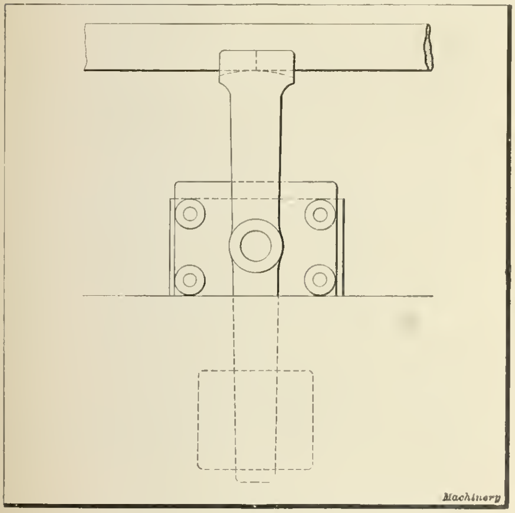


Fig. 1. Swing Bearing for Intermediate Support on Long Shafts

$$d = \frac{5\,W\,L^3}{384\,E\,I}.$$

Taking the case of a shaft 4 inches in diameter which is supported by two bearings 24 feet 2 inches apart; $W = 1008$ pounds, $L = 24$ feet 2 inches, $= 290$ inches, and $I = \frac{\pi D^4}{64} = 12.57$, and $E = 29{,}000{,}000$ pounds as previously given.

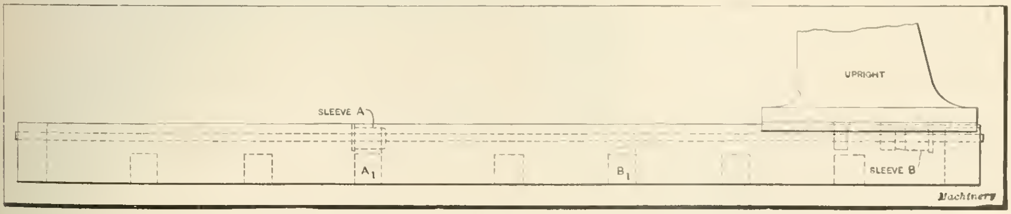


Fig. 2. Adjustable Bearing for Intermediate Support of Horizontal Boring-mill Driving Screw

$$d = \frac{5 \times 1008 \times 290^3}{384 \times 29{,}000{,}000 \times 12.57} = \tfrac{7}{8} \text{ inch (approximately).}$$

For the same condition, but with a shaft 3 inches in diameter, instead of 4 inches, the deflection would be about 1½ inch; it is thus clear that the deflection of a shaft due to its own weight is considerable in some cases, and it is important to realize the advantage that is gained by the introduction of a central bearing support. The relation of the deflection of a shaft where a central bearing is used, to that of a shaft that is merely carried by the end bearings, is determined as shown below.

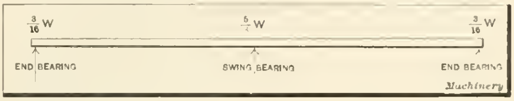


Fig. 3. Distribution of the Weight of a Shaft carried by Three Bearings

$$\frac{\text{Deflection of shaft supported at ends}}{\text{Deflection when supported at center and ends}} = \frac{\dfrac{5\,W\,L^3}{384\,E\,I}}{\dfrac{5\left(\dfrac{W}{2}\right)\left(\dfrac{L}{2}\right)^3}{384\,E\,I}} = \frac{5\,W\,L^3}{5\left(\dfrac{W}{2}\right)\left(\dfrac{L^3}{8}\right)} = 16$$

from which it will be seen that the introduction of a center bearing support reduces the deflection to 1/16 of its value where no central bearing is used.

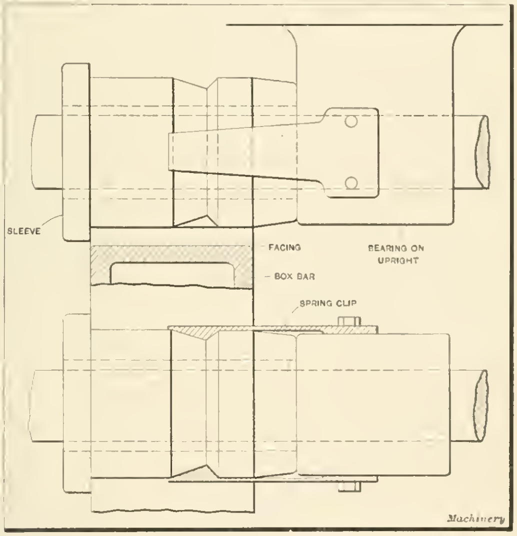


Fig. 4. Spring Clips for returning Bearings to Box Bars

In many classes of service it is impossible to have a fixed central bearing, owing to the necessity of sliding a wheel along the shaft. This means either that the provision of a central bearing must be neglected, or that some form of removable bearing must be used. Fig. 1 shows a very simple type of bearing that is sometimes used; this bearing has proved unsatisfactory for several reasons that will be better understood by referring to Fig. 3. This illustration shows the distribution of the load on a shaft supported by three equally spaced bearings. If the total weight of the shaft is *W*, the central bearing carries ⅝ of this weight, while the load carried by each of the end bearings is 3/16 of the weight. In the type of swing bearing shown in Fig. 1, it is evident that the provision of means for swinging the bearing greatly reduces its efficiency, as the length of the bearing has been reduced to practically a single line, thus providing virtually no bearing surface at the point where the load is greatest.

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[*] Address: 25 Rothwell St., Manchester, England.

This discussion will probably place the practice of using central bearings of this type in a somewhat new light. It is obviously desirable to provide a central bearing which has a greater bearing surface than in the preceding case. There are numerous removable bearings that provide more surface for the shaft to run on than the type shown in Fig. 1. Among these, the type shown in Fig. 4 is simple, cheap and effective. It is illustrated in Fig. 2 in use on the driving screw of a horizontal boring and milling machine. The screw in this case does not revolve, but this type of bearing is equally applicable for use on a rotary screw or shaft. It will be seen from Fig. 4 that the bearing consists of a cylindrical sleeve on the screw, which rests on a facing on one of the box bars in the bed, thus providing a rigid support and ample bearing surface for the screw. When the upright is moving along the bed, the bearing is pushed off the box bar by the bearing on the upright, thus carrying the sleeve along the screw. When the upright reverses, the sleeve is drawn back by means of two spring clips which are fastened to the bearing as shown in Fig. 4, and which engage in a V-groove in the sleeve. When the sleeve is brought back to its supporting box bar, the flange on the sleeve prevents it from going any further; the spring clips are then drawn out of the V-groove as the upright proceeds. The front of the sleeve is slightly tapered to insure its being drawn up onto the facing before the spring clip is disengaged. It will be seen in Fig. 2 that there are two sleeves, *A* and *B*. Before the upright pushes sleeve *A* off its facing A_1, sleeve *B* has been brought back into position on its facing B_1, as previously described. Consequently there is always an intermediate support for the screw, regardless of the position of the upright. These sleeves are made of cast iron and give the best results if they are bronze-bushed, when intended for use on rotating shafts.

In some cases the engagement secured by the spring clips is not positive enough, and for such classes of service a latch of the design shown in Fig. 5 is substituted. This type of latch is mounted on a pivot carried by the upright; at one end of this pivot there is a lever *B*, and when the sleeve is pulled back into position on the facing, the catch is released by the action of this lever, which runs up an inclined surface placed on the inside of the bed. When the catch has left the sleeve, it is prevented from falling by means of a stop, which comes into engagement with the under side of the upright.

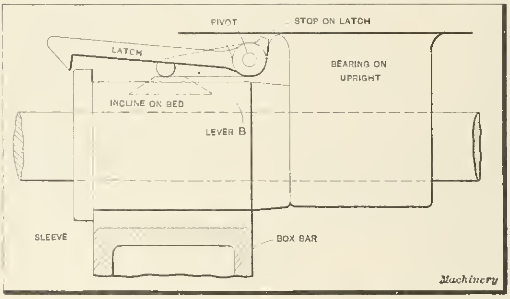

Fig. 5. Latch Mechanism for returning Bearings to Box Bar

The objectionable feature of this type of bearing is that it does not give any side support to the shaft, except that which is due to the friction between the sleeve and the facing upon which it rests. In many classes of service this is insufficient, and, in this case, the side thrust of the screw should be taken up between bearings on the upright. The end bearings are relied upon to carry a considerable amount of the side thrust on the shaft, and they should be made fairly long in order to retain the alignment of the shaft in a sidewise direction. In cases where swing bearings of the type shown in Fig. 1 are used to provide a central support for the shaft, it is necessary to have a pit in the foundation to provide clearance for the counterweight. This is unnecessary in the case of the type of bearing shown in Fig. 2, and makes it possible to apply bearings of this design in many cases where it would be out of the question to use a pit for the counterweight on the swing bearing.

In cases where bearings of the type shown in Fig. 2 are to be used for a rotating shaft, the sleeve remains stationary on its facing. If the pressure on the shaft is denoted by *P*, the pressure between the sleeve and facing will also be *P*. This will produce a frictional force between the shaft and sleeve which tends to rotate the sleeve, but there will be the same amount of frictional resistance due to the pressure between the sleeve and facing which tends to prevent the sleeve from rotating. These conditions are illustrated diagrammatically in Fig. 6, where it will be seen that the turning moment about the center of the shaft tending to rotate the sleeve, is UPR_1, while the moment of the frictional force resisting rotation is UPR. Since R is greater than R_1, the moment of the resisting force is greater than that of the rotating force, and as a result the sleeve will remain stationary on the facing. This is a point of importance, because if the sleeve were permitted to rotate on the facing, there might be a tendency for it to work out of place. In cases where spring clips are used to draw the sleeves back into place, the side of the vee on the clip that engages the sleeve has a much more gradual taper than the side which holds it in position on the return stroke. The reason for this is that the spring clips have to run up on the sleeve, and if the springs are fairly strong, it would be difficult for them to do so if an abrupt taper angle were used.

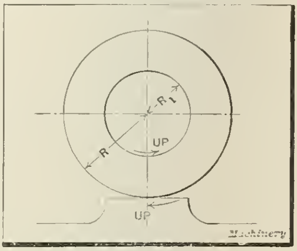

Fig. 6. Rotating and Retarding Moments on Sleeve

* * *

Recently analyses of cast, rolled and forged monel metal have been made at the laboratory of the Board of Water Supply, New York City. For such a material as monel metal, which is not a pure alloy, the feature of these analyses is the remarkable approach to uniformity in composition. If compared with the early published analyses, it would appear that the manufacturers have perfected the methods of reduction from ore and matte to such a degree as nearly to control the proposition. In the present process of manufacture the claim is made that the physical properties of monel metal are not materially affected within the limits of variation in which the constituents occur. A lathe can be run at about the same speed on monel metal as on mild steel, although monel metal is somewhat tougher.

* * *

An example of the perfection to which capable designers have brought wire working machinery, may be found in a machine that has been recently built for making small staples or double pointed tacks. This machine operates on four strands of wire at once, and produces 3000 staples with ½-inch legs per minute. On a run of ten hours, eleven hundred pounds of these double-pointed tacks were made. Of course it may be observed that the actual production speed is but 750 tacks per minute, inasmuch as there are four strands being operated on by four sets of mechanism at once, but even 750 pieces per minute is some speed!

* * *

Successful wireless telephone communication has been established, it is stated, by the Italian naval authorities, between Monte Mario and Becco di Vela, a distance of about 160 miles.

SPIRAL GEAR DESIGN*—2

BY JAMES H. CARVER†

In the December number of MACHINERY, spiral gear design, when the shafts of the gears are at 45 degrees angle, was dealt with. In the present article, and in the accompanying Data Sheet Supplement, the methods used when designing spiral gears with shafts at any angle will be treated. Four cases will be considered:

1. Shafts at any angle, ratio equal, and center distance approximate. 2. Shafts at any angle, ratio equal, and center distance exact. 3. Shafts at any angle, ratio unequal, and center distance approximate. 4. Shafts at any angle, ratio unequal, and center distance exact.

When designing spiral gears with shafts at an angle other than 90 degrees to each other, it is of considerable advantage to draw the outline of one gear on a piece of drawing paper tacked to the board, and the outline of the other on a piece of tracing paper, as indicated in the accompanying engraving, Fig. 20. In this way the gear drawn on the tracing paper can be moved about to the correct angle with relation to the gear beneath, and the conditions of thrust, direction of rotation, and hand of spiral can be more easily determined.

The procedure to be followed in calculating the required dimensions for the four cases mentioned above is given in the accompanying Data Sheet Supplement, in the same manner as in the September and October, 1911, and December, 1912, numbers of MACHINERY. The thrust diagrams, Figs. 2 to 17 in the December number can be used also for the gears at present dealt with. With the shafts at any given angle, the sum of the spiral angles of the two gears must equal the angle between the shafts, and the spiral must be the same hand in both gears, if each spiral angle is less than the shaft angle; but if the spiral angle of one of the gears is greater than the shaft angle, then the *difference* between the spiral angles of the two gears will be equal to the shaft angle, and the gears will be of opposite hand.

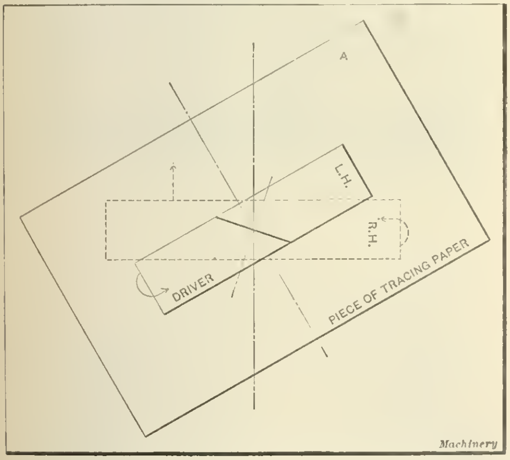

Fig. 20. Method of using Tracing Paper when analyzing Spiral Gear Problems

Detailed explanation of the derivation of the formulas in the accompanying Data Sheet Supplement is unnecessary, as these are arrived at in a manner similar to that referred to in previous numbers of MACHINERY in connection with the articles on spiral gear design. It may be mentioned, however, with relation to Case (3) that the formula for the number of teeth in the smaller gear, in the case when both have the same spiral angles, is found by substituting cos α for cos β in the formula:

$$\frac{2\,C_a\,P_n \cos\alpha \cos\beta}{R \cos\beta + \cos\alpha}$$

from which we get the number of teeth in the pinion:

$$\frac{2\,C_a\,P_n \cos\alpha \cos\alpha}{R \cos\alpha + \cos\alpha} = \frac{C_a\,P_n \cos\alpha}{R + 1}$$

In Case (4) it sometimes happens, after the exact spiral angles α and β, and the corresponding pitch diameters have been determined, that the center distance does not come exactly as required, within a few thousandths inch. Theoretically it would then be necessary to alter the spiral angles found from one-quarter to one-half a minute, in order that the center distance may figure out correctly. However, this refinement is of doubtful practical value, as it would be impossible to set the machine on which the gears are to be cut to such a minute sub-division of a degree.

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* With Data Sheet Supplement.

† Address: 761 Eastern Ave., Schenectady, N. Y.

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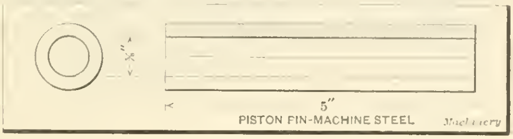
COMPRESSED AIR AS A COOLING MEDIUM FOR DEEP HOLE DRILLING

It is generally recognized that compressed air can be used as a cooling medium for drilling cast iron, but there are few mechanics who would advocate its use for machine steel. It may be interesting, therefore, to record an application of compressed air to deep hole drilling in machine steel, which is being put into use in the plant of the Dayton Motor Car Co., Dayton, Ohio.



Machine Steel Part which is drilled, using Compressed Air as a Cooling Medium

The piece to be drilled, as shown by the accompanying illustration, is a piston pin made from round bar stock containing from 0.20 to 0.30 per cent carbon. This piston pin is machined in a 1¼-inch Cleveland automatic screw machine, which is fitted up with the regular oil feed arrangement for the turret tools, but instead of forcing oil through the piping, compressed air of 75 pounds gage pressure is used.

The drill used is a regular fluted high-speed steel oil-tube drill, ground on the cutting edges so as to break up the chips. A long curling chip would be difficult to remove, as it would twist around the flutes of the drill. The most interesting point about this operation is that the drill is not withdrawn from the work until it has been forced in the desired distance —5 inches—at a steady feed of 0.015 inch per revolution, and a surface speed of about 70 feet per minute. This surface speed is much lower than that which a high-speed steel drill will stand, but it has been found that a heavy feed with a lower surface speed gives the best results, as it produces a chip which is easily blown out.

The chips which are blown out by the compressed air are quite cool and can easily be held in the hand. The hole produced is smooth as compared with that obtained when oil is used as a lubricant. A good grade of lard oil was used on this job before compressed air was tried, but the oil proved unsatisfactory as the drill would bind and heat up before the lubricant reached the bottom of the hole. It seems that the oil made the chips adhere to each other and thus prevented them from being washed out of the hole, while on the other hand the chips are kept clean and cool by the compressed air and are blown out just as soon as they are removed by the drill.

D. T. H.

* * *

According to *System*, the practice of a large engineering concern is to send a note asking the opinion of interested department heads, foremen and even of skilled workmen, before new machinery and supplies are ordered. The result of this practice has been very satisfactory, and often valuable advice has been secured, aiding the purchasing agent in getting the best goods at the right prices. The practice of entirely ignoring those who are to actually use the machinery or the supplies, which is quite common, especially in large industrial plants, certainly does not seem to be good policy.

SOME TOOLS USED BY THE GRAMM MOTOR CAR CO.

A COLLECTION OF JIGS, FIXTURES AND TESTING DEVICES USED IN AUTO TRUCK MANUFACTURE

BY P. STEINER*

The plant of the Gramm Motor Car Co., Lima, Ohio, devoted exclusively to the manufacture of the heavier types of commercial cars or trucks, is a good example of the up-to-date shop, in both buildings and equipment of machinery and tools. A few of the special tools and fixtures used by this company will, therefore, probably be of interest to MACHINERY'S readers.

Reaming Fixture for Crank- and Cam-shaft Bearings

Fig. 1 shows the crankshaft and camshaft bearing reaming fixture. The point of interest in this tool lies in the fact that the three crankshaft bearings, which are of the same diameter, are reamed simultaneously. The reaming bar *A*, shown in position in the fixture, has three reamers *B* separated and spaced from each other by collars, which bring the reamer into the proper position relative to the bearings in the crankcase. These reamers and collars are clamped in position by a nut on the end of the bar.

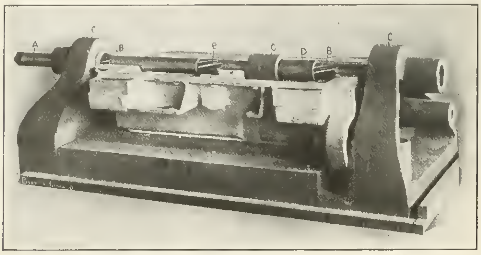


Fig. 1. Fixture for reaming Crank- and Cam-shaft Bearings

In operation, the crankcase is slipped onto the fixture and held in place by suitably arranged clamps, which are not shown. The reamer bar is supported in the fixture by collars or bushings which are a free fit in the bushed holes of the three brackets *C*. One of these collars is shown on the bar outside of the bearing or bracket at *D*. The bar, or rather the collars on the bar, are of the same size as the reamers, excepting the one ahead of each reamer; these collars are relieved sufficiently to clear the bearings when they are not yet reamed. Before the bar is placed in the fixture, the slip bushings are removed from their bearings, and the bar is then placed so that the relieved portions are at each of the bearings. The bearing caps are next fastened over each bearing, the caps having been omitted in the illustration for the sake of clearness. Then the bushings are slipped into place; this locates the bar properly and the bearings are then reamed simultaneously.

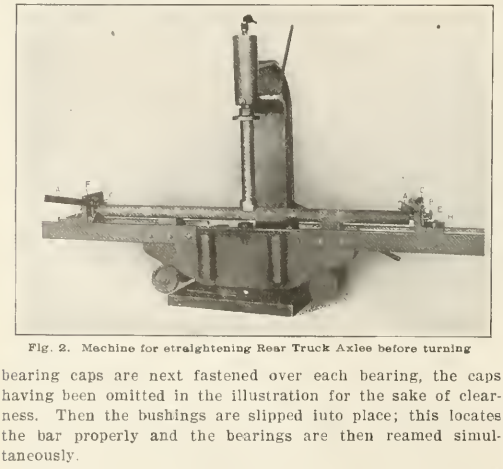


Fig. 2. Machine for straightening Rear Truck Axles before turning

The camshaft bearings are reamed with a bar having a reamer on the end and, of course, only one bearing can be reamed with it at a time. After reaming one bearing, the bar has to be pushed ahead for the next bearing, and so on until the job is finished.

Centers for the Straightening Press

By the combination of a hydraulic press with part of a screw-press and attachments, as shown in Fig. 2, the work of straightening the rear axles of the trucks before turning them on the lathe—otherwise a laborious job—has been greatly facilitated. Interest, of course, centers on the attachment designed by Mr. Adams, tool-room foreman of the company, which consists of a pair of centers and means for rotating the shafts on them. The two handles *A* fulcrumed on each head, move the sliding blocks *B* up and down. These blocks slide in guides in the body *C* of the heads and carry the adjustable centers *D* which have a horizontal movement controlled by the knurled head of the screw *E*. A series of holes are arranged on each head in an arc as shown at *F*, and holes of similar size in each handle allow a sliding pin *G* to be used to lock the handle in position. With the shaft lying on the V-blocks, it is possible with these heads to lower the centers to the shaft by means of the handles *A*, instead of resorting to the usual method of bringing the shaft to the centers and then adjusting the centers. The shaft is easily lifted from the V-blocks and held that way by inserting the pins *G*, and the shaft is then ready for spinning to determine its trueness. The different holes in the heads are provided to accommodate the different sized shafts; the heads are also adjustable lengthwise to accommodate different length shafts. In case the axle needs straightening close to one end, the head is easily slipped off by loosening the two screws *H* which relieve a clamp.

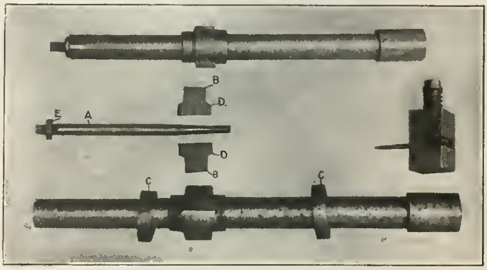


Fig. 3. A Useful Type of Adjustable Boring Bar. Small View of Shearing Device, Fig. 4, shown to the Right

Adjustable Boring Bar

Fig. 3 illustrates an adjustable boring bar which is shown both assembled and in detail. The idea is almost self-explanatory. The pin *A*, which is tapered at one end and threaded at the other, forms a seat at the tapered portion for the cutters *B* which have a corresponding taper. The cutters are locked onto their seat by the two internally threaded collars *C*, which also have tapers on the inside that engage the taper *D* on the cutters, thus forcing them securely onto their seat. To adjust the cutters, the two collars are backed away; this allows adjustment to be made by means of the tapered pin. The threaded section at the front of this pin engages a corresponding thread on the inside of the bar, and when the pin is turned, it either expands or contracts the cutters on account of the engagement with their tapered surfaces. The pin is locked in position by the jam nut *E*.

Pin Shearing Device

The device shown in Fig. 4 is used for shearing a variety of pins. It will be observed that its capacity is limited to three different diameters, and any length within the range of the gage or stop which is adjustable. The scheme, no doubt, is clearly illustrated by the sketch and needs no further explanation. This fixture is used under a small arbor-press and it is surprising the number of pins which can be sheared in a short length of time.

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*Address: 802 S. McDonald St., Lima, Ohio.

Drilling Jigs for Front Axles

Fig. 5 shows a jig for drilling, reaming and tapping the holes for the steering knuckle bolts in the front axle. This jig was designed and built to be adjustable so that it would accommodate all the different sized axles and handle variations in the dimensions *A* and *B* shown in Fig. 6. The surfaces *C*, *D*, *E* and *F* are first milled and then the axles are ready for drilling, reaming and tapping. The axle is placed in the jig, and the bosses of the axle are then centered up and brought into correct relative position with the holes in the jig by means of the sliding V-plates *A*, which are adjustable in and out by the star wheel *B*. The brackets *C* are adjustable up and down, being fitted with tongues which slide in grooves *D*, thus keeping the upper and lower holes in line with each other. They are securely clamped to the columns *E* by the two bolts *F*. The adjustment of these brackets takes care of the dimension *B* in Fig. 6. It will be evident that the holes *G* in the jig locate the holes *G* in the axle, and that the holes *H* locate the holes *H* on the axle. The column to the left is shown without the top bracket in order to illustrate the sliding V-plate more clearly. When the axle is in place and secured by a suitably arranged clamp, the jig is set under the drill press spindle; the holes in one column are then lined up with it, when the axle is ready to be drilled. After that end of the axle has been drilled, the other column is brought around to the same position by means of the swiveling plate *I*, to which both columns are secured by bolts and locating pins. The swiveling plate swings around the central stud *K* which is carried by the sub-plate *J*. The sub-plate remains in one fixed position during the drilling operation. The swivel plate is located in position by the dowel pin *L* which is shown withdrawn from its place. The columns are adjustable on the swivel plate along the tongue groove *M*; they are located in their relative positions for different axles by dowel pins and secured to the plate by the bolts. This adjustment takes care of the dimension *A* of Fig. 6. The brackets containing the bushings are fitted with lining bushings, and are large enough to include all the different sized bushings with the same set of brackets.

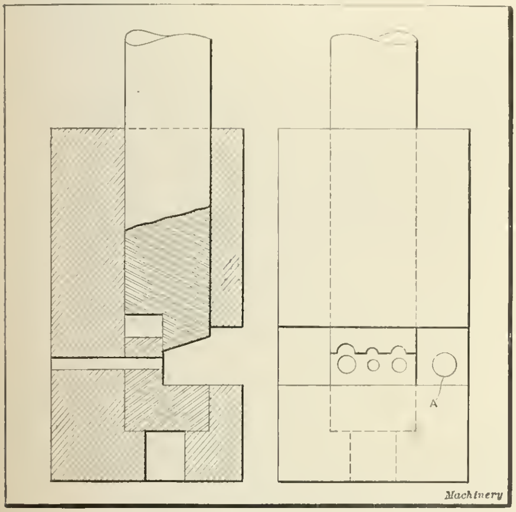

Fig. 4. Device used for shearing off Pins of Standard Length

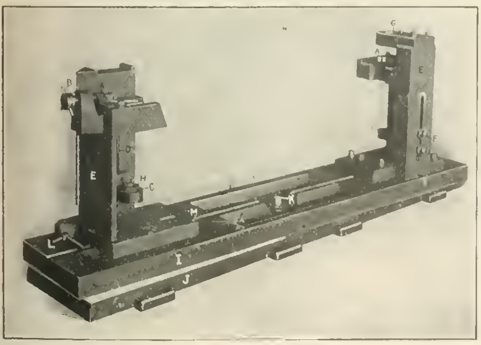

Fig. 5. Adjustable Jig for drilling Holes in Axles of Different Dimensions

Precision Gear Tester

In Fig. 7 is shown a precision gear tester that was built by this company's toolmakers and certainly is an example of exquisite workmanship. The following points on gears are determined: Pitch diameter, trueness of pitch diameter with hole, thickness of teeth on the pitch line, and parallelism of teeth with axis of gear.

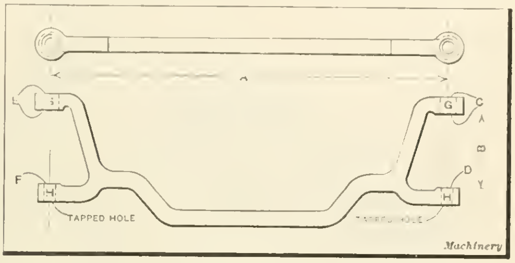

Fig. 6. Axle drilled, reamed and tapped in Jig shown in Fig. 5

The revolving stud *A* is mounted in a fixed position and forms a basis from which the principal dimensions are checked. The removable plug *B*, which is located in the sliding block *C* that slides in the ways *D*, is located in its relative position to stud *A* by the locating pin *E*. It will be noticed that the blocks *C* and *F* are connected by two bolts, only one being visible in the illustration. One end of the bolts is screwed into the block *C* while the other end is a free fit in the block *F*. The heads of these bolts are countersunk. The blocks are normally separated by two springs on the two bolts, the function of which will be explained later.

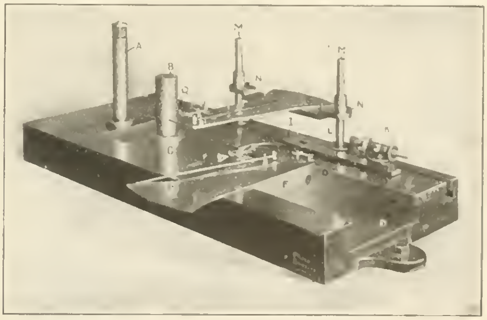

Fig. 7. Device for testing Pitch Diameter, Concentricity of Bearing, Tooth Thickness at Pitch Line, and Parallelism of Teeth with Gear Axle

The indicating mechanism *G* is located in its relative position to plug *B* by the vernier *H*. The scale of the vernier is fastened to the block *C* while the vernier is fastened to the part *I* making it integral with the indicating mechanism. The vernier and indicating mechanism are adjusted by the two nuts *K*. The part *J* is secured in the T-slot by the nut directly below it and is adjustable along the slot, which extends the full length of the fixture. The indicating mechanism and vernier are locked by the two nuts *L*; the indicating mechanism is adjustable, vertically, on the two pillars *M* and secured to them by the two thumb-screws *N*.

In operation, a master gear is placed on the driving stud *A* and the gear to be tested on the plug *B*, where it is free to revolve on the plug. The locating pin *E* is then inserted in the proper hole along the edge of the gib *O*, thus locking the block *F* securely and locating the two blocks in their proper relative positions. The gear being in place, it is now revolved by the master gear, which is turned by a handle on the squared end of the stud. It will then show whether or not the gear teeth are concentric with the hole; the correct pitch diameter will also be indicated. The pin *E* locks the block *F* to the gib *O*, while the block *C* is free to move within certain limits. This movement is indicated by the multiplying levers and is shown on the graduated dial *P*. In case the size of the gear varies, or if it is out of round, it will cause the block *C* to slide back and forth against the tension of the springs already mentioned, thus imparting movement to the multiplying lever. The scheme of the levers, no doubt, is clear without further explanation. The removable gage *Q*, for measuring the thickness of the teeth, is held against them by spring tension; any variation will then be shown upon the dial by means of the multiplying lever. For testing the parallelism of the teeth and axis, the mechanism is slid up or down along the pillars *M*. It is to be remarked that the indicating needles are at zero in the center of the dial, at the original setting, and will then indicate above or below normal size.

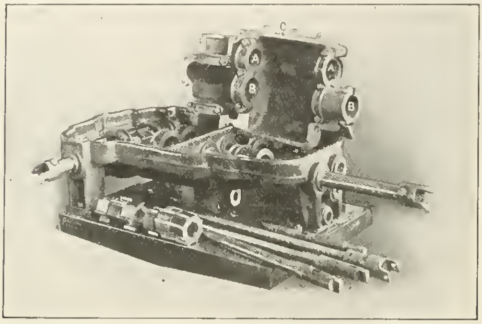

Fig. 8. Jig used for boring and tapping Bearings in the Transmission Case

Transmission Case Boring and Tapping Jig

Fig. 8 shows the jig for boring and tapping the transmission case. A case is shown in the jig and also one on top of it, in which the holes that are bored and tapped are shown more clearly. The two sets of parallel holes *A* and *B* carry the two shafts upon which the gears are mounted. To the left of, and at right angles to these holes, there are two tapped holes which carry the jack shafts and differential gear. The cases are first surfaced at the joint *C*; they are then drilled and tapped on the drill press, to receive the clamping bolts which secure the cover onto the case. The case is held in the jig by bolts which screw into these tapped holes. The jig is mounted on the rotary table of a horizontal boring mill, which allows the jig to be swung around. The bars are driven by means of a universal joint. Ample lubricant is used during the boring and tapping operations, and in order to prevent the lubricant from running onto the machine and floor, a tin pan is placed under the jig where all surplus oil is caught and conveyed back to the pump tank. The styles of cutters and taps used in these operations are shown in the illustration.

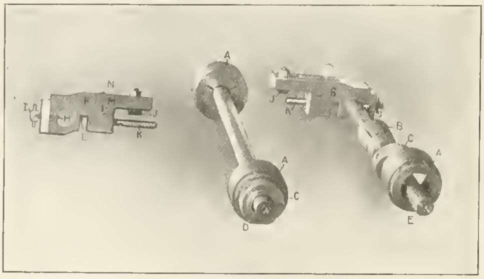

Fig. 9. Method of gaging Accuracy of the Position of Transmission Case Bearings

Gages for Transmission Case

The gages shown in Fig. 9 are for testing the center distances of the two sets of holes *A* and *B* of Fig. 8, and will also show if their axes are in the same plane. These gages are adjustable, which adapts them for all the different sized cases. The gaging is accomplished by having two shafts in the threaded holes and gaging between them, in the manner that will now be described.

The exterior threaded sleeves *A* are an accurate fit in the tapped holes *A* and *B* of Fig. 8. The inside of these sleeves is finished tapering, and the collapsible sleeves *B* fit into this taper. One end of the sleeves *B* is threaded for the nuts *C* which draw them into the tapered holes, thus clamping them snug on the shafts *D* and *E*. The gages *F* and *G* are mounted on the same shaft, which is splined to receive the key *H*. This key is seated firmly in the spline by means of the screw *I*. The key locates the gaging points *J* in the same plane with respect to the center of the shaft; these points are adjustable in and out from the center. The gaging points *K* are removable and when in place, they are in contact with the point *L*. The points *K* are held in place by the screws *N* which force a sliding piece into the notched place on *K* forcing it against *L*. To remove the point *K*, the screw is loosened and the sliding piece raised by means of the pin *M*. The gaging points are made in different lengths to accommodate all the different sized cases.

In use, the two shafts are held in place in the holes *A* and *B* of Fig. 8 by the threaded sleeves, the gages being mounted on the splined shaft, as already explained. Any deviation in the center distances will then be shown up on the points, which rest on top of the shaft and against it. For instance, if the shafts are not parallel or if they are spaced too far or close, the error will be indicated by the points. In case the centers are not in the same plane, the points will indicate this in that only one of them rests on the shaft. Feelers are used to note the discrepancy.

A noteworthy feature in the drill press department is the method of supplying lubricant to the drill presses. At each of the machines, there is a pipe supplying the lubricant which is fed from an overhead tank. A receptacle under each machine gathers the used lubricant, which is then emptied in a screen covered tank from which it is forced up by means of a power pump to the overhead tank.

* * *

At the fourth international aeroplane exhibition, held in Paris during the latter part of October and the early part of November, twenty-eight principal makers of aeroplanes exhibited their products. In addition, there were a number of engines exhibited and a great many stands where accessories were featured. The most vivid impression created by a visit to the exhibition was that the aeroplane has passed the early experimental stages and that present developments are directed wholly into two channels—the aeroplane for military purposes and that for racing. The hydro-aeroplane aroused considerable interest, it being the first time at which the hydro-aeroplane had taken an important position at an exhibition. The past year has witnessed some important progress in motors, in respect to increased power in relation to weight, simplicity of construction, ease of control and facility of starting. The Gnome motor, in which the cylinders radiate from the central shaft, appears to retain its well-earned prominence, and probably three-fifths of all the aeroplanes on exhibition were equipped with this type of motor.

* * *

In the *Zeitschrift für Elektrochemie* the results of a number of experiments relating to the protection of iron against rust by means of paint are recorded. It is pointed out that the idea that several coats of paint protect iron from rusting better than one is fallacious. In the experiments undertaken, iron with two coats of paint was found to be partly rusted, that with three coats more so, and iron with four coats of paint was entirely covered with rust, while iron with but one coat of paint appeared unaffected. The author believes that the application of several coats of paint increases the number of local electric currents at the surface of the iron and hence gives rise to a greater amount of corrosion than would be possible with a single coat of paint.

MODEL-ROOM TOOLS AND METHODS

BY FRANK B. LUCAS*

It is not generally recognized how much work is put into the development of the original models of many common forms of mechanism. In work of this kind a great number of minor improvements are made before the device is brought to a final stage of perfection, and each of these changes generally involves the production of an entirely new model.

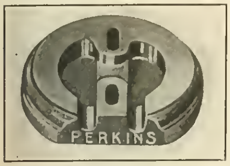

Fig. 1. Model for Frame of an Electric Switch

A good example of this kind is shown in the model for the base of an electrical switch which is illustrated in Fig. 1. This switch was in an experimental stage for about two months, and during most of that time two men were constantly engaged in making model after model, each of which was rejected in favor of some improved idea which was incorporated in the succeeding design. The work of making so many models, with only minor changes in the design of each, is frequently rather trying to the model-maker who has practically nothing to do with the designing department and naturally becomes tired of working constantly along the same line. But the model-maker's work is not entirely of this nature. He employs a number of very interesting tools and methods, and in the present article the writer intends to outline some of the tools and methods used in making the model of the switch base shown in Fig. 1.

The base of this switch is made of porcelain, but this is a very brittle substance and cannot be worked to advantage; consequently some other form of non-conductor, which is more easily worked, was used. Hard rubber and box-wood were tried for this purpose; the latter was found to be more suitable, not only from an economical standpoint but also from the ease with which it can be worked. Box-wood has one bad feature, however, which is its tendency to check or warp. The difficulty experienced through shrinking can be entirely overcome by using kiln-dried stock which has been cut up into strips and allowed to stand in this condition for a period of six months. Immersing the pieces of box-wood, which have been cut roughly to the required size, in boiling paraffine for about fifteen minutes also preserves the wood and helps wonderfully when polishing the finished model.

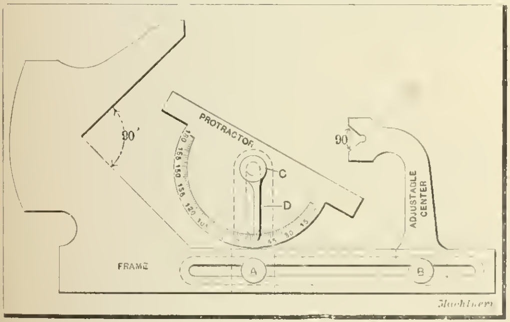

Fig. 2. Adjustable Protractor with Centers to hold Work

The difficulty experienced with warping or shrinking is greatly reduced by the use of kiln dried stock. A better method of avoiding this difficulty is to glue the stock together in strips of from ¼ inch to ⅝ inch thick according to the size of the model, and then turn the work endwise of the grain. This does away with the danger of the work changing shape and thus losing the accuracy with which it has been made. The end grain of box-wood can be very nicely polished by using yellow shellac and linseed oil on a piece of waste or cheese-cloth. This treatment made an excellent surface for laying out the slots and holes that were required.

The model for this switch had to be made with slots for the wire, means for holding the parts of the switch together, anchors for the insulation, and holes for the screws that hold the switch on the wall. All of these different elements must be accurately spaced in accordance with the drawing from which the model-maker is working.

Two very handy tools for laying out work of this kind are shown in Figs. 2 and 3. Fig. 2 consists of a frame with a large 90-degree center head at one end and a small movable center head at the other. A sliding arm works between these two centers and carries a protractor, the position of which is adjustable in two directions. The protractor pivots about the pin *A* and can be set to lay off any desired angle on the work. These angles are indicated by the fixed finger *D* under which the scale rotates. The protractor and the adjustable center are secured in any desired position on the frame by means of knurled thumb-screws *A*, *B* and *C*. Fig. 3 might well be described as a movable center square. It consists of a small T-square with a shoulder which slides on the center square as shown. When the blade of the T-square is at the center of the 90-degree angle, the zeros on both the center head and the T-square head coincide. The T-square head has 1 inch laid off on it in thirty-seconds, and by adjusting the tool, the blade of the T-square can be set to scribe a line at any required fraction of an inch off center. When the tool has been brought to the desired adjustment, the parts are held in position by means of the knurled thumb-screw shown in the illustration. The blade of the T-square is slotted to receive the protractor from the tool shown in the preceding illustration. It can thus be used for laying off angles, and is a very useful tool for any mechanic's kit.

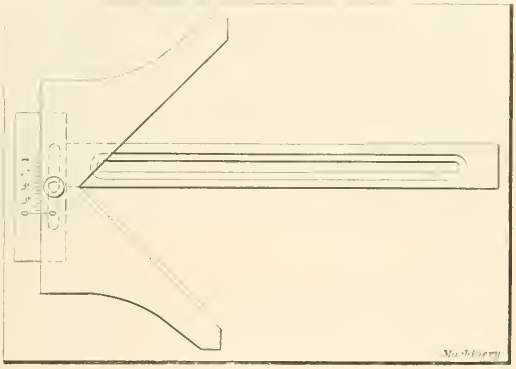

Fig. 3. An Adjustable Center Square

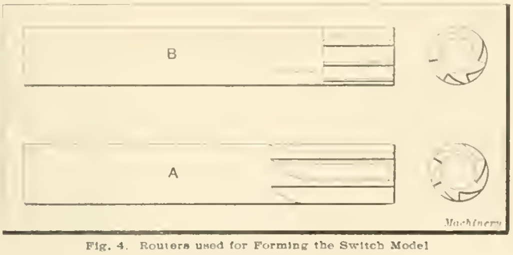

Fig. 4. Routers used for Forming the Switch Model

Another good device for use in model making, and one which could also be applied on a larger scale in pattern shops, consists of a set of three iron faceplates which differ from the ordinary lathe faceplates in that they are turned with a solid ½-inch projection in the center of each plate. In making the box-wood bases for the electrical switch models, a ½-inch hole was counterbored in the block of wood and it was then held on the faceplate by means of two small screws. This made it possible for the model to be taken off the faceplate at any time that it was required to lay out and drill holes or to mill wire slots. It could then be rechucked in exactly the same position which it formerly occupied, and there was no danger of marring the sides of the model as there would have been if it was held in an ordinary chuck. After the model was completed, the counterbored hole could easily be filled in.

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The routers shown in Fig. 4 were used for forming the hollow in the switch model. The shape of these models is so irregular that it would be difficult to work them out in any other way than by routing in a drill press. The two types of cutters shown in Fig. 4 are particularly well adapted for this operation. The cutter *A* is first set to work out the outline to a depth equal to the cutting edge of the tool, which is approximately 3/16 inch. The cutter *B* is then placed in the drill chuck and set 3/16 inch below the first cut. The shoulder or shank of this cutter prevents the teeth from cutting into the outline made in the preceding operation. It is thus possible to finish the work very rapidly without any danger of spoiling the model. The cutter *A* is slotted for six teeth and the end is slightly concaved so that it can be forced down into the wood. The cutter *B* is slotted and turned down, leaving a small projection. A piece of drill rod of the correct size has a hole drilled in its end, of the same size as the projection on the cutter and the cutter is then fastened on the drill rod as shown by the dotted lines in Fig. 4.

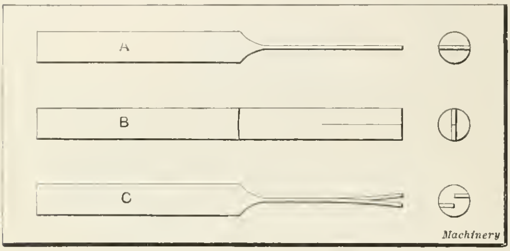

Fig. 5. A Useful Screw-driver for Model Makers

A convenient form of screw-driver for holding small screws in places where lack of space prevents using one's fingers is illustrated in Fig. 5. A piece of 1/4-inch or 3/16-inch drill rod is milled down to a thickness of 1/32 inch. The thin section is then sheared as shown at *B* and the two sections of the blade sprung apart as at *C*. The blade is then oil-tempered. In using this screw-driver, the two sections of the blade are pressed together and slipped into the slot of the screw head. The tension is then sufficient to enable the screw to be held and entered into the hole in which it is to be driven.

* * *

THE EVOLUTION OF GOLD DREDGING MACHINERY

BY A. H. MARTIN[*]

The development of the gold dredge and its equipment extends over a period of about fifteen years. In March, 1898, the first California gold-boat was commissioned, but the evolution of gold dredge machinery properly commenced in 1901, when the Indiana Dredging & Mining Co. originated the type of bucket-elevator dredge used in California today. This type is generally deemed standard throughout the world, and earlier designs in other fields have been gradually displaced by the California model. In the brief space of eleven years the dredge has grown from a small unwieldy device of questionable merit into a mammoth, easily handled, successful apparatus.

The first of the early dredges were small affairs equipped with three-cubic-foot buckets. About seventy-five or eighty buckets were carried by the bucket line; they were able to excavate to a depth of 35 feet below the water level. The digging ladder, formed of plate-girder steel, averaged 78 feet between centers and was driven by a fifty horsepower motor. The buckets were of ordinary steel and their rapid wear constituted an important item of expense. The stacker was a Robins belt conveyor, about 86 feet long between centers, carrying a 28-inch belt, and driven by a twenty-horsepower motor. The wooden hull had a length of 86 feet and width of 35 feet. Five electric motors, varying in size from twenty to fifty horsepower were used on most of the boats.

In the latest gold dredges steel hulls have replaced those of pine and spruce, and the size and power of the machinery have made remarkable advances. The latest models have hulls 150 feet long by 58 feet wide, and weigh over 600 tons. The digging ladder is of plate-girder construction and weighs 105 tons, exclusive of ladder rollers and attachments. The upper tumbler weighs nearly 18 tons and is a solid high-carbon casting. The hollow-bored, forged, nickel-steel shaft has a length of 14 feet 11 inches with a diameter of 25 inches at the center. The cushion plates are chrome-nickel steel. The lower tumbler is made from a single high-carbon steel casting, weighing, with the shaft, 12½ tons. The shaft is of similar construction to that of the upper tumbler, and is 7 feet 8 inches long, with a diameter of 15¼ inches. The buckets number 90, arranged in a close-connected line, each bucket having a capacity of 15 cubic feet. Each bucket is composed of three sections—bottom, lip and hood. The bottom is made from high-carbon steel, with a plate of manganese steel inserted in a recess under the back eye to assist in bearing the strain. The lip is of manganese steel, 13 inches wide and 2¼ inches thick at the cutting edge. It is this portion of the bucket which bites into the gravel bank and which must stand the excessive wear. The hood is formed of half-inch steel plate, pressed into shape. The complete bucket has an approximate weight of 3700 pounds. The 90 bucket-pins are each 33 inches long and composed of high-carbon steel. These weigh about 445 pounds each. The 184 bucket bushings are manganese steel. The 17 ladder rollers are 16 inches in diameter. Rollers and bearings weigh over 26 tons. The total weight of digging ladder, bucket line, tumblers and ladder rollers is over 350 tons. The main drive weighs 30 tons additional.

The stacker ladder is of latticed-girder design, 142 feet long, and built of steel plates and angles. It supports the conveyor belt, employed to carry and stack the tailings beyond the stern of the dredge; with idlers and bearings it weighs 20 tons. The single-friction roller type screen drive mechanism weighs 13 tons. The main hopper, formed of half-inch plate steel, with the discharge spout lined with heavy manganese steel, weighs about 8½ tons. This receives the gravel from the buckets and feeds it to the revolving screen. The latter is about 50 feet long and 9 feet in diameter, lined with ⅝-inch high-carbon steel plates. It weighs 56 tons. The two spuds are built of steel plates and angles. Each has a length of 70 feet with dimensions of 38 by 60 inches, and represent a weight of 45 tons. The steel spud point, used in moving the dredge ahead, weighs about 10½ tons. The ladder suspension tackle is of double type, made exceedingly large and strong to enable one line to bear the strain, should the other break. The total weight approximates 60 tons. The ladder hoist winch weighs 33½ tons and is mounted on a cast-iron base. It consists of double drum, gears, shafts, bearings and clutches. The swinging winch, comprising eight drums, bearings and clutches, mounted on cast iron, weighs 17 tons. The stacker hoist winch weighs 3700 pounds and is mounted on a rigid cast-iron sub-base. It is operated by means of a set of worm gearing. The worm is made of steel and the worm-wheel of bronze. Four pumps, three centrifugal and one monitor, are employed, the combined weight, with piping, approximating 21 tons. The centrifugal pumps range in capacity from the No. 6 with 700 gallons capacity per minute, to the two No. 14, having capacities of 5500 gallons of water per minute. The machinery is driven by nine motors, developing a total of 1072 horsepower. The first California dredge had operative machinery capable of developing 63 horsepower. With the exception of the pump motors, the electrical machines are of the variable-speed type, and range in power from 30 horsepower for the winch to 400 for the main drive. Current of 2000 volts is used. The total weight of motors and transformers aggregates 37½ tons. The latest dredges have a theoretical capacity of 650 cubic yards per hour, excavating 55 feet below water level.

The Bucyrus Co., of South Milwaukee, Wis., was the first firm to undertake the manufacture of new model machinery for the original type of California dredge, after other concerns had declined to meet the requirements of O. B. Perry, D. P. Cameron and F. W. Griffin, the engineers for the Indiana Co.

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[*] Address: Redding, Cal.

Today Bucyrus machinery is largely used on the California boats.

As the profitable working of dredging ground depends largely on the quantity and value of the ground handled, the capacity of the buckets has been constantly increased. As mentioned, the modern bucket-elevator dredge has a theoretical digging capacity of approximately 650 cubic yards per hour, or 15,600 cubic yards per day, but this performance is possible only with easily worked ground; where difficult deposits are handled, 500 cubic yards per hour, or 12,000 cubic yards per day, are considered a good average record. Naturally, the depth and structure of the deposit largely influences the results, but 12,000 cubic yards constitutes a fair day's work.

The value of dredging ground is influenced by its gold content, nature of bed-rock, and ease with which it may be worked. A deposit may contain considerable gold and yet prove unprofitable because of limited extent, uneven bed-rock, or excessively compact gravel. With the larger dredges operating under fairly favorable conditions, the material is handled at about two cents per cubic yard. At times, even lower working costs have been reported, but two to three cents is considered a most favorable figure. The smaller the dredge, the less gravel is handled, and the cost per cubic yard increases. Ground running from ten cents per cubic yard and up is considered worthy of attention, provided it is of sufficient extent, and of favorable structure. Only a very small amount of the free gold is lost in dredging, but when gravel of low gold value is handled, it is evident that a vast yardage must be treated at a minimum expense to provide profits. Favorable ground testing from ten to thirty cents per cubic yard is usually deemed a most satisfactory dredging proposition.

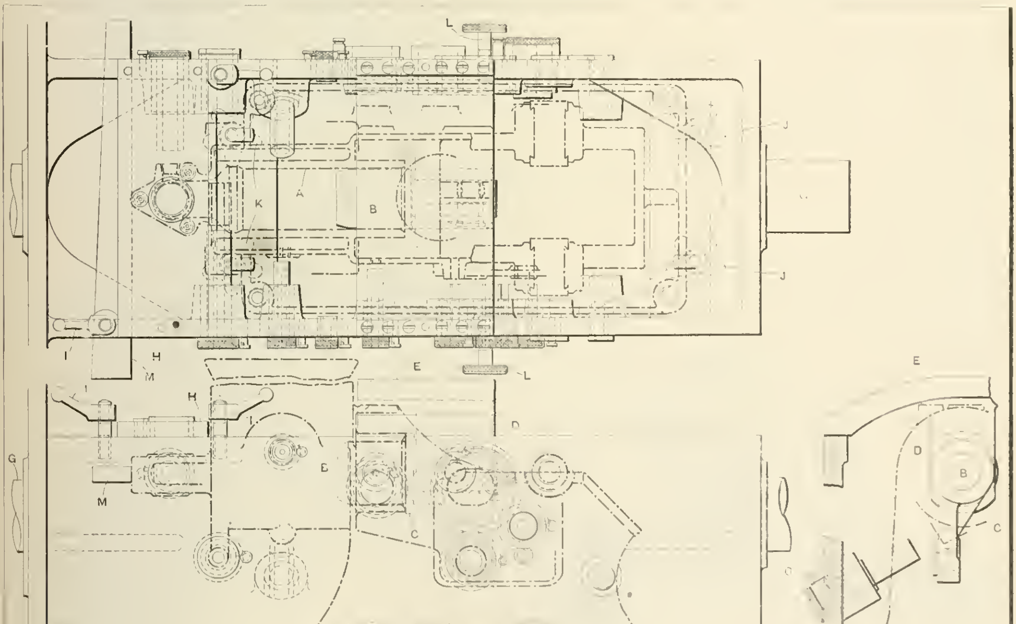

Fig. 2. Construction of the Rotating Trunnion Jig

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The metal iridium is used principally for three purposes: first, for the hard points on the gold pens used primarily in fountain pens; second, as a material for hardening platinum to make it springy; and third, as a material for producing a black glaze on the surface of glass or porcelain.

MACHINING GAS ENGINE BEDS WITH A BICKFORD RADIAL DRILL

The capacity of the radial type of drill as a manufacturing machine, when the work to be operated on can be held in a jig, is demonstrated in a remarkable manner in the accompanying illustrations. Fig. 1 shows a Cincinnati-Bickford regular plain radial drilling machine at work on horizontal gas engine beds in the plant of the Seager Engine Works, Lansing, Mich. One of these engine beds is shown at A in Fig. 3. The cylinder *a* is cast integral with the bed and is of the water-cooled type, the water being held in the reservoir *b*. The crankshaft is held in bearings *c*; the working mechanism, when assembled in the engine, is encased in a cover. This engine (the 1A 1) is used mostly for farm purposes.

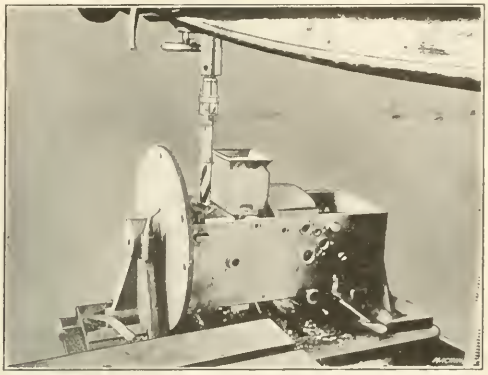
Fig. 1. Rotating Trunnion Jig in Position on a Bickford Radial Drill

Before these engine beds come to the radial drilling machine, the cylinder is drilled, bored and reamed in a Baker Bros.

vertical drilling machine. The casting is then ready for the remaining machining operations, which are forty in number The construction of the jig used for holding this engine bed when it is being machined is shown in Fig. 2.

In the jig shown in Fig. 2, the engine bed *A* is located from the cylinder bore by a plug *B*, which is provided with a shoulder *C*, and which is driven into the boss *D* cast integral with the strap *E*. This strap is fastened by screws and dowels to the sides of the box casting *F*, which has trunnions *G* cast on each end. The engine bed is inserted in the jig by removing strap *H* which is located by dowels and fastened by clamping levers *I*. These levers have an eccentric base, allowing the strap to be removed when given one-half turn. The bed is clamped by means of draw-bolts *J* and *K* and thumb-screws *L*, and is held tightly up against the shoulder on stud *B* by a tapered wedge *M*. The hook-bolts are just tightened sufficiently to prevent any movement of the work when being machined, but not tight enough to spring the casting.

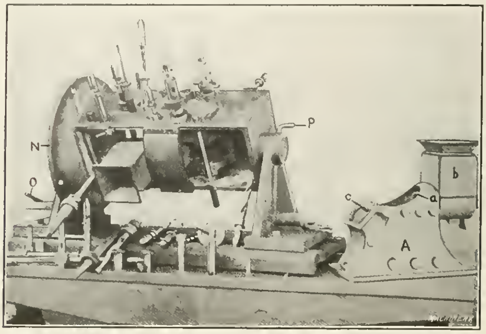

Fig. 3. The Gas Engine Base and Jig in which it is held when the Forty Operations are being performed

The holes in the engine bed are drilled, bored, counterbored, reamed, faced, back faced and tapped by means of the tools shown in Figs. 3 and 4. In all, there are forty different tools. Slip bushings, as shown in Fig. 2, are provided to guide the various tools when in operation on the work. All of the tools are provided with "pin shanks," so that they can be easily removed, and, if desired, the spindle need not be stopped.

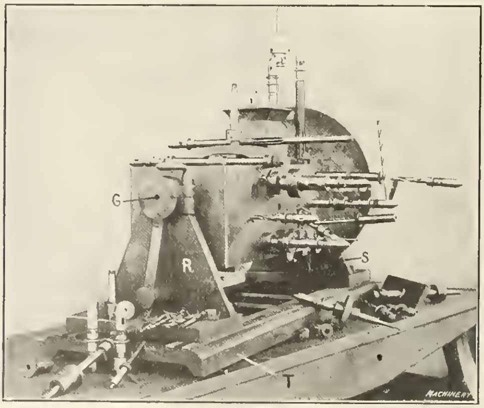

Fig. 4. Another View of the Jig and Some of the Forty Tools used

As it is necessary to perform the various operations on this engine bed in six different positions, the jig is provided with a disk *N*, see Fig. 3, in which hardened and ground locating bushings are held. The disk is located in the different positions by means of a spring-operated locking plunger, which is withdrawn by the lever *O*, and is forced inward by a spring when the plunger is in line with one of the bushed holes. Before the jig can be revolved, clamps *P* must be released. The trunnions *G*, as shown in Fig. 4, are located in brackets *R* and *S*, which are bolted to the plate *T*, the latter being located on the base table of the drilling machine. D. T. H.

SCREW THREAD STANDARDS

BY F. P. BROWN*

On page 204 of the November issue of MACHINERY, engineering edition, a discussion of the relative merits and use of the U. S. standard and so-called V-thread appears. It is a matter of some surprise that the published figures regarding the use of these two kinds of threads show so wide a variation. Some figures recently brought to the writer's attention would indicate quite a different relative use from those published in the article referred to. A record of sales, taken from the books of a leading manufacturer of tools for measuring screws and taps, shows that 77 per cent of the sales are for V-thread screws and that there has been a slight increase in percentage in favor of V-thread screws in the last three years. Another concern—one of the largest producers of machine screws in the country—manufactures screws with V-threads exclusively. Some inquiries among machine tool builders show that this form of thread is also used by them almost exclusively. It would be interesting if a canvass were made to learn what the actual facts are regarding this important question.

The fact that the U. S. standard has been kept prominently before us, and its adoption urged for half a century without its being universally accepted, seems to indicate that there must be some advantages in favor of the V-thread which have continued its extensive use up to the present time. One of these reasons is mentioned in the article under discussion; this, however, is only one of many. Another reason of importance is that the use of the V-thread allows the same threading tool to be used for all pitches, instead of requiring a tool ground with a different flat on the point for each different pitch. Still another reason is that such a system secures more clearance, allowing for greater wear in the taps and greater variation in the outside diameter of the screws. A further important consideration, where systems of gaging are used, is that the greater variation between the tapped hole and the top of the screw thread allows a satisfactory gaging system to be used, including workmen's and reference gages. A common misunderstanding exists in considering the V-thread system as using a screw with a sharp thread. All practical V-thread systems, on the contrary, have the thread flattened. In the case of fine thread screws, this flattening often amounts to more than the one-eighth allowed on the U. S. standard.

While appreciating the great advantage of having all screws made under one system, we should not blind ourselves to the actual facts, and it is only by a full discussion of these facts that the best results can be obtained. In adopting the A. S. M. E. standard, it was distinctly stated in the report that this standard provided for making taps sufficiently sharp to allow for ample clearance, even outside the limits given, and that this would apply equally to the threading tool in making the bottom of the thread sharper than the given limits. Taking advantage of this extra allowance for the U. S. standard form of thread, would give it some of the advantages which have here been pointed out for the so-called V-thread. The real remaining difference would then be in the relation of the pitch diameter to the outside diameter. In the case of the V-thread, this pitch diameter is figured from a theoretical screw with sharp threads, and gives the advantage mentioned in connection with tapping counterbored holes, while in the case of the U. S. standard, the pitch diameter is figured from a screw flattened one-eighth of the depth of the thread when measuring the full diameter.

It is believed that a clear understanding of the differences between these two types of threads, and an intelligent discussion of the whole subject, would help to clear the atmosphere and might suggest a way in which one standard could be made to include all of the points of advantage. If not, it might at least show that the two systems must be perpetuated, and if so, to provide for doing it by establishing proper standards and limits for each, rather than allowing matters to drift. It does not seem possible that the tap manufacturers can discontinue keeping V-thread taps in stock, as has been suggested, when screw manufacturers are manufacturing screws with V-threads in such large quantities.

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A PRACTICAL FORM OF TOOTH FOR SKEW BEVEL GEARS

PROPOSED SKEW BEVEL GEAR TOOTH WHICH CAN BE PRODUCED BY THE MOLDING GENERATING PROCESS

BY GEORGE M. BARTLETT[*]

The following is a description of a proposed method of generating the teeth of skew bevel gears by the "molding generating" process. The method is based on the assumption that Sang's theory holds true for skew gears as well as for spur and bevel gears. In a system of interchangeable involute spur gears, each gear will mesh perfectly with a rack whose pitch surface is a plane, and whose teeth can each be swept out by a single stroke of a straight-edged planing tool. In a system of interchangeable bevel gears (octoidal system), each gear will mesh perfectly with a crown gear whose pitch surface is a plane disk, and whose teeth can each be swept out by a single stroke of a straight-edged planing tool. In the proposed system of interchangeable skew gears, each gear will mesh perfectly with a "rack" whose pitch surface is a "right helicoid," and whose tooth surfaces are hyperbolic paraboloids capable of being swept out by a single stroke of a straight-edged planing tool. The teeth in these gears do not vanish at the gorge, do not have to be undercut to avoid interference, are reversible, and give the same obliquity of action throughout their length. By using sections of the hyperboloids some distance from the gorge, drives of this type can be made more efficient than is possible with either worm or spiral gears.

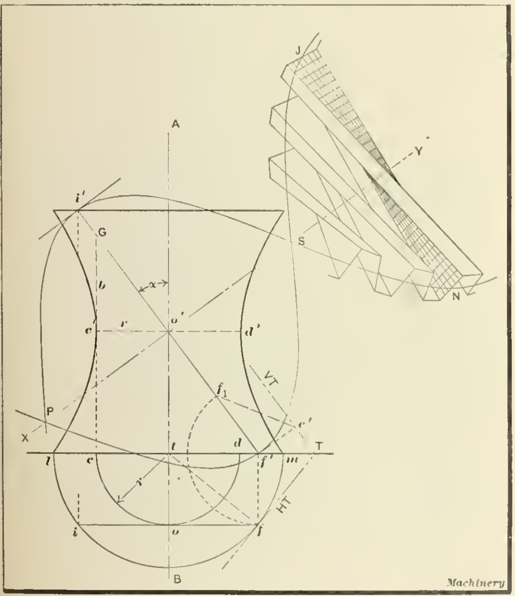

Fig. 1. Theory of Skew Bevel Gears and Requirements for Planing Conjugate Teeth

The problem of transmitting rotary motion to non-parallel, non-intersecting shafts by means of toothed wheels has been solved in several ways, *viz.:* by spiral gears, by several types of worm-gears, and by skew bevel gears. While spiral gears possess the advantage of working perfectly when the center distance is slightly altered, or when either gear is shifted along the shaft, they have the disadvantage of rapid wear on account of point contact. A worm mating with a helical gear (straight faced) possesses the same advantages as well as disadvantages. A straight worm mating with a hobbed wheel (the most common type) has line contact, and consequently better wearing qualities when properly mounted; but a slight displacement of the worm-wheel from its correct position along the shaft will seriously affect both the efficiency and durability of the drive. The Hindley worm and wheel, while theoretically giving line contact only, are so constructed that to the eye there appears to be surface contact. When properly mounted these, too, possess very good wearing qualities; but the slightest displacement of either worm or wheel, or of the shafts, will affect the correct working of the gears.

To students of gearing problems, the solution by means of skew bevel, or hyperboloidal gears, has always seemed the logical one, although up to the present time no form of tooth has been found that possesses the qualities of strength, reversibility, and low pressure angle, and that can be accurately cut or planed. Three notable attempts to produce such gears are worthy of mention: 1. The epicycloidal system of Willis, in which the tooth surfaces are swept out by an element of a hyperboloid simultaneously rolling on the interior of one of the two-pitch hyperboloids, and on the exterior of the other. This method of generating the teeth is exactly analogous to that used in connection with the epicycloidal system in spur gearing, but Prof. MacCord has shown that skew teeth produced in this way are not theoretically correct, since the tooth surfaces cannot be tangent to one another for all positions. 2. The Olivier involute system, in which the tooth surfaces are single curved surfaces known as Olivier spiraloids, or helical convolutes. In this system, the teeth vanish at the gorge, and hence it is necessary to form the gears from sections some distance from the gorge, but as we depart from it, the obliquity of action increases so rapidly that it is difficult to find a position where the teeth are satisfactory. Moreover, this method provides for the generation of only one side of the teeth. The backs must be formed by another method. 3. The Beale skew gear is a modified form of the Olivier gear, but more practical, since the teeth do not vanish at the gorge. They are somewhat undercut, however, and like all preceding forms are difficult to make.

It does not seem likely that any type of skew gear will ever be of more than theoretical interest, unless the teeth are of such a form that they can be accurately generated by the planing process. To discover this form of tooth, the natural method of procedure is to seek something that will bear the same relation to the hyperboloidal gear that the rack bears to the involute spur gear, or that the crown gear bears to the octoidal bevel gear. Then, assuming that Sang's theory is applicable to skew gears as well as to spur and bevel gears, a tooth section with straight sides can be chosen for this skew rack similar to those of the spur and bevel gear systems, and the teeth can be swept out by a straight-edged planing tool that is made to move in accordance with the proper geometric laws. It will then be true that all hyperboloidal gears that will mesh with this skew rack will mesh with each other. The process of generating the teeth of a pair of hyperboloidal gears will then at once suggest itself, for we have only to cause our planing tool to pass along the tooth surface of an imaginary skew rack with a reciprocating motion, at the same time moving laterally at the end of each stroke to correspond with the motion of the pitch surface of the rack as it rolls upon the pitch hyperboloid. The blank must also turn on its axis a corresponding amount at the end of each stroke, these motions continuing until one side of a tooth has been completed.

The nature of the skew rack is determined as follows: Let AB, Fig. 1, be the axis of a hyperboloid of revolution of one nappe, assumed as the pitch surface of a skew bevel gear. The horizontal projection of the circle of the gorge is cod, and the vertical projection, $c'o'd'$. Line $i'f'$ is one of the rectilinear elements of the surface, and is parallel to the plane on which the figure is projected. In this position it is the asymptote of the hyperbola which constitutes the contour lines of the surface. The angle α is the asymptote angle of the hyperbola; $o'c'$ is the radius of the gorge circle, and will be referred to as r; $c'G$ parallel to AB, will be referred to as b. The equation of the hyperbola referred to the axes AB and $c'd'$, origin at o', is:

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$$\frac{x^2}{r^2} - \frac{y^2}{b^2} = 1$$

It can easily be proved that any two hyperboloids, so related that they can form the pitch surfaces of skew gears, will have the same value of b. Now $b = r \cot a$. Hence in a set of interchangeable hyperboloidal gears, the product of the gorge radius and the cotangent of the asymptote angle is constant and equal to b, the modulus of the series. Through o, the intersection of $i'f'$ with the gorge circle, pass a line XY, perpendicular to $i'f'$, and parallel to the vertical plane of projection. At any two points on the element $i'f'$ equally distant from o, such as i' and f', draw lines perpendicular to $i'f'$ and tangent to the hyberboloid. The slope of these tangents with respect to a plane perpendicular to XY will be $\frac{b}{o'i'}$. Through i' and f' pass two helices whose common axis is XY, and whose slope is the same as that of the tangents through i' and f'. These helices will then be tangent to the hyperboloid. Their pitch will be $2\pi b$. Now let these two helices, and the line XY, be taken as the three directrices of a warped surface. The result will be a right helicoid, all elements of which will be perpendicular to XY. One of these elements is evidently $i'f'$. This helicoid is tangent to the hyperboloid all along the element $i'f'$ (since three common tangent planes can be passed at points on this element). If the helicoid is moved in the direction of XY, it will roll upon the hyperboloid while turning upon its own axis; and successive elements of the two surfaces will come into contact. The sliding motion that accompanies the rolling will be entirely in the direction of the element of contact.

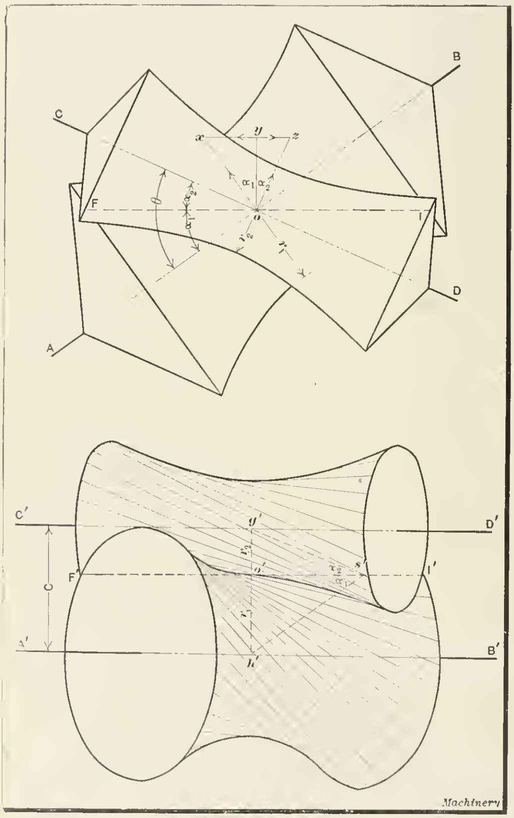

Fig. 2. Pitch Surfaces of Skew Bevel Gears showing Rectilinear Elements of Engagement

If we conceive the mate to the hyperboloid of Fig. 1 to be placed in contact with it along the element IF in Fig. 2, and a right helicoid to be constructed tangent to it along IF, this helicoid will be identical with the first one. It is then evident that the analogue of the pitch surface of the rack, for hyperboloidal gears, is a right helicoid whose pitch is $2\pi b$. Now conceive a number of normals to the hyperboloid of Fig. 1 erected at points of the common element $i'f'$ or IF in Fig. 2. Each will cut AB, and also the axis of the mating hyperboloid. Each will be parallel to any plane perpendicular to IF. Hence these normals are elements of a hyperbolic paraboloid which is normal, not only to the two hyperboloids, but also to the right helicoid. By laying off equal distances from I and F along the normals through those points, and joining them by straight lines, the second generation of the hyperbolic paraboloid will be formed, the plane director of which is parallel to IF and XY. Divide the axis XY of the helicoid into parts, each equal to the thickness of the proposed rack tooth, and through the several points of division pass rectilinear elements of the helicoid. Then through each of these elements pass a hyperbolic paraboloid normal to the helicoid (in the same way that the first one was passed through IF). Now, beginning at one end of the series, turn the first hyperbolic paraboloid, about the helicoidal element as an axis, through, say, 15 degrees. Turn the next one through the same angle in the opposite direction, and thus alternate throughout the series. A limited portion of these surfaces, extending equal distances on both sides of the helicoid, will form the surfaces of rack teeth which are analogous in every respect to the rack teeth in the involute spur gear system. They fulfill the condition required by Sang's theory for a conjugating rack, *viz.*, that the faces and flanks be formed of four equal curves arranged in alternate reversion. Hence any two hyperboloidal gears that will mesh properly with this rack will mesh with each other. Three of these rack teeth are shown in Fig. 1.

If we imagine a planing tool whose point is made to travel along the straight line at the root of the rack tooth, and whose cutting edge, at the same time, is made to turn in such a way that it constantly coincides with some rectilinear element of the tooth surface (see the tooth at JN, Fig. 1), it only remains for us to supply the mechanism necessary to give the proper motions to the hyperboloidal blank and to the imaginary helicoidal rack, and we shall have a means of accurately generating conjugate teeth for skew gears. The teeth in these gears do not vanish at the gorge, as do those of Olivier and Herrmann. The obliquity of action is the same at points some distance from the gorge as it is at the gorge. The teeth do not have to be undercut to make them work at the gorge; hence they are not weakened near this point. The gears are reversible, and by using sections of the hyperboloids some distance from the gorge, drives of this type can be made more efficient than either worm or spiral gears.

* * *

French army officers stationed in Algeria have carried out a series of experiments with a vehicle built like a sledge, mounted on wheels, and equipped with an air propeller driven by a 50-horsepower engine. The object of this vehicle is to enable traveling over the desert sand. During the experiments the vehicle has proved itself capable of carrying three persons over the sand at a speed of from twelve to eighteen miles per hour, and also to be able to ascend gradients of 1 to 5. Improvements are attempted with a view to fitting wings to the vehicles so that it would be enabled to leap over mounds or other impediments. It is expected that this development may greatly facilitate communication in deserts.

* * *

A correspondent to the *Engineering Record* calls attention to the fact that orange colored ink has been substituted in a large engineering office for red ink for center and dimension lines on tracings. A very fine line can be drawn with the orange colored ink on tracing cloth, and the lines will print clearly, although they will show a marked contrast to the black lines on the print. Another advantage is that these lines can be erased almost as easily as pencil lines and present a pleasing appearance on the drawing.

SOME INTERESTING DRAWING AND CURLING DIES

BY DOUGLAS T. HAMILTON*

The following interesting examples of drawing and curling die work were obtained in the shop of the Budd & Ranney Mfg. Co., Columbus, Ohio, manufacturers of Budd & Ranney gas engines, special machinery, tools, and all sorts of punch press work. The firm devotes the greater part of its attention to the manufacture of special tools, punches and dies, etc. Some of the punch and die problems submitted to it and successfully solved are described in the following article.

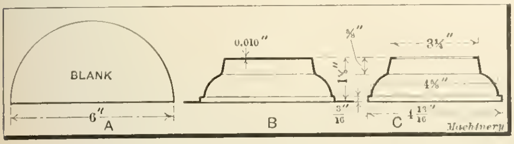

Fig. 1. Successive Drawing Operations on a Brass Top for a Wire Gas Globe

Fig. 2 shows a drawing punch and die which was made for producing the brass top for a wire gas globe shown assembled at *A* in Fig. 5. This globe is a recently patented protector for gas mantels. The wire mesh permits a free circulation of the air around the burner. This globe fills the additional function of a fire prevention device, as if the mantel should break, it is caught and held by the wire basket.

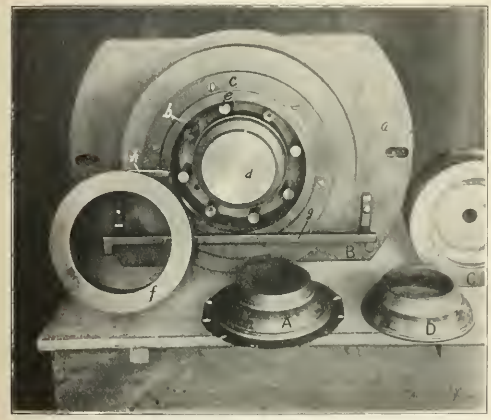

Fig. 2. Drawing Die and Punch and Brass Top after Drawing and Trimming Operations

The top for this wire gas globe is made from 0.010 inch thick sheet brass and is blanked and drawn up completely to shape in one operation. The piece is shown after this operation at *A* in Fig. 2, and also at *B* in Fig. 1. The die and punch used for this purpose are shown at *B* and *C* in Fig. 2, and are used in a single-action punch press. As indicated in Fig. 1, this brass top is produced inverted and not drawn through a die in the usual manner.

The die *B*, Fig. 2, consists of a cast-iron bolster *a*, bored to receive the blanking die *b* which has an irregular top face providing for a shearing cutting edge. This blanking die is held in place by ring *c* and the screws shown. The forming part of the die proper consists of a circular form *d*, made to suit the internal diameters and shape of the brass top, and held in the recess in the bolster by screws and dowels. Projecting through from the base of the die bolster are eight pins *e* which rest on a steel ring bearing on top of a rubber spring pad, 10 inches long and 6 inches in external diameter, having a 3½-inch hole. This rubber spring pad is held on a bolt screwed into the bolster.

When in operation, pad *f* (shown removed in Fig. 2), rests on pins *e* and provides a support for the sheet while the blank is being cut by the outer edge of the punch *C*. Then, as the ram of the press continues to descend, pad *f* is forced down by punch *C*, compressing the rubber spring pad and at the same time allowing the recess in the punch (made to suit the outside diameters and shape of the brass top) to force the work over forming die *d*, thus producing the desired shape. The bar *g* is used as a guide for the sheet, while the finger *h* locates the sheet for each successive blank.

It will be seen from Figs. 1 and 2 that there is considerable excess material left around the edge of the brass top after it has been formed to the desired shape. The chief reason for this is that the brass top, which is made from comparatively thin stock, can then be nicely trimmed in a succeeding punch and die with little difficulty. On the other hand, if this excessive material were not provided for, it would be much more difficult to draw the cup successfully, and would also increase the difficulty of trimming. As it is also necessary to cut out the bottom of this brass top in a succeeding operation, the trimming and blanking can be done in the same die.

The punch and die used for trimming the wire gas globe is shown in Fig. 3. This punch and die is also held in a single-action press, the punch being held to the ram, while the die is held in a bolster on the bed of the press in the usual manner. The trimming die consists of two steel rings or dies; the larger one *A* is doweled and screwed to the top face of the bolster *B*, while the trimming ring for the bottom of the brass top is let into the bolster. The distance between the top faces of the two trimming rings is slightly greater than the corresponding distances on the brass top.

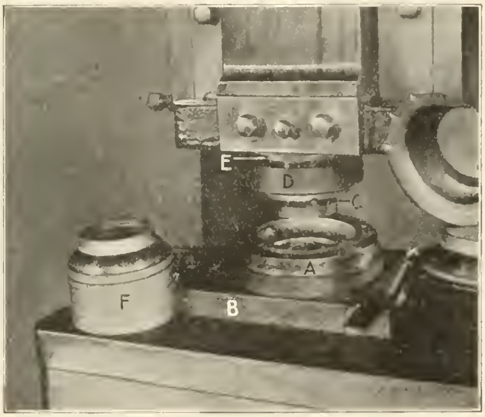

Fig. 3. Trimming Punch and Die for Brass Top set up on a Single-action Press

The punch consists of two main parts *C* and *D*. The lower part *C* which continues up, in shank form, into the ram of the press, is used to cut out the bottom of the brass top. Part *D* is in the form of a ring surrounding punch *C*, and is held down on a shoulder on the latter by stiff coil springs located between the rings *D* and *E*, the latter of which bears against the lower face of the press ram.

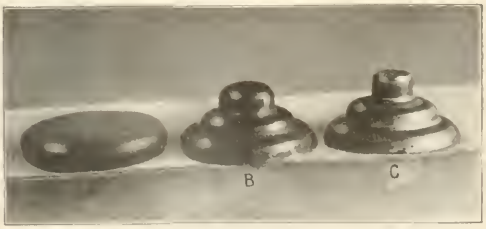

Fig. 4. Successive Drawing Operations on a Steel Cup, which is drawn to Shape without annealing (Last Operation not shown)

The operator places the work in the die, as shown in Fig. 3, and then trips the press, when punch *C* descends and cuts out the bottom of the brass top. Upon further downward movement of the ram, punch ring *D* comes in contact with the flange on the work, pressing it tightly against the die ring *A* and compressing the coil springs. This action continues until punch ring *D* comes into contact with ring *E*, when further upward movement of the punch ring is prevented, and the excess metal is sheared from the brass top. The disk cut out from the bottom of the work falls to the floor, while the ring and top are removed from the die by the operator with the stick shown lying on the bolster of the press. A pile of finished pieces is shown at *F*, and a single finished top at *D* in Fig. 2. In this single action press it is possible to turn out 4000 wire gas globe tops in 10 hours, this production including both operations—drawing or forming, and trimming.

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* Associate Editor of MACHINERY.

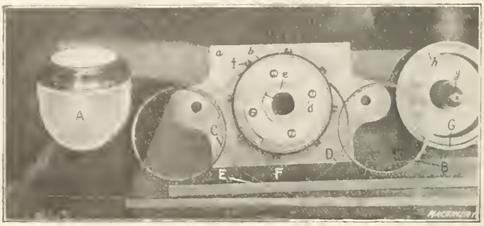

Fig. 5. Curling Die and Punch for a Steel Ring, Ring in its Various Stages of Formation; and Complete Wire Gas Globe in which Ring is used

Another interesting example of press drawing of sheet metal is shown in Figs. 4 and 6. Fig. 6 shows the various press operations diagrammatically, and illustrates the successive steps followed in the production of a steel cup. The most remarkable feature is that this cup is completed in four operations without annealing. The material used is mild steel 0.042 inch thick. Upon referring to *B* and *C* in Fig. 4, and also to *C* and *D* in Fig. 6, it will be seen how this feat is accomplished. Instead of endeavoring to produce square shoulders and straight sides in the preliminary drawing operations, the corners are formed with liberal radii and the sides inclined at an angle with the axis of the cup. The object in making the cup of this shape is to assist the metal in "flowing," and to distribute the strains throughout the greater portion of the blank.

Sharp corners and straight sides tend to put all the strain on the corners and cause rupture at these points. Furthermore, by forming the cup in the manner shown, the final operation simply shapes the work by stretching it at the corners, without increasing its length to any perceptible extent. Upon cutting one of these cups in two, it was found that the metal was only slightly reduced in thickness at the point *a*, in section *E*, Fig. 6, the remainder of the cup being practically of uniform thickness. As the top of the cup had to be of an exact diameter externally, the metal was drawn more at this point, to remove what spring still remained in it. This steel cup was produced in dies of practically the same construction as those shown in Fig. 2, in a single-action punch press.

Mr. E. A. Ranney, to whom the writer is indebted for the information in this article, stated that it is the practice in this shop in making drawing dies, to calculate roughly the diameter of the blank required and to make the successive drawing and redrawing dies before making the blanking die. A simple method of obtaining the approximate diameter of the blank is to multiply the circumference of the finished cup by the height, and then add the area of the bottom, which gives the area of the blank; then find the diameter of a circle whose area equals this area. This rule applies to cups that must be made of a uniform thickness on the sides and bottom and that are of an approximately cylindrical shape. For irregular shaped cups the usual practice is to take the mean diameter and use the rule previously given.

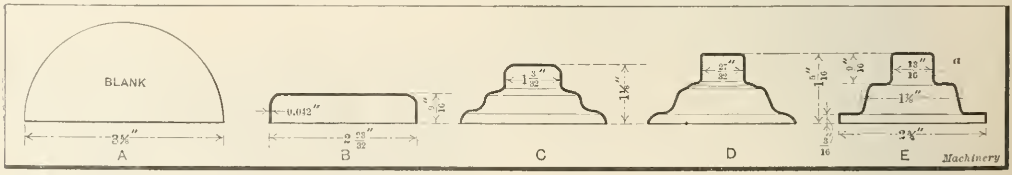

Fig. 6. Press Operations on the Steel Cup also shown in Fig. 4

It is impossible by any known method to calculate the exact diameter of blank required, as the "stretch" of the material cannot be definitely determined except by trial. Considering this, it is good practice to follow the method suggested—that is, making the successive drawing dies before the blanking die. A blank can be cut out and filed to the approximate diameter in a short time, then passed through the drawing dies, and when completely formed, if found to be of the required length, the blanking die can be made to the same diameter as was this trial blank. If, on the other hand, the shell is too short or long, the diameter of the blank can be increased or reduced accordingly, and the same procedure followed until the exact diameter of blank is obtained.

An interesting curling die for forming the ring *B*, Fig. 5, used in holding the wire mesh in the gas globe shown at *A*, is shown in the same illustration. The ring is shown in its successive forming steps at *A*, *B* and *C* in Fig. 7; *A* is the strip from which the ring is made, cut from a sheet of Russian iron to the dimension shown. The first step is to bend the blank into a hoop in a pair of bending rolls, bringing it to the shape shown at *B*, and also at *D* in Fig. 5. It is now ready for the curling die, which is held in the press shown in Fig. 3.

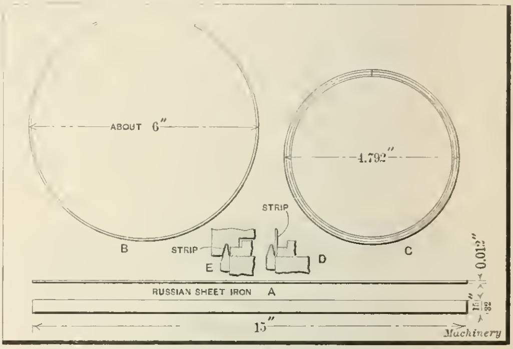

Fig. 7. Steel Ring in Various Stages of Formation, and Diagram illustrating how it is held and curled

Referring to Fig. 5, the curling die shown at *F* consists of a bolster *a* having a projection around which the forming ring or die *b* is held. Retained inside the forming die, by a ring *c* and four screws *d*, are four jaws *e*. These jaws are provided with elongated holes in which screws *d* fit, and are acted upon by open-wound coil springs located in front of the eight headless screws *f* placed equidistant around the die ring. The inner sides of the jaws are provided with a projection and form a tapered hole into which the tapered spring-operated pin *g*, held in punch *G*, fits.

In operation, punch *G* is held in the ram of the press and die *F* is fastened to the bed. The operator grasps the partly bent band *D* with both hands, placing it between jaws *e* and die ring *b*, as illustrated diagrammatically at *D* in Fig. 7. Then when the ram of the press descends, the tapered pin *g* comes in contact with jaws *e*, forcing them out and thus gripping the hoop securely. As the ram continues to descend, the tapered pin recedes, allowing the groove *h* in punch *G* to force the band over the die ring in the manner shown at *E* in Fig. 7. When the ram of the press ascends, the jaws are returned to their normal position by the eight coil springs, thus freeing the ring and allowing it to be easily removed by the operator.

THE NEW ERA IN MACHINE TOOL DESIGN[*]

A REVIEW OF IMPROVEMENTS IN DESIGN WHICH PROMOTE PRODUCTIBILITY, DURABILITY AND ADAPTABILITY

BY E. P. BULLARD, JR.

A new era has come in the mechanical world—the era of greater efficiency. We have been given a new word during recent years and a new profession has been created. We are told that our shops are inefficient—that our methods are out of date; and that we make a great many false motions. Our railroads have been informed that they lose a million dollars a day by inefficient operation. It is stated that a railroad car is in use but two hours out of the twenty-four. This new knowledge is the result of careful analysis, and exact knowledge, so obtained, forms the foundation for the new era.

What do all these things mean? They mean that there is a great demand being placed on the mechanical world at large. All of our industries are being called upon to produce better goods at a lower price and to increase production. We must be more efficient in all our work, as engineers, as shop managers, if we are to succeed. We cannot hope to be paid for inefficiency. The world is going on—it is not standing still—and those of us who are going to uphold the names of our concerns, and our individual reputations before the mechanical world, can do it only by keeping pace with the times.

Importance of Analysis and Time Study

You ask, what has this to do with machine tools? Stop and think. Can you think of a device, a mechanism of any description, which is not affected by the efficiency of machine tools? Everything we have, safety razors, even the capsules in which we take our medicine, are the product, indirectly, of machine tools. We have come to an age of exact knowledge. We no longer do things in a haphazard way. We have means for measuring accurately and of determining the strength and hardness of materials. A bolt made in the East will fit a nut made in the West. We have come to that state of exact knowledge where we must use that knowledge in the design of our product, so that we may benefit by the experience of others, and so that we may produce products which will be comparable with products turned out in this country and abroad. We know the physical and chemical characteristics of materials. We no longer buy our materials by guesswork. We do not place an order for so much steel and let the steel mill send us any kind of steel it has in stock. We specify the percentage of carbon and the chemical analyses of the steel and we expect it to show certain physical qualities—so many thousand pounds tensile strength, a certain elastic limit, a certain percentage of elongation, etc.

We have come to the age where we can specify definitely what we want—and get it. Standardization has become the watchword. We can specify a certain number of thousandths gage and get it. A gage made in one section of the country will fit or check with a similar gage made in another part of the country. We standardize our operations. We make time studies of operations and benefit thereby. We have gone by the age when it is argued that a time study is of no benefit. We know that we can definitely calculate the time of machining a certain piece. We know also that the time that is definitely calculated may appear to be absolutely impossible of accomplishment. I remember the first automobile flywheel that we produced. Our estimators figured that we could machine one of these flywheels in nineteen minutes. The work came into the shop and the shop superintendent came to me and said: "That's a joke." "What's a joke?" I asked. He replied, "That nineteen minutes. It will take nearer forty-five minutes." However, we found that by following out the time study we obtained our planned result. We have a letter in our files to-day from the concern that purchased the machine saying that they have averaged a time of seventeen minutes per piece on 14,000 flywheels. I give you this as an illustration of the value of a time study. Without planning the sequence of operations and following the plan we could not have accomplished it. As it was, we averaged seventeen minutes each on 14,000 wheels, showing that many of those wheels must have been made in considerably less time.

We have our instruments of precision. Have any of you ever stopped to think what marvelous things they are? Marvelous in their exactitude—instruments with which we can measure almost anything you can think of from the hardness of material to the exact size of a particular piece. I sometimes marvel because I know the difficulty of fixing and maintaining these standards.

The Demand for Higher Standards of Living

We have a demand—a tremendous demand, an exacting demand, a demand from the masses—for better conditions of living, of travel; they want heat, light, comfort—all the thousands of luxuries which this age has given us, and which now become necessities. Now, how is this demand to be met? We think of it as extravagance, but is it? It is simply the masses living up to the age. There was extravagance in earlier periods than ours. Louis XVI, it is said, spread gold dust on his royal signature instead of blotting it. We have other ways of being extravagant. We want automobiles, we want telephones, we want the thousands of things to-day which were luxuries at one time, but are now considered as absolute necessities. The luxuries of to-day are the necessities of to-morrow.

Progress of the Machine Tool Industry

The machine tool must meet this demand. The burden of this demand bears directly on the machine tool, which is the prime factor in the development of civilization—a fanciful thought I will admit, but it is always the prime factor in meeting this demand—in producing the articles which the world wants. If we are to meet this demand we cannot do it by walking in the footsteps of our fathers. They bought iron and bought steel, but they did not specify what their iron was to be, nor did they specify the analysis of the steel. They used other materials, such as bronze, which was yellow, and as long as it was yellow it was good for a bearing. We cannot walk in their footsteps and win. We must utilize the knowledge which is invaluable. We must use the instruments of science and we must profit by the experience of other industries. Other industries have advanced amazingly. Take the automobile industry as an illustration. It started but a few years ago—very few, comparatively speaking. The first automobiles were crude machines; the materials that were used were not suitable for the service required of them. The demand arose for better and more suitable materials, and they have been supplied, until to-day a study of the materials that enter into a good automobile is a wonderful study, a comprehensive study. The manager of one of our automobile concerns told me there were fifty-three distinct varieties of steel in his machine, each one selected as best for a certain service.

Machines Required to be More Powerful

Granting that the machine tool is a prime factor in the advancement of our civilization, it seems right and proper that machine tool builders should exercise their energy to make their machines more productive and useful, if they are to be a real help in the upbuilding of other industries. How may this object be attained? The answer lies in the one word "analysis"—analysis of the work to be done, the conditions to be met, and an analysis of the means already at hand. For example, what is indicated by an analysis of present day shaft-turning conditions? First, the material to be worked is tough and hard, requiring more power to obtain a given result. Second, tool steels are wonderfully improved, enabling us to plan a greater result in a given time—still more power required. Greater power must be transmitted, to attain which we must increase, throughout, the proportions and strength of the machine parts involved. How to satisfactorily accomplish this result can only be learned through analysis.

Have designers followed this method? What difference is there between many lathes of to-day, for instance, and the lathes of ten years ago? There is *not* the difference between the machine tools of to-day and the machine tools of ten years ago that there should be. They have not, in all cases, kept up with the times. Many machine tools are, to-day, identical in detail with the construction of ten years ago. But I tell you that anyone who continues to build an inefficient machine of that kind cannot hope to keep his trade. The machine tool of to-day must meet the conditions of to-day.

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[*] Abstract of paper delivered by Mr. E. P. Bullard, Jr., president of the Bullard Machine Tool Co., Bridgeport, Conn., before the Cleveland Engineering Society, Cleveland, Ohio, November 26, 1912.

Importance of Machine Control

In analyzing the various elements of machine tools the question naturally arises, wherein can they be improved? There are many ways. First, let us consider the question of control. Control is the essence of machine tool operation. It plays the largest part in the production of work. Control is everything. We see it in other products and never think anything about it. When you touch a typewriter key and the letter is impressed on the paper, you think little of that; but there is infinite exactitude in getting that impression. And so with the machine tool. It must not merely be started and stopped; it should start precisely at the right time, and should stop exactly as wanted, and stay stopped until it is again started. The machine tool should do the work, and the operator should use his energy solely in directing it. He should not be called upon to spend his valuable time nor his mental energy in operating an oil can on sixty or a hundred different holes which are supposed to be oiled. He should not be called upon to shift dangerous belts or move heavy parts. We can do all of those things by power. There is absolutely no reason to-day for an operator to be required to do those things, and any machine which compels the operator to use his physical energy to move heavy parts, to shift belts, or do any of those things which waste time and productive energy, is inefficient in design and construction.

The Essentials of Machine Tool Design

What, then, are the essentials of machine tool design? The things that we can lay down and say we must have. It seems reasonable that we should ask first for productibility—the ability to produce. It is of prime importance, for it is what we buy the machine for, and if we cannot get productibility we have not spent our money wisely.

Second, durability. Is it unreasonable to suppose that, having paid coin of the realm for a machine, we are entitled to durability? Should not a machine stand up and do its work under present conditions—with inefficient men, perhaps? We are entitled to that. So I place durability second. Productibility, of course, is qualified by durability. If it is not a durable machine its ability to produce soon ceases. So, it is reasonable to ask that a machine be durable; that it will remove the amount of material required in a given time and do it easily and comfortably, and have a sufficient factor of safety in the design of its parts to provide for a continuous performance of the work for which it was installed.

Third, adaptability. By adaptability I mean the ability of the machine to meet conditions. Let us assume that we have purchased a machine for a given purpose. The machine should meet our conditions. It is of little interest to us that it may be able to produce work for somebody else—that it may meet Jones' conditions. What we purchased it for was that it should meet our conditions.

We have, then, three essentials in machine tool design: Productibility, which means the ability to produce; durability, or the ability to stand up and do the work; and adaptability, or the ability to meet conditions.

Factors Affecting Productibility

There are several factors which enter into the question of productibility, each of which is, in a way, related to the others. If, for any reason, the machine is not in service it is not producing and is, therefore, inefficient.

Continuous operation is an essential factor which is dependant not only on durability but on adaptability as well. If minor details of construction are constantly giving trouble it is not a durable machine, and if long delays are frequently occasioned by the necessity of changing or providing complicated and expensive tool equipments, the machine is not adaptable, and the expenditure therefor has not been wisely made.

I have already spoken of the starting and stopping and wish to impress upon you the importance of that detail. I believe the starting and stopping of a machine is, possibly, the most important function of the operating mechanism. The machine should start just when the operator wants it to. It should not start a little ahead of time and take his hands off or his arms off, and it should not lag in starting. It ought to stop just as exactly as you stop an automobile, a trolley car, or any other moving object. The starting and stopping of a machine are two very important factors in its operation. Shifting belts do not meet the new conditions—they are too slow. Efficient clutches are difficult to make. In fact I think the weak point in about ninety per cent of the automobiles is in the clutch. The clutch does not work—it starts too quickly, or it drags. Some of you probably drive automobiles and you know that the clutch is a very important part of your machine. And a clutch in a machine tool is equally important. It cannot be too good, and the brake merits equal consideration.

Power Traverse of Slides and Other Machine Parts

Let us consider the power operation of heavy parts. Did you ever stop to think what it means to take hold of a large planer or a lathe and move the heads or carriage any distance? It is a tremendous piece of work. A man who is not in training cannot do it, and a man who does it frequently during the day is spending a large part of his energy in useless work, wasting his physical as well as his mental abilities, because power can be applied to the operation of those parts just as easily as to driving the tool. Power operation of heavy machine parts is here to stay. It may be inefficient on some machines, it may be inefficient on all, but the time will come when you cannot hire a man to run a machine in your shop unless the machine is equipped with mechanical means for operating the heavy parts. I refer to machines having heavy parts, of course. I do not expect to see the little light parts power controlled, but the time will come, just as sure as can be, when men will refuse to run machines not so equipped. Consequently it is essential that we should produce machines that are equipped in that way. Incidentally it is just as essential that we should perfect the operation and motion of those parts so that they are under as absolute control as the control of starting and stopping, which I have already stated is very important.

Time Lost in Setting Tools for Sizes

In the matter of the setting of tools, I wonder if any of you gentlemen have ever done what I have done? I have gone around the country with a stop-watch in my pocket so that the operators could not see it and have made time studies on my own account, recording the time which the average operator requires for the setting of tools. My calculations may not agree with your ideas on that subject, but I am convinced, and I think it can be demonstrated in your own shops, that about one-third of the total time you pay for is spent in cutting to size. For instance, a man takes a steel casting, and he does not want to spoil it. He has to reduce it to an exact size. He puts it on the machine and spends about fifteen minutes cutting it down a little. After that he tries the calipers on the turned surface and finds that it is about one-eighth inch too large. I notice it is usually about one-eighth inch. He then starts in and repeats that operation several times. One man out of a thousand can set a machine accurately enough to do this work without wasting time, and the other nine hundred and ninety-nine will do just as this one did. You can see it everywhere. Consequently, your machine tool should, to be efficient, take that burden off the man and give him means of obtaining sizes quickly and accurately, and of duplicating sizes every time, so that the mental strain, due to his feeling of responsibility for the casting, is taken off his mind, and he feels free to set the tool in the shortest time and in the most effective manner.

Importance of Adequate Belt Power

Under productibility comes the question of power. How often do you see a machine that can be loaded right up to all the tool steel will stand, and take cuts easily and comfortably and look as if it was going to continue to take them as long as necessary to machine the piece? What do you say? I suppose there are fifty compounds on the market for making belts pull, but let me tell you that a truly efficient machine tool does not need them. The power transmission means will be there in the form of a big belt—a wide belt—and there will be plenty of strength of materials between that belt and the cut to take all that the belt will pull, and that belt will pull more than the cutting steel will stand. We know that it is possible because we do it.

I have seen a comparatively small machine turn off 1785 pounds of cast iron chips in an hour. The casting was large and the cuts deep, heavy and fast, in fact unnecessarily so, but the machine came through that durability test without difficulty and proved that the design was right.

Power in abundance—excess of power—is an essential part of a producing machine, and it is in this respect that the average machine in the shop to-day is lacking.

Proper Distribution of Metal

Now as to the correct distribution of metal: Probably every man when he buys a machine tool first asks the question, how much does it weigh? Now stop a minute. What does that question amount to? If I as a machine tool builder wish to deceive you I can pour pig iron into the base of my machine and give you weight that costs little and is valueless to you. We can take small lightly designed machines and fill them up in the bottom and give you weight, but you would not have productibility, because the weight would be in the wrong place.

You will find in the text-books which have been prepared during the past ten years, statements to the effect that machine steel may be turned at the rate of 25 feet per minute, and cast iron at 30 feet. Now let me tell you something: I have seen a piece of machine steel, forty-point carbon open-hearth steel, turned at 425 feet a minute—just like a piece of wood—and turned easily and freely. This feat was possible because the machine could do it easily—it did not vibrate and the cutting tool had an opportunity to work. The cutting tool is a delicate thing, when you think of it. It must have a keen edge to work properly. If it has a dull edge—which it gets very soon after vibration sets in—it ceases to be a cutting tool and becomes a *pushing* tool, and these ragged, torn pieces you see around a shop represent inefficiency, lost power, poor tools and poor machines. The correct distribution of metal is an essential point. I have seen a boring machine take a cut 1 1/8 inch wide, 1/32 inch deep, at 150 feet per minute cutting speed and produce a smooth cut. That was a finishing cut on a cylinder, and it was satisfactory. Only the correct distribution of metal in the machine can give that result, and that tool could not be made to stand up if the metal in the machine were not there to properly support it and hold its cutting edge right to the work. The correct distribution of metal is one of the very important factors in machine tool design. I believe that machine tools as a rule are light in some of the very essential parts. I am speaking of the general run of machines which I produce and which others produce. I believe they are light in essential parts, and I believe that when we come to have a full understanding of where we should place metal and how we should place it and what kind of metal it should be, we will have made a great advance.

How Lubricants Affect the Power Factor

There is another factor in the cutting of metals, that seems to me to have great possibilities, and that is the use of cutting lubricants. I had it brought very forcibly to my attention some time ago that there was a large saving to be made in power by the use of cutting lubricants. A machine was in operation in our plant on a steel casting. For some reason the foundry had left about three-quarters inch on the diameter of the casting, which had to be taken off. The surface was about sixteen inches wide. The machine was running along very nicely with two large streams of water—about thirty-six quarts a minute—thrown directly on the cuts. There were two cuts, one on the top and one on the side. The chips were turning blue when they came out of the water.

I stood watching the machine and I said to the operator: "Fred, if we turn that water off what will happen?" He said, "It will burn the tools." "Well, let's shut it off and see," I replied. So we shut down on the water and the machine made one-half of one revolution and the belt went off. We thought that we had a broken tool: that a tool had burned. We backed the machine out and the tools were just as they were before. They had not run far enough to be destroyed. So we started the machine with the water and it went along easily and comfortably, and then we cut the water off again. It went less than half a revolution. I tried that enough times to convince me that there was something there I did not understand. I had always thought that lubricant simply made the tools last longer. I did not know that there was any appreciable difference in power consumption, so we brought a motor to that machine and attached a recording watt-meter and went at the proposition in such a manner that we could find out what was happening, and after experimenting for several days we found that on that heavy cutting there was a difference of forty-three per cent in the power required to machine that piece with and without cutting lubricant. As we came down and tried lighter cuts we found, of course, less difference. But there was forty-three per cent on that particular piece, and it is an item, because we have to pay coal bills and we also have to pay for tools that we burn up. Under those conditions it does not pay us to generate too much heat or to keep on generating any unless means are provided to absorb it in a cutting lubricant.

Further experiments along that same line showed us that pieces which we tried to machine without any lubricant became so heated that it was not only difficult to handle them, but the dimensions were all out. A hole 15 inches in diameter, when the piece was cold, became 15 inches plus 0.009 inch when a light facing cut was taken across the top of the casting. Had we taken measurements of that piece when it was hot they would have been incorrect, and we should have had to make an allowance for that heat, and the allowance for that heat is an unknown quantity, depending entirely upon the shape of the piece and the amount of heat which we generate. I believe that not only will we turn all steel with cutting lubricant in the future, but I believe that we will turn cast iron with cutting lubricant. We have tried that in our works and it is not such a foolish thing as you might think. We had some large castings which had to be accurate and which got very warm in roughing out; consequently the error was an unknown quantity. We found that by using cutting lubricant we kept the piece cool and eliminated the possibility of error. Cutting lubricant is a thing you will have to deal with. It will represent an investment that it is wise to make, and you will find that production will be increased for the investment, particularly when you come to turn alloy steel.

Use of Better Materials to Promote Durability

We will now take up the question of durability. What are we going to do to make our machines stand up? As we go around our shops we find a machine "down" here and there. Now what are we going to do to make them stand up? We cannot do it by using the carbon steels. Automobiles would not run to-day if they depended upon the steel which went into automobiles ten years ago. We must use alloy steel. This is not the age of steel any more—it is the age of alloy steel. The alloys introduced into steel give it wonderful qualities. You can make a gear from chrome-nickel alloy steel and after heat-treating it you can hammer one of the teeth over against one of its fellows without breakage. You cannot do that with a piece of cast iron. Why is it possible with alloy steel? Because of its physical characteristics—240,000 to 245,000 pounds elastic limit and 260,000 to 270,000 pounds tensile strength. From this grade of steel we can produce machines guaranteed to give certain fixed results.

There is another machine building material available to-day that we did not have ten years ago. Now we can get beautiful steel castings—castings made of steel that run almost as good as gray iron castings, and much stronger. We can buy them on a chemical and physical analysis; if we want 40-point carbon, the foundryman can produce them.

Machines should be Self-oiling

About a year ago I was in a machinery dealer's store looking at a very handsome machine. It was beautifully painted and beautifully polished. Every detail had been taken care of. I noticed a little round disk as large as a twenty-five-cent piece which said "Oil here." I commenced to look over the machine and I found one-hundred-and-fourteen of them. There were one-hundred-and-fourteen holes on that machine that required attention. A man had to go around every morning with a squirt-can and oil those holes. There are one-hundred-and-fourteen chances to one that he will miss *one*, and it may be the most important one on the whole machine.

Now, that set me to thinking and making comparisons. I had an automobile years ago that I had to go over about every twenty miles with a squirt-can to oil the engine and other parts. Later I had a car which pumped oil into the engine; it pumped oil through the engine and back again automatically—the perfection of lubrication. Naturally, we studied the problem of lubrication on our own machines from the new viewpoint, and to-day I am convinced that forced lubrication—not squirt-can lubrication—is one of the elements in machine design which we have to consider. I believe that five years from now all machine tools will be so lubricated. It is obvious—we cannot get away from it. There is no amount of criticism that will prevent its being done. The objection which is raised that the oil will get dirty has no foundation. You can filter it if you want to. You can pump it up into your machine, distribute it to the running parts, and you will be surprised to notice the increased efficiency of a machine so lubricated. I think it is a fair assertion to make that with properly proportioned bearings, so lubricated, the two metals cannot come in contact with each other. The film of oil being constantly maintained by a fresh supply, the life of the machine is prolonged indefinitely. We have produced machines that I fully expect to run a hundred years and not wear out. They will become out of date, but the parts lubricated by the automatic system will not wear out.

Limited Belt and Gear Speeds

Another factor in durability is limited belt speeds. There are limits to everything. Belts are efficient up to a certain point, and when you run them faster than the critical speed they cease to be efficient and larger belts are required. Some of you may argue that you do not believe in belts—that you want the machines motor driven. Very well, reasonable speed still holds good. We all prefer moderate speed motors. We no not want our gears running like buzz saws. Gears can run comfortably and easily and still do their work. This applies just as well to a machine tool as to an automobile.

Another word about excess belt power. I spoke of that before. You do not want to be right up to your limit in everything. If you erect a building you want to have a factor of safety in that building. Should you not have that same reasonable factor in your belts? A factor which will give your belts longer life and give you larger results. Your belt need not be so tight if it is large enough.

A further word about limited gear speeds. Gears running above 600 feet a minute are liable to be noisy, whereas gears running less than 600 feet peripheral speed a minute will be quiet. Our text-books tell us that gears can be operated at 1200 feet per minute. Our automobile men run them up to 2000 feet at times, but only on a low gear and the maximum engine speed.

Importance of Adaptability

I gave as the first two essentials of machine tool design productibility and durability, and will now take up adaptability. The first point is adaptability to the work. The tool equipment must be universal equipment. We are not considering a special machine purchased for a special purpose. Therefore the tool equipment should be a universal tool equipment; it should be a standard tool equipment purchased from the maker of the machine. The second point is ease of setting up. If the total time for doing a piece is an hour, and a man has to spend half an hour setting it up, that means inefficiency. Now, how to save on that setting up time—how can it be reduced? By getting machines which, when you shift a lever, will go ahead as you direct. That machine which can be controlled will be adaptable because of the ability to set it up for each job in the shortest possible time; it will be efficient in that respect. And how shall we save time between cuts? What is the use of taking cuts at high speed—ripping things to pieces—and then losing all the gain because we cannot reduce the time between cuts? To reduce costs you must reduce the time between cuts. Losing time between cuts is a condition exactly like that of the idle freight car which is said to be in use but two hours out of the twenty-four. You can make big saving of the time lost in your shops by using a machine which is so controlled that the changes of speed and changes of feed and everything required to put that machine into operation can be effected in the shortest possible time.

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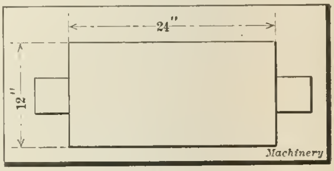
RELATION OF PRICE OF TOOL STEEL TO MANUFACTURING COSTS

BY FREDERIC B. JACOBS*

Mr. D. G. Clark's article on the relation of price of tool steel to manufacturing costs, published in the November issue of MACHINERY, brings out a few interesting points that are well worth considering. His conclusions are correct, from the viewpoint of the salesman who is selling a high priced steel, but we should not lose sight of the fact that the gentleman who sits at the other side of the desk—that is, the purchasing agent—generally considers the fact that there are two sides to every argument. In fact, many purchasing agents can show figures to prove that production should increase in direct proportion to the cost of materials.



Type of Casting used to test Efficiency of Different Tool Steels

Let it be supposed that a steel salesman loaded with figures to back up his claims, and all cocked and primed to shoot off convincing arguments, calls on the purchasing agent of the average manufacturing concern. Now in these days of keen competition, it is indeed hard to find a purchasing agent who will "fall" for a mere "line of talk," no matter how convincing; he must be shown. It must be taken into consideration that the purchasing agent has to listen to the arguments of salesmen who are keen competitors and, therefore, he hears the question of efficiency discussed from all the conceivable points of view. However, after the enthusiastic salesman, with a line of high priced steel, has summed up his argument to prove that his is the *only* brand of steel on the market that will attain the results he claims for it—all salesmen have faith in their own goods, or at least they should have—it will do no harm for the purchasing agent to order a small quantity to be tested as he sees fit.

Let it be supposed that the manufacturing concern in question does quite an amount of cast iron turning. In this case, a practical test can be undertaken with two castings of the form shown in the illustration. It is advisable for all tests of materials to be performed under the supervision of the mechanical engineer, if the concern employs one; otherwise they should be undertaken by the shop foreman. The steel that the shop has in use at the present time should be tested on the first casting, at the peripheral speed and feed that are in use for the regular production of the work. The object of the test is to prove the efficiency of the steel by showing the amount of metal removed at one grinding of the tool. The depth of cut should be the same in all cases throughout the tests, and the test should be carried to a point where the tool refuses to cut. By weighing the casting before and after making the test, the exact number of pounds of metal removed at one grinding can be accurately determined. The sample steel should then be tested on the second casting, and the results carefully compared. It is the saving in grinding that amounts to dollars and cents, both on account of the steel ground away and because of the time consumed in grinding.

The purchasing agent mentioned in the first part of Mr.

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Clark's article takes the stand that a steel that costs twice as much as another should give twice the production. Let us suppose that a steel selling at forty cents per pound removes fifty pounds of metal before refusing to cut, and that steel at eighty cents per pound removes one hundred pounds. In this example, the high priced steel requires only half as much grinding as the low priced steel, to remove a given amount of metal. Therefore, to remove two hundred pounds, it is necessary to grind the high priced steel twice, once before starting work and again after the first one hundred pounds have been removed. To make the low priced steel remove the same amount of metal, it is necessary to grind it four times, once before starting, and again after every fifty pounds are removed. The results in the two cases then compare as follows:—

Forty-cent Steel—

Time of four grindings 20 minutes at ½ cent per minute	$0.10
Cost of ⅛ inch of 1½ by ¾ inch steel	0.01 2/3
Total cost	$0.11 2/3

Eighty-cent Steel—

Time of two grindings 10 minutes at ½ cent per minute	$0.05
Cost of 1/16 inch of 1 1/2 by 3/4inch steel	0.01 2/3
Total cost	$0.06 2/3

In these figures, 1/32 inch of steel is allowed for each grinding; the tools are newly ground when starting and are supposed to be used until they refuse to cut. It is evident that if the high priced steel will do double the amount of work, its use is economical, as in the preceding test it saves the cost of two grindings—or 5 cents. It is also apparent that the grinding wheel is used only half as much with the high priced steel, and therefore should last twice as long. For the sake of another example, let us assume that a grinding wheel costs $7 and lasts for a year of 300 working days. We will also suppose that on the regular production work, six grindings per day are necessary with the high priced steel and twelve grindings with the low priced steel. From this we have the following result:

Forty-cent Steel—

Steel consumed in grinding, allowing 1/32 inch for each grinding, 112.5 inches; weight of 112.5 inches 1½ by ¾ inch steel, 37.5 pounds; cost of 37.5 pounds	$15.00
Cost of grinding 3600 times, at 2½ cents per grinding	90.00
Cost of wheel	7.00
Total cost	$112.00

Eighty-cent Steel—

Steel consumed in grinding, allowing 1/32 inch for each grinding, 56.25 inches; weight of 56.25 inches 1½ by ¾ inch steel, 18.75 pounds; cost of 18.75 pounds	$15.00
Cost of grinding 1800 times at 2½ cents per grinding	45.00
Cost of wheel	3.50
Total cost	$63.50

From the above example, it is evident that a saving of $48.50 per man has been effected by using the high priced steel for a period of 300 working days. So far, very good; but where is the $48.50? According to the purchasing agent, no saving is shown, as his purchases of steel are the same in both cases. The only economy that he can see is the $3.50 saved on the purchase of grinding wheels. In a well organized shop, the works department could probably show where production had been increased, thus accounting for the $48.50. In the average shop, however, it would be a hard matter to locate the amount that was saved, or at least to show that a saving had been accomplished which could be laid directly to one item, as tool grinding in this instance. In actual practice, a machinist seldom waits until a tool really needs grinding; he grinds it as soon as it commences to become dull.

Making due allowance for the personal element as regards the grinding of tools, let it be assumed that a machinist grinds the high priced steel tool nine times a day, where it was formerly ground twelve times a day when the low priced steel was used. This is a fair argument, as it does not go to extremes in either direction. The results with the high priced steel would be as follows:

Eighty-cent Steel—

Steel consumed in grinding, allowing 1/32 inch for each grinding, 84⅜ inches; weight of 84⅜ inches 1½ by ¾ inch steel, 28⅛ pounds; cost of 28⅛ pounds	$22.50
Cost of grinding 2700 times at 2½ cents per grinding	67.50
Cost of wheel	5.25
Total cost	$95.25

As the total cost with the low priced steel is $112, we have a saving for a year of 300 working days of $16.75. Again, where is the $16.75? If we ask the purchasing agent, he will tell us that he has effected a saving of $1.75 in grinding wheels, but that he has paid out $22.50 for steel as against $15, the price paid when forty-cent steel was used. In other words, it has cost $7.50 more per year per man to use the high-priced steel, even though the steel showed an actual saving of twenty-five per cent in the grinding time.

To sum up the whole matter, if a steel salesman informed a purchasing agent that his steel would effect a saving of twenty-five per cent of the grinding time, the argument would be interesting no doubt, even if the material did cost one hundred per cent more than an inferior article. The figures in the last example prove, however, that the results would not warrant paying the extra price. When it comes to a question of efficiency, Mr. Clark is correct from his point of view, and the writer is also correct from his standpoint. Yet there are plenty of efficiency engineers who would claim that both are wrong. It is up to every manufacturing concern to test materials according to their own methods, and to be guided by the results thus obtained. Aside from the fact that the writer is himself a salesman, he strongly believes in buying the best material that the market affords. However, we must not lose sight of the fact that the purchasing agent knows a little about salesmanship himself, and while it is unnecessary to doubt any salesman's word, it is a good plan to have all new material thoroughly tested, and to be guided by the results shown in actual use.

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EFFICIENCY OF COPPER PLATING IN PREVENTING CARBONIZATION

A paper on "Case Carbonizing" by Marcus Lathrop, which was presented at the December meeting of the A. S. M. E., sets forth the results of experiments that were conducted to determine the efficiency of different thicknesses of copper plating in preventing the absorption of carbon by steel during the process of casehardening. An effort was also made to ascertain the conditions under which a plate could be obtained to effectually prevent carbonization. The stock used for the test pieces consisted of 20-point carbon basic open-hearth steel. These test pieces were 3½ inches long by 0.450 inch in diameter; they were set up on centers in the lathe and turned to 0.460 inch and then ground down to the required diameter of 0.450 inch. The final size was carefully micrometered to 0.0001 inch, all of the micrometer measurements being made by the same man to reduce personal error as far as possible. The test pieces were then copper plated, all conditions of the operation being kept constant except the actual time of plating, this time being carefully noted in each case. Direct electric current for all plating operations was furnished by a 4-pole direct-current dynamo, which was belt-driven by an alternating-current constant speed motor. The rated capacity of the dynamo was 360 amperes at 6 volts.

After plating, the test pieces were micrometered to determine the thicknesses of the plate; they were then carbonized under standard conditions to give a depth of case of 1/32 inch. The carbonization was conducted in an American Gas Furnace Co.'s gas fired muffle furnace No. 4 and the carbonizing material consisted of a mixture of one-half new and one-half used carbonaceous material. After carbonizing, the pieces were set up in a lathe and the copper removed with emery cloth, after which they were again carefully micrometered.

Two cuts were taken on each test piece, each point being 0.005 inch on the radius, reducing the diameter 0.010 inch. The turnings obtained were very fine, and particular care was taken to prevent the introduction of any foreign material. The carbon determinations on the turnings obtained from each cut were made by direct combustion.

The results of the experiments showed that the thickness of the copper plate that is necessary to entirely prevent the penetration of carbon must be 0.0005 inch. Microscopic inspection before and after carbonizing the copper plated test pieces of steel showed that the copper coating was not continuous when the thickness was less than 0.0005 inside.

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MACHINING CROWN BRASSES ON A DILL SLOTTER

The usual manner of finishing crown brasses for locomotive driving boxes is first to plane the ends of the rough castings, scribe them to the particular driving boxes into which they are to be forced, mount them upon special arbors and turn them in the lathe, after which the sides are planed so that they may be dovetailed into place. At the Philadelphia & Reading Railroad shops, Reading, Pa., this work is handled in an entirely different manner. After the rough castings have been faced on the ends and the lines scribed preparatory to fitting to the driving boxes, they are mounted on the rotary table of a Dill slotter, as shown in Fig. 1. By means of a special indicator which may be seen fulcrumed from the top of the stud, the brasses are quickly located. They are moved about until the scribed line coincides with the path of the indicator, after which the work is clamped firmly in position. A roughing cut is then taken, using the tool shown in the slotter head. This operation is shown by the illustration Fig. 2. A finishing cut follows, which leaves the work in good condition. At the same setting the sides of the brass are dovetailed to fit the driving box. This last operation is made possible by the fact that the slotter tool is sharpened to cut from any of three directions, and thus the subsequent operation of planing is dispensed with. Because of the reduction in the number of operations from three to two, as well as because of the fact that the slotting operation is performed more quickly than the turning operation, the reduction in the time required on this job is very decided. In fact, the slotting operation, including roughing and finishing, is performed in from 7 to 22 minutes, according to the size of the brasses, which range, in depth of cut, from 8 to 13 inches.

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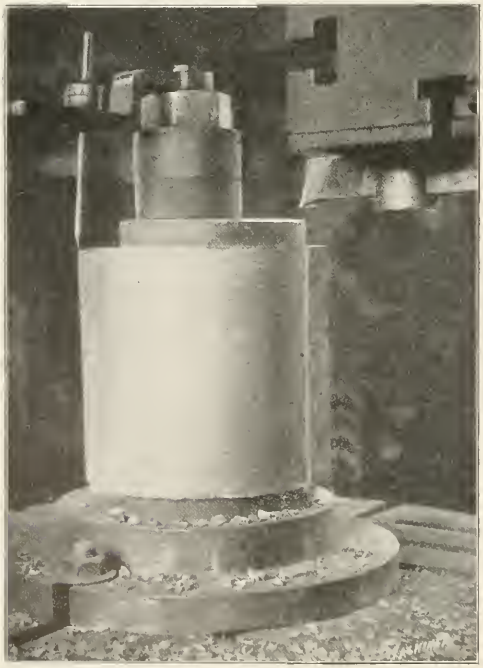


Fig. 1. Method of mounting the Crown Braes on the Slotter

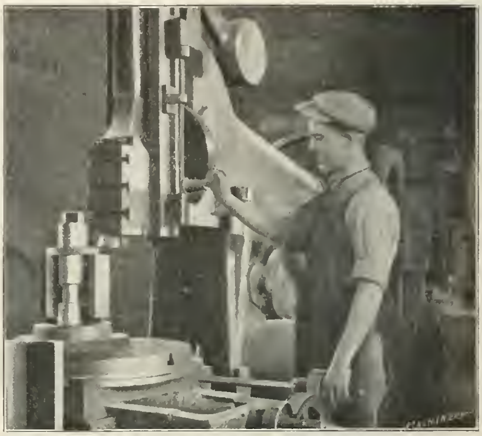


Fig. 2. Machining Crown Brasses by Slotting

* * *

SPECIFICATION FOR CEMENT TOP FLOORS

The Aberthaw Construction Co., Boston, Mass., specifies as follows for cement top floors. "This specification is for laying hard finish on new rough concrete, either paling or slabs supported by forms. Finish to be mixed one part of cement to two parts of crushed trap rock or hard gravel which will pass through a half-inch sieve, and from which the fine dust has been removed. This is to be thoroughly mixed in a mixing box or by a machine mixer, with a sufficient amount of water to produce a plastic but not a sloppy consistency, and spread on the under-concrete before either the finish or the under-concrete has had time to set. It is next floated with a wooden float to a true level, and then lightly troweled with a steel trowel to bring it to a proper level and to smooth the top slightly. This will give a finish which is pebbly; it will not be dead smooth or slick like a sand finish. After the finish has been troweled and has set sufficiently so that the covering will not mar the surface, it should be covered with sawdust, sand, cloths, or any other material which will hold water continuously. In building reinforced concrete work, difficulty will be caused by the sand and sawdust blowing about the work, filling the forms, and getting in the way generally. In working around a textile mill there is usually plenty of old bagging, and in a paper mill there is generally plenty of old felts which can be borrowed for the purpose of preventing this difficulty. The finish should be kept soaking wet for at least a week, or better for ten days. After two days it is possible to put up studs, and do miscellaneous work on top of the new finish, provided it is not allowed to dry out."

* * *

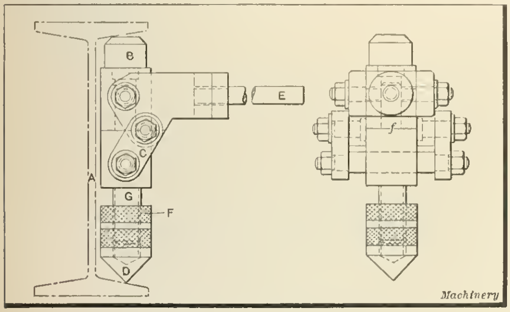
The following claim is quoted from a patent application recently filed at the patent office in London: "No. 21,262-1912, Holroyd. Floating docks and pontoons combined with ship molding and casting in one, jointless and rivetless sunken ship lifters, telescopic tubular deep sinking, working observatories, syphonic capillary power generators, quadruple compound explosive reversible turbines, smelting furnaces, segmental ship molds, cranes, rams, pumps, machinery in workshops, in one complete whole." This claim indicates, says the *Practical Engineer*, that Mr. Holroyd is a well-meaning man, and it is to be hoped that he will secure for himself a period of monopoly in his improvements as a return for the information which he is adding to the engineering knowledge of the world.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

TOGGLE-JOINT HOLDER-ON

The usual method of riveting plates, etc., to I-beams is not always an easy operation. In order to facilitate the work, a toggle-joint holder-on, such as shown in the accompanying engraving, is of advantage when riveting I-beams or channel irons. The illustration shows a holder-on, such as is used in the works where the writer is employed. At *A* is shown the outline of the I-beam; *B* is an ordinary rivet set attached by counterboring the top of the holder-on. Rivet set *B* engages the head of the rivet, while the point *D*, which is hardened, grips the lower flange of the I-beam. This point is adjustable on screw *G* and is held in place by lock-nut *F*. Considerable power can be exerted by applying pressure to the end of handle *E*, operating the toggle-joint *C*. This device makes it possible to hold the rivet firmly until a thorough job of riveting has been made, and it can be very quickly and easily operated.

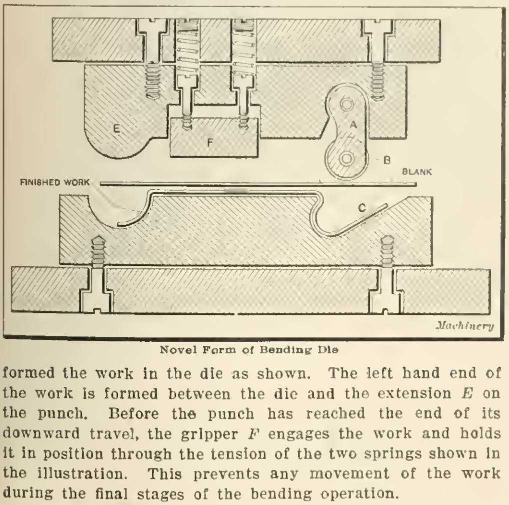


A Holder-on for riveting I-beams and Channels

M. W. W.

A BENDING DIE

In the illustration is shown a bending die, designed by the writer for the Eagle Tool Co., Cincinnati, Ohio, to meet the requirements of a certain bending operation on 16 gage sheet metal. It will be seen from the illustration that a swinging arm *A* is pivoted at one end of the punch; this arm carries a steel roll *B*. When the punch descends this roll bends the stock down into the die at *C;* when the downward travel of the roller is checked by the die, the arm *A* swings to the left and continues to move in this direction until the roller has formed the work in the die as shown. The left hand end of the work is formed between the die and the extension *E* on the punch. Before the punch has reached the end of its downward travel, the gripper *F* engages the work and holds it in position through the tension of the two springs shown in the illustration. This prevents any movement of the work during the final stages of the bending operation.

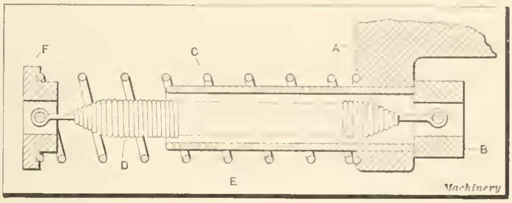


Novel Form of Bending Die

Cincinnati, Ohio HENRY BECKER

A COMPOUND SPRING

We wished to lengthen the stroke of the slide on a machine without lengthening the spring which controls its return. The illustration shows the method which was adopted, the compound spring members *C* and *D* being substituted in place of the single spring *D* which was originally used. *A* is the slide which is to be returned by the spring to the stop *B*. The action of the compound spring is as follows: the compression spring *C* is compressed until the tube *E* comes in contact with the stop *F*. From this point, the travel of the slide is against the tension of the spring *D*. The slide then travels forward the desired distance, its return being effected by the action of the two springs, in the same manner as for the forward travel of the slide. The tube *E*, in addition to affording a method of engagement between the slide and stop *F*, serves the further purpose of keeping the two springs apart.

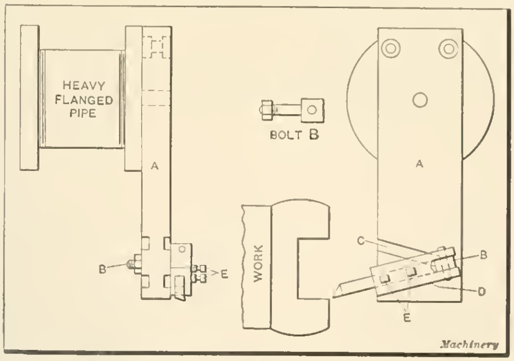


Compound Spring for returning Slide after Stroke was increased

Manchester, England H. GUSENNEP

SIDE EXTENSION FOR PLANER HEAD

The side extension for a planer head shown in the accompanying illustration was made for use in connection with a piece of work that really required the use of a planer equipped with a side head. It happened, however, that such a machine was not included in the shop's equipment, and consequently it was necessary to rig up the device which it is the object of this letter to describe. The piece of work to be planed is shown in the illustration, where it will be seen that there is a horizontal channel in the side of the work. The length of this piece was too great to enable it to stand on end and pass under the crosshead, but very satisfactory results were obtained by using this substitute for a side head.



Side Extension for Planer Head and Work on which it is used

The bar *A* is faced on each side and one end is drilled to receive the bolt *B* which secures the tool-holder *D* in position. The opposite end of the bar *A* is bolted to the planer head in place of the clapper and clapper box. Two grooves *C* are located on each side of the bar *A*, one groove only being shown in the illustration. These grooves are milled at an angle of 15 degrees with the horizontal and central with the hole for bolt *B*. The block *D* has a square hole to receive the tool and two set-screws to hold the tool in place.

A tongue is planed on *D* on the opposite side to the set-screws, which is of such a size that it is a working fit in the grooves *C*. The block *D* and the bolt *B* are pinned together and bolted to the bar *A*.

The illustration shows a tool in position to plane the lower side of the channel in the work. To plane the upper side of the channel, the nut on the bolt *B* is loosened sufficiently to allow the block *D* to be changed over to the upper groove *C*. The tool is changed for one of the opposite hand and the device is then ready to plane the upper surface of the channel, which it would be practically impossible to do without either some device of the kind mentioned or a regular side head planer. Part of the vertical face of the channel is planed with the block *D* in each position. The tool and block *D* would raise somewhat when the planer reversed for the return stroke and a spring, which is not shown in the illustration, returns it to place when it is about to start on the cutting stroke. When the device is to be used on the other side of the planer, it is merely necessary to turn bar *A* over, remove tool-holder *D*, and bolt it on the opposite side.

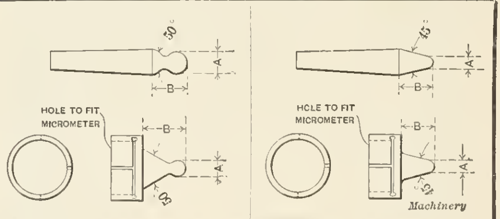
The extension, shown more clearly in the side view, is used for working on pieces which are too wide to pass between planer housings. The extension is made of heavy pipe and a flange screwed on each end holds the bar *A* as far as necessary in front of the crosshead. The device is as rigid and satisfactory as an equipment of this kind can be made.

Pueblo, Colo. C. L. NEWTON

MEASURING SCREW THREADS BY MEANS OF MICROMETERS

The editorial entitled "Measuring Screw Threads" in the November number of MACHINERY, refers to a subject that is of interest to all makers and users of screws and taps. There is a great deal of ignorance on this subject, and it would be of advantage to all concerned if the users of taps and screws could be taught the proper methods of measuring screw threads.

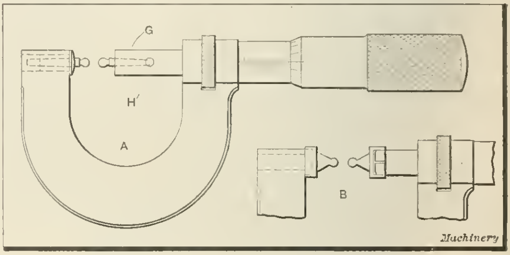
TABLE OF POINTS FOR BALL-POINT MICROMETERS



No. of Threads per inch calculated for	A	B	No. of Threads per inch used for	No. of Threads per inch calculated for	A	B	No. of Threads per inch used for
3½	0.164	9/32	3½	18	0.031	3/32	18–20
4	0.143	9/32	4	22	0.026	1/16	22
4½	0.127	9/32	4½	24	0.023	1/16	24–26
5	0.111	9/32	5	28	0.020	1/16	27–30
6	0.095	5/32	6	32	0.018	1/16	32–34
7	0.081	5/32	7	36	0.016	1/16	36–38
8	0.070	5/32	8–9	40	0.014	1/16	40–46
10	0.059	3/32	10–11	52	0.011	1/16	48–60
12	0.049	3/32	12–13	66	0.0086	1/16	62–72
14	0.042	3/32	14–15	..	.....	..	..
16	0.036	3/32	16	..	.....	..	..

When measuring screw threads by micrometers, in cases where a standard gage is available to use for comparison, the ball-point micrometer shown in the accompanying illustration is a most convenient tool. This type of micrometer, as is probably well known, is used almost exclusively for comparing the angle diameter of a tap or screw thread with that of a standard thread plug gage. Wherever a great deal of measuring of screw threads has to be done, there is no question but that this micrometer will prove very advantageous, as it does not get out of true as quickly as the ordinary screw thread micrometer, which, when used regularly, will give incorrect readings on account of its delicate construction and consequent wear, and, therefore, must be frequently and carefully adjusted.

Neither kind of micrometer, however, (the ball-point micrometer or regular screw thread micrometer) will give correct readings unless the angle of the thread is correct, and frequently users of these measuring tools make serious mistakes owing to the fact that they depend entirely upon the thread micrometer, without investigating whether the angle of the thread is exactly correct. The regular screw thread micrometer has, of course, an advantage in this respect, as it is possible with this type to detect any appreciable error in the angle of the thread by noticing the contact between the anvil and the thread to be measured.



Ball-point Micrometers for measuring Screw Threads

Anyone engaged in the manufacture of either screws or taps, or any user of large quantities of these that are regularly inspected, will, of course, find the regular screw thread micrometers indispensable, but they should be used for reference only. For constant comparison with standard gages, the ball-point micrometer shown in the accompanying illustration should be used. It will be found that the saving in expense and upkeep of micrometers will amount to a considerable sum in a year. Two types of ball-point micrometers are ordinarily used. One is simply a regular plain micrometer with ball points made to slip over both measuring points. (See *B* in the accompanying illustration.) This makes a kind of combination plain and ball-point micrometer, the ball points being easily removed. These ball points, however, do not fit solidly on their seats, even if they are split, as shown, and are apt to cause errors in the measurements. The best, and in the long run, the cheapest method is to use a regular micrometer arranged as shown at *A*. (An inexpensive grade will do, as the ball-point micrometers are only used for comparison anyway.) Drill and ream out both the end of the measuring screw or spindle and the anvil, and fit ball points into them, as shown. Care should be taken to have the ball point in the spindle run true. The holes in the micrometer spindle and anvil, and the shanks on the points are tapered to insure a good fit. The hole *H* in spindle *G* is provided so that the ball point can be easily driven out when a change for a larger or smaller size of ball point is required.

A table is given with dimensions for ball points to be used for different numbers of threads per inch. These points will fit approximately halfway between the top and the root of the thread in a U. S. standard thread.

It might be remarked that if one wishes to obtain the correct angle of a screw thread, as compared with that of a gage, this can be done with a ball-point micrometer by using different sizes of ball points, comparing the size first near the root of the thread, then (using a larger ball point) at about the point of the pitch diameter, and finally near the top of the thread (using in the latter case, of course, a much larger ball point). If these three measurements agree on the gage and the thread being measured, the thread angle is correct. A.

ERASING ON TRACINGS

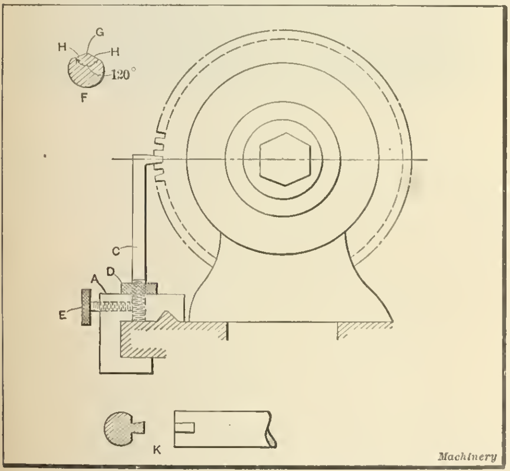
In the article in the September number of MACHINERY, entitled "Erasing Ink Marks from Tracings," Mr. Allison says: "Always allow the ink to dry thoroughly." The writer's advice is: Do *not* allow the ink to dry, but smear it over the tracing cloth with the finger, and *then* let it dry. This action in no way affects the surface of the cloth, as it merely spreads the ink out thin, so that it can be erased very easily without much rubbing, and, if carefully done, without the slightest injury to the surface of the cloth. Very little if any mark will be left by the erasing, and never enough to show on a blueprint. As the surface is not injured, the use of soap-stone is not necessary and the erased spot will not collect dust.

Ink, when placed on tracing cloth, will stand above the surface of the cloth. When it is allowed to dry without disturbing it, there is a thick film of ink powder deposited. This is very hard to erase and a great deal of rubbing is required, which usually injures the cloth. By thinning the ink, the film of ink powder deposited is very thin and more easily rubbed out. The writer has used this method for a long time and found it very successful.

La Grange, Ill. CLYDE L. ADAMS

BROACHING HEXAGON COLLETS IN THE LATHE

Probably the most unusual work done on the lathe is that of keyseating and broaching. However, there are times when it is very handy to be able to do this work in a lathe. The writer has had occasion to broach some hexagon collets in the lathe, and the method used may be of value to others. A taper bushing was first made for holding the collet in the lathe spindle. The collet blank was then turned to size and pressed into the bushing. A stop *A* for the carriage was provided, as shown in the accompanying illustration. This stop also served the purpose of holding the index rod *C*, and was clamped to the lathe bed by suitable means. The indexing rod *C* was made of ¼-inch drill rod, and by means of collar *D* was made adjustable. The rod itself was clamped into position by the knurled screw *E*.



Showing Method of Indexing for broaching Hexagon Collets in the Lathe

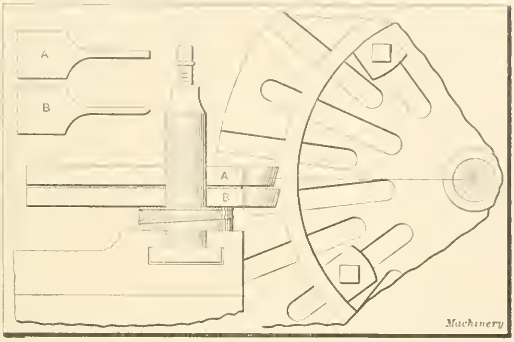
The tool for the broaching was made from ¾-inch round tool steel, milled on the end as shown at *F*, so as to provide two cutting edges with an angle of 120 degrees between them. This tool was placed in the toolpost, care being taken that point *G* was in line with the lathe center and that the cutting faces *H* were in correct relation to the collet to be broached. The teeth in the cone gear were now counted and divided by six, and the indexing rod *C* brought into position, as shown. The spindle was locked and two sides of the hexagon broached by feeding the tool through the collet by hand until the proper depth was reached. Then the spindle was unlocked, turned one-sixth of a revolution and the same operation repeated until all the faces were broached to a uniform size.

Good keyways may also be cut by using a lathe tool of the type shown at *K*. A great deal of work can be done in the lathe by methods similar to the one described.

Lafayette, Ind. W. H. ADDIS

CUTTING OFF PACKING RINGS

When the metal is hard, the operation of cutting off packing rings according to ordinary practice requires the tool to be reground at frequent intervals. In order to reduce the loss of time caused by this grinding to a minimum, a combination of the two tools illustrated was adopted. The tool-post in which these were used takes tools 1½ by ¾ inch; consequently, they were made of stock ¾ inch square.



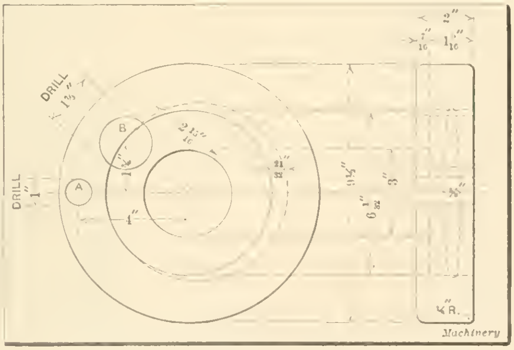
Improved Method of cutting off Packing Rings

The upper tool *A* is made with the usual clearance and a square point ⅛ inch thick. The lower tool *B* has no clearance; it is somewhat thinner than *A* and has a gothic point. The two tools are placed in the toolpost with a strip of metal about ⅛ inch thick between them. Tool *B* leads tool *A* by about 1/64 inch. The increased efficiency of operation secured in this way is due to the action of *B* in splitting the chip. By this means it was possible to turn out three times the amount of work formerly done.

Birmingham, Ala. W. B. ODELL

SAFETY LATHE DRIVER

The accompanying illustration shows a safety lathe dog or driver designed by the writer and used in the machine shop in which he is employed. The special features of this driver are the positive grip or hold on the end of the shaft, and the absolute safety, as the operator, even when filing close to the driver, cannot possibly be caught or injured by the device, as there are no projections on it. The shafts on which this particular driver is used are of machine steel, 4 feet 1 inch long, with a head on one end turned to a diameter of 6 inches, the width of the head being 1⅝ inch. The remainder of the shaft is turned to a diameter of 4 inches. The driver is made of forged machine steel of the dimensions shown. It is counterbored with a hole 6 1/32 inches in diameter by 1 9/16 inch deep. The remainder is bored to



An Unusual Type of Safety Lathe Driver or Dog a diameter of 3 inches to allow the lathe center to enter. A groove of 5/16 inch radius is cut at one side in the 6 1/32-inch bore and eccentric to it. A ⅝-inch hardened steel ball is laid in this groove and rolls freely in it. The groove is casehardened. The hole *A* opposite the deepest part of the ball groove is drilled for the driving stud in the faceplate. Hole *B* is used for inserting a gage by means of which the length of the head on the shaft can be measured, when the shaft is in place in the driver.

The driver, with the ball in the deepest part of the groove, is slipped on the head of the shaft and the shaft placed on the lathe centers. When the lathe is started and the cutting tool brought into contact with the shaft, the ball becomes wedged between the bottom of the eccentric groove and one side of the shaft head, and will thus drive the shaft. To release the driver, the lathe is stopped with the driving stud on the top. The shaft is held from rotating and the lathe reversed slightly. The ball will then fall to the deepest part of the groove and the shaft with driver attached can be taken from the lathe centers, and the driver slipped off. The only evidence of the use of this driver on the shaft is a small oval shaped dent on the shaft head, caused by the pressure of the ball. **Edwin Chapman**

Catasauqua, Pa.

A FORMING TOOL FOR ROUGHING AND FINISHING

The accompanying illustrations show a cone for a ball bearing and the tool which is used for roughing and finishing it from bar stock. This bearing is one of the numerous types which are made for use in a large line of builders' hardware and hardware specialties. In the process of manufacture, the cones are turned from bar stock in either an automatic or hand screw machine, the type of machine used depending on the quantity of work required. After machining, the cones are casehardened and are then ready for use without any subsequent machining or grinding; consequently it is necessary that they have a good finish and be close to the required size.

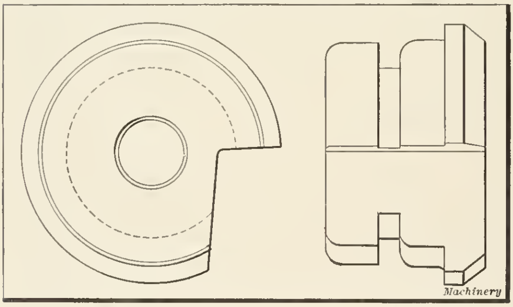


Fig. 1. Forming Tool for roughing and finishing Ball-bearing Cones

Fig. 2 shows the bar stock with a cone which has been formed and is ready to cut off. The dimensions of the finished cone are given to show the difference in the roughed and finished parts. It will be noted that the size of the roughed portion *A* is larger in diameter than the finished part *B*, also that the length of the roughed cone is longer than the finished cone; this provides for the metal removed in the finishing operation and by the cutting-off tool. Fig. 1 shows the general appearance of the forming tool used for the production of these cones. The design of the tool and the method of holding it, could be varied to suit the requirements of a variety of work used from bar stock. It has been found advisable to make forming tools of this kind from high-speed steel. Forming tools made on this principle are more expensive than single tools would be, but the saving in the cost of production by this method fully justifies the additional expense involved in tool making. The roughing portion of the cutter is not required to be made with great accuracy as the finishing end governs the final dimensions of the work. This tool is, of course, intended for single spindle machines.

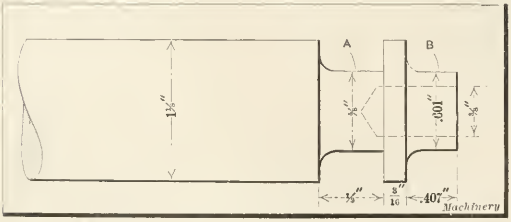


Fig. 2. Bar with Finished Cone ready to cut and Second Cone roughed

Aurora, Ill. **Corwin Lamoreaux**

EMERY WHEEL DRESSER

Many of the universal grinding machines are not provided with a good device for holding the diamond when truing up a grinding wheel. The device shown in the accompanying illustrations eliminates the necessity of relying upon the steady hand of the operator, which, in many cases, is impracticable. A simple device is shown in Fig. 1 applied to a Brown & Sharpe machine. It is quickly placed in position by being clamped to the table with a T-head bolt. It is rigid and suitable for all shapes of wheels. The line engraving shows the

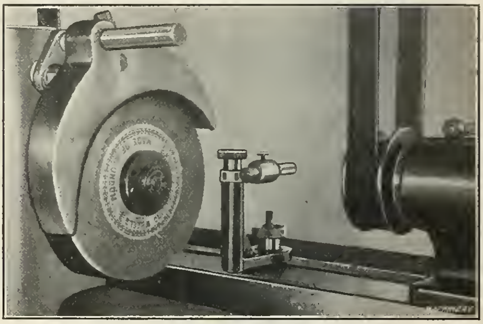


Fig. 1. Adjustable Emery-wheel Dresser applied to a Brown & Sharpe Grinding Machine

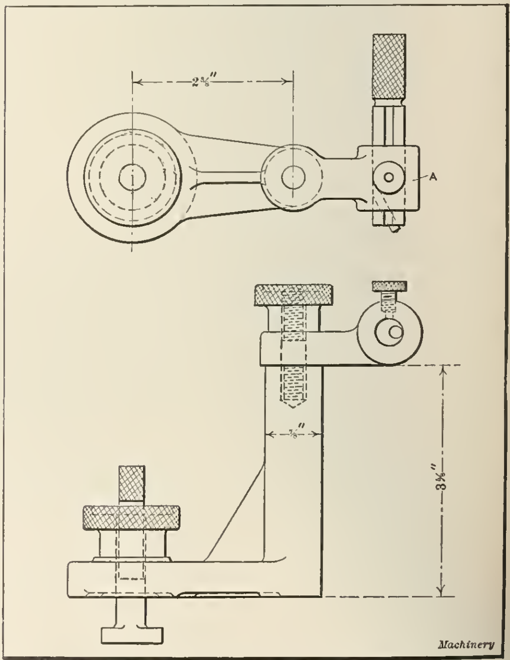


Fig. 2. General Construction of Emery-wheel Dresser

general construction, and indicates that the arm *A* can be swung to various positions to suit the different wheels. The diamond is brazed into a taper pin, which is set at an angle to the axis of the holder. This provides a self-sharpening means for the diamond. When a flat appears, the pin is driven out and revolved a slight amount so as to bring a new point in contact with the wheel. C. T.

DO BELTS RUN TO THE "HIGH SIDE" OF PULLEYS?

In the October issue of MACHINERY, "T. J. C." stated "It is a common experience noted by all mechanics that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, run to the 'high side.' Why is this so?" In reply to this the writer wishes to say that he does not agree with "T. J. C." In fact, his experience has been just the reverse. For instance, in installing motor drives the writer never bothers about lining up the motor shaft with the first counter- or main-shaft, but simply sets the motor on the floor or platform about square, levels it up and puts on the belt. The motor shaft is then turned by hand, taking care not to touch the belt, when the side of the pulley to which the belt runs indicates the alignment of the shafting. It has always been the writer's experience that the belt runs in the direction in which the two shafts come together, or to the "low side" of the pulley, and to cure this trouble he simply spreads the shaft on this side by slipping the motor around. If "T. J. C." has had a different experience than this, the writer would like to know about it.

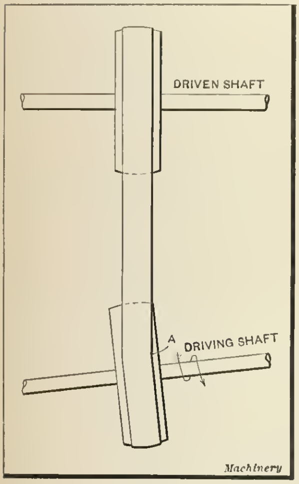


Diagram showing why Belts run off Pulleys

The rule governing the side of the pulley to which the belt naturally runs, may be affected by other causes than the alignment of the shafting. For instance, in parallel and level shafts, the writer has known a new belt to run to one side of the pulley; in this case the trouble was caused by the pulley being of greater diameter at one side than at the other, and although it appeared to be crowned correctly, the difference in the side diameters was great enough to draw the belt over to the side that had the greatest diameter. In this instance, the belt ran to the "high side" of the pulley, and when this error was corrected by turning the pulley down until it was the same diameter on both sides, and then re-crowning it, the belt ran at the center and is running there today. There seems to be considerable misunderstanding about this subject among mechanics, and for that reason it would be interesting to have the matter discussed in MACHINERY.

The illustration shows the way in which the writer has figured out the principle governing the direction in which the belt will run on the pulley. The drive shown in this illustration is about to be started. It is obvious that the top strand of the belt is in tension, also that it is bent. The natural tendency will be for the belt to pull straight but the friction between the belt and pulley will not allow it to move much, as anyone knows who has tried to slip a tight belt off a stationary pulley. At the point *A* where the belt comes in contact with the pulley, the friction is less, and consequently the belt will slip a little to the right. It will then keep its place on the pulley until it leaves on the opposite side, when it will be delivered over to the driven pulley a little further to the right than the point of travel on the preceding revolution, and if the rectifying effect of the crowning is not sufficient to balance the error in parallelism, the lateral movement of the belt will continue in this way until it gradually crawls off at the right hand side. In many cases, however, the belt will merely run over to the side, where it over-laps the edge of the pulley an inch or so. Where drives are being operated at high speeds, there may be different conditions which introduce different results, but the writer is speaking of average operating conditions.

Exeter, N. H. GEORGE P. PEARCE

ECCENTRICITY OF REAMED HOLES

The use of the floating reamer to prevent oversize reaming in the turret lathe is sometimes accompanied by another error—eccentricity of the hole. By this is meant that the hole does not always ream concentric with other portions that are turned at the same setting. This error is due to the weight of the reamer being too great to be properly supported by its cutting edges when it enters the hole. In some cases this error does not matter, as when the reamed piece is to be subsequently turned on a mandrel, but in order to take advantage of the possibilities of a turret lathe, it is often desirable to turn, bore, and ream at one setting of the work.

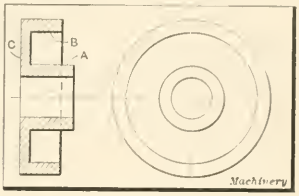


Fig. 1. Example of Work advantageously handled by Turret Lathe

Take, for example, the piece shown in Fig. 1, which is of cast iron and required to be finished all over. The cylindrical surfaces *A* and *B* must be exactly concentric with the bore. When held in a chuck, with the face *C* on the inside, the proper tools will turn, face, and bore the piece so that its surfaces will be perfectly concentric and square. The reamer would then be brought up to the hole, and would strike first at the lower edge, as indicated in Fig. 2. This statement refers to the common, unbalanced floating reamer. If the reamer is light, has enough cutting edges and is ground accurately, it will slide up into place and cut a fairly concentric hole. If, however, the reamer is heavy and has few cutting edges, as is sometimes the case with adjustable reamers, the weight causes the lower edges to dig in first and deepest. The hole then reams eccentric.

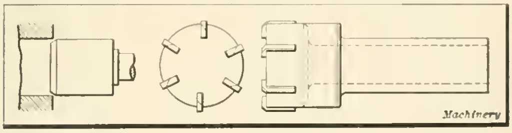


Fig. 2 Fig. 3

To prevent this trouble the following precautions should be taken: 1. Bevel the edge of the hole slightly and accurately before starting the reamer; this will give its edges more bearing. 2. Guide the reamer to the hole carefully by hand. 3. Balance the weight of the reamer by springs placed on the holder as shown in Fig. 4. 4. Increase the number of teeth in the reamer. 5. Use a pilot on the reamer.

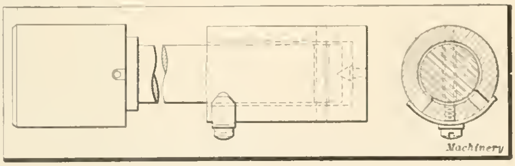


Fig. 4. Showing Springs which balance Weight of Reamer to prevent Holes from reaming eccentric

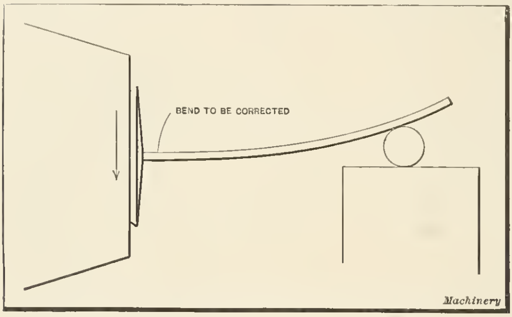
This matter came to the writer's attention when he was designing a set of turret tools, and an old reamer was brought to him for use. It had a bad reputation but no one knew just what was wrong with it. Examination showed it to be 4 inches in diameter, very heavy, and equipped with six inserted blades as shown in Fig. 3. This reamer was fixed up temporarily by turning away the excess metal, as indicated by the dotted lines in the illustration. Later it was replaced by a tool with more teeth.

Pittsburg, Pa. H. A. Stevens Howarth

STRAIGHTENING SMALL PUNCHES

Pieces of wire or drill rod for piercing punches, etc., up to ⅛ inch or 5/32 in diameter, may be quickly and easily straightened in a bench lathe. This is done by gripping the piece in the draw-back chuck and then revolving it at top speed. At the same time, the work is deflected with a suitable lever, such as a piece of ⅜ inch drill rod, which is smooth and will not score the rotating rod. The important points to observe in using this method are to grip the rod near the first bend, to use a chuck that grips the rod firmly, and to deflect it to a somewhat greater angle than the bend that is to be corrected. On the smaller sizes of drill rod this method "works like a charm." The larger sizes—from 3/16 inch and up—do not seem so amenable to this manipulation. It may be that if more powerful apparatus than a hand lever were used it would produce the same result on the larger sizes as on the small ones. The writer is of the opinion, however, that the larger sizes have greater proportional elasticity and not so soft a core, and that this prevents their being easily straightened at ordinary temperatures. The theory that the smaller sizes are not so elastic and have a softer core is supported by the well-known fact that a small punch—say ⅛ inch in diameter—is more durable if made of ⅛ inch drill rod than if turned down from larger drill rod.

M. H. P. A.



Method of straightening Small Punches in a Bench Lathe

A DIE-SINKER'S VISE

The phenomenal and continued growth of the use of drop-forgings in building machine tools, and in other classes of general manufacturing, has been the cause of developing many interesting machines and accessories for the rapid and economical production of drop-forging dies. Of the latter class, an especially useful vise, of massive construction and wide range of usefulness, was seen by the writer, in use in a shop of the Middle West, where a specialty is made of drop-forgings for the trade. This vise is designed to be used on any of the various types of profiling machines on the market.

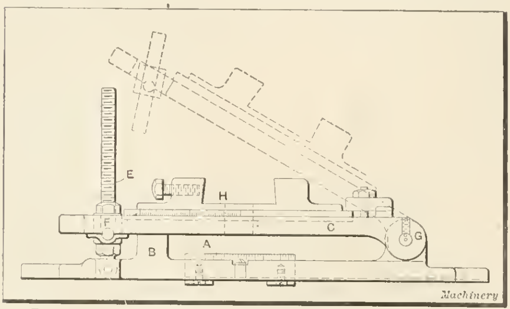


Fig. 1. Die Sinker's Vise with Three Adjustments that provide for securing Any Desired Angle

The swivel block *A* has inserted tongues to fit the T-slots in the machine table, and is held to the table by one bolt passing through the center of the block. The upper side is graduated in degrees, so that the entire vise can be set to any angle. The base *B* is bored to fit swivel *A* and is fastened to the table through circular slots at each end. To one end of this base is fulcrumed the tilting table *C*, which can be raised or lowered by means of the elevating screws *E* and adjusting nuts and trunnions *F*. Each end of the fulcrum pin *G* has a small tapped hole and a small pin hole which locates a graduated dial; this dial is interchangeable at either end. The upper side of tilting table *C* is recessed to fit the die holder *H*, and a zero mark is placed on the front of the table, where it can be readily seen by the operator when adjusting the holder *H* to the graduations which extend to 90 degrees each side of the center line. Three clamps fasten holder *H* in its desired position, and the die block is held in place in an angular slot by three set-screws coming against a key which is placed between the block and screws to prevent marking the edge of the die.

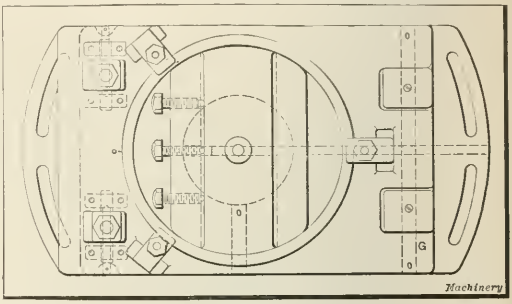
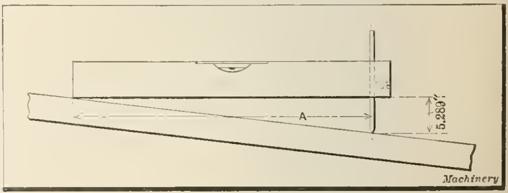


Fig. 2. Plan View of Vise showing Swivel and Method of securing Vise to Table

As can readily be seen, any combination of angles can be obtained by means of the three methods provided for adjusting, and the great amount of hand work which this vise has done away with can best be understood by those who have come in touch with this class of work. Automatic

AN ANGLE LEVEL

A very useful tool for setting up angular work on a drill press or planer may be made from an ordinary carpenter's level. When the work to be done is large and rough, a cheap and accurate tool is always acceptable. The whole device consists simply of a carpenter's level, a piece of ½-inch rod, and a binding screw. To use the device, a table of natural tangents is also required.



A Useful Tool for setting Angular Work

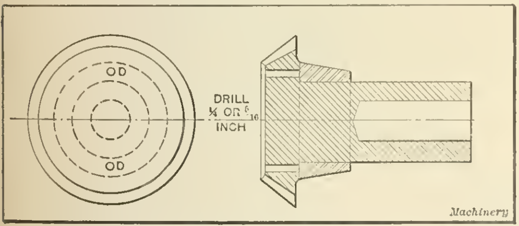
A hole is bored through the level near one end to fit the rod, as shown in the engraving, the distance *A* being made an even number of inches from the opposite end. One end of the rod is ground to a knife-edge and pushed through the hole, and a locking screw used to bind it, as indicated. To illustrate the use of the device, let us assume a practical example: Let the distance *A* be 30 inches and the angle to which the work is to be set, 10 degrees. Multiply the tangent of 10 degrees, as taken from a table in any handbook, by 30; then 30 × 0.1763 = 5.289. Then set the rod this distance from the bottom of the level, and level up the work as shown.

This device has numerous other uses, among which is finding the height of buildings, smokestacks, etc. To use the device for measuring the height of a smokestack, for example, a certain distance is measured from the stack and marked off, the distance being great enough to permit a convenient sighting angle to the top of the smokestack of, say, about thirty degrees. A board is laid on the ground and leveled up. The rod is then taken out of the level and reversed; that is, the flattened end should point upward. The end of the level opposite the rod is placed at the mark determined by the measurement from the smokestack, with the rod end nearer to the object the height of which is to be measured. A light, straight strip of wood about four feet long is laid to rest on the further end of the level, with one end resting on the end of the rod. This stick is now sighted like a gun, the rod being pulled out to elevate the end until it comes in line with the top of the smokestack to be measured. The rod is then fastened and the distance that the rod protrudes from the level is measured, and this distance divided by the distance *A* in the engraving. The quotient is then multiplied by the distance from the smokestack, and the result is the height of the latter. Thus if the distance marked off is 80 feet, and if, after sighting, the rod is found to protrude 12 inches, the height of the smokestack would be $(12 \div 30) \times 80 = 32$ feet.

F. A.

A SUGGESTION FOR AUTOMOBILE DESIGNERS

The writer has had considerable experience in the repairing of automobiles and in the replacing of broken or worn parts. Some parts, especially ball races and roller bearing sleeves, are difficult to remove, as no provision is made in the original design for disassembling. Recently a case came up where a roller-bearing sleeve on a transmission drive shaft was to be removed. The accompanying illustration shows plainly the difficulty. (The holes marked "Drill ¼ or 5/16 inch" were not provided). The inner sleeve or cone upon which the rollers bear is casehardened and made a press fit upon the shaft. The small bevel pinion is solid with the shaft and, as indicated, the roller-bearing sleeve is pressed against the hub of the pinion. As the larger end of this sleeve was of the same diameter as the hub of the gear, it was almost impossible to remove the sleeve without injury, after it had once been pressed into place.



Suggested Method for facilitating the Removal of a Roller-bearing Sleeve from its Shaft

The writer would, therefore, suggest that some consideration be given to the dismantling of a machine. Purchasers and operators would value features of this kind as they are important with relation to the cost of repairs. In the case of the present design, if two small holes 1/4 or 5/16 inch in diameter were drilled through the pinion, parallel with the shaft axis, as shown at *D* in the accompanying illustration, this would assist a great deal in removing this sleeve. The holes could be drilled without materially diminishing the strength of the gear, and would permit a punch to be driven through the drilled holes for removing the cone or sleeve without damage.

Denver, Col. STANLEY EDWARDS

ON THE GENERAL DISTRIBUTION OF CATALOGUES IN JAPAN

Being sole agents for many prominent manufacturers of machine tools, we receive weekly from our principals post cards and letters from people in Japan, asking for catalogues of the machines we handle. We have made it a point to investigate all these inquiries, but have come to the conclusion that it is simply a waste of time to take any notice of inquiries unless they come from established firms or persons in an official position, such as government engineers, high school professors, etc. Practically all other demands for catalogues come from school boys or, at the best, students of technical schools, who have found this the cheapest way to obtain professional information. This practice has become a nuisance, and we think that you would do a service to United States manufacturers, if you would warn them against it. They will not miss any business, if they consign all demands for catalogues to the waste paper basket, unless such requests are written on business paper or contain information as to the position of the sender. We feel sure that other importers of machine tools will endorse our statements.

Tokio, Japan. YAMATAKE & CO.

[The conditions in Japan may be quite different from those in this country, where manufacturers of machinery in general, and machine tools in particular, commonly consider that it is good business policy to send small catalogues free to all applicants. Of course many are wasted, but, in general, the fact that a young man requests a catalogue is regarded as pretty good evidence that he is interested in machinery and will probably become identified with it in one way or another. Many men now in responsible official positions in the manufacturing world remember gratefully the help they received in acquiring a mechanical education from a study of catalogues.—EDITOR.]

AVOIDING SPHERICAL SEATS FOR BALL THRUST BEARINGS

In applying ball thrust bearings to the spindles of machine tools, most builders consider it necessary to interpose some form of spherical seat to permit self-alignment of the ball races to correct negative errors in workmanship. The writer was formerly under this impression, and made provision for spherical seats in his own designs of lathe headstocks. However, after some little thought, he finally decided to try omitting the spherical seats, at the same time taking particular care to get the seatings on both the stationary and rotating pieces as square as possible with the axis of the spindle.

In order to do away with the chance of an unsuccessful result, the shoulder on the spindle, against which one part of the ball race was to take location, was ground at the same time as the other operations of grinding. A bar was ground to fit both of the headstock bearings after scraping. A bushing was mounted upon this bar, the bushing being ground exactly square at one end. This end was then used as a surface plate with which errors in the squareness of the bearing, against which the other ball race was to fit, were located and then corrected by scraping. The method, which proved a success, has now been used for some hundreds of headstocks with a considerable saving in the cost of production.

Manchester, England L. GRIERSON

RESTORING OVER-EXPOSED BLUEPRINTS

Regarding the use of hot water for the purpose of developing blueprints which have been over-exposed, as described by Mr. C. J. Kranz in the November issue of MACHINERY, the experience of the writer is that, while the use of hot water does effect this result, the print is much distorted—far more so than when cold or tepid water is employed—so that the print is really useless for scaling purposes. Of course if the scale of the drawing is of no material importance, then the above point need not be considered and is no bar to the use of hot water. Restoration can be effected in many cases of over-exposure, however, by simply leaving the print for a fairly long time in a bath of cold or tepid water. One advantage in favor of hot water is that the prints so treated dry far more quickly than those which are immersed in cold water.

GEORGE W. BURLEY

Sheffield, England.

RIVETING IN A HAND-PRESS

The method outlined in this article will show how the capacity of a shop was increased by transferring a riveting operation from a skilled workman to a less skilled worker operating a hand-press. Incidentally, the results obtained were somewhat better, and the output considerably increased; more work was turned out using the press for this operation, and the skilled worker was able to devote his attention to operations that could not be done mechanically.

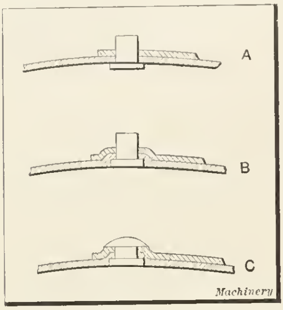


Fig. 1. Different Steps of the Riveting Operation

The work in question was riveting a small part onto some sheet-metal ware. As a hand operation, the rivet was assembled through the body and the small part placed on the outside; the work was then held on an ordinary tinsmith's side stake and a hollow punch and hand hammer used to draw the rivet up so that its head was level with the inside of the body. This condition is shown at *B*, in Fig. 1. The rivet was then headed by hand and finished with a snap, the result being shown at *C*.

It was decided to do this job in a hand-press, and for this purpose a small press with a horn was selected. The horn forming the anvil was made of the same radius as the inside of the work. The holder *B*, Fig. 2, carries the punch *C*, and its lower end is reduced to fit a bracket *D*, which is a force fit on the punch holder. This bracket carries a swinging arm that is pivoted as shown at the right-hand side of the illustration. A side elevation of the work-holder, which played an important part in the success of this operation, is shown at the left-hand side of the illustration. Two brackets *E* and *F* are bolted to the body of the press; *E* is slotted at its lower end and carries a lever *G* which is pressed onto the work at one end by the spring *H*. The other end is fitted with a rod *I* that connects with the treadle.

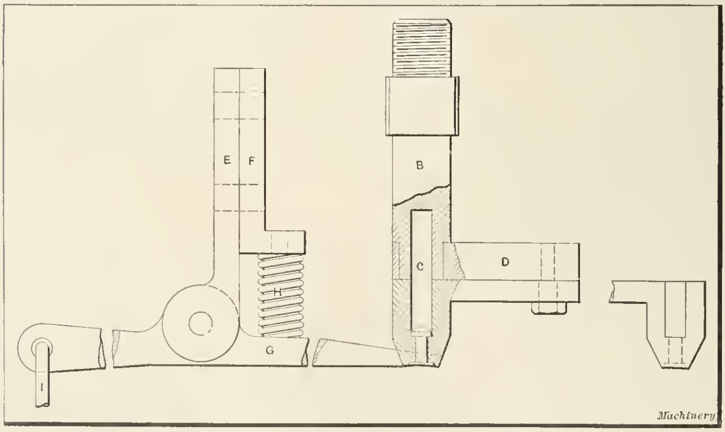


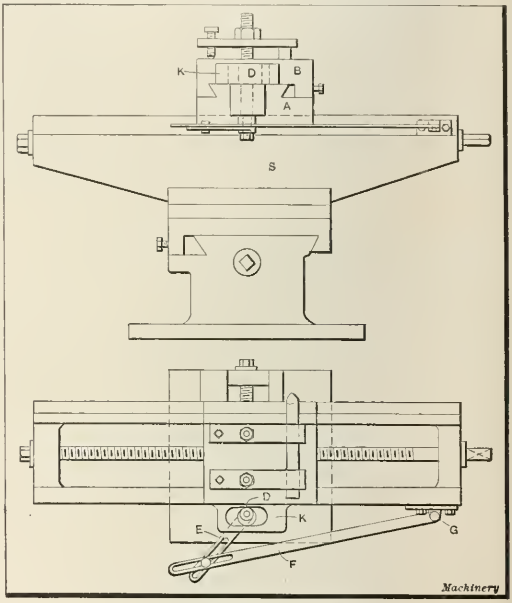
Fig. 2. The Hand-press used for riveting the Work shown in Fig. 1

The method of operation is as follows: The operator assembles a rivet, body and small part together. By the use of the treadle, the lever *G* is raised and the work is slipped onto the horn. The punch is next brought down and the position of the work adjusted until the rivet enters the hole in the lower part of the swinging arm. The treadle is next released and the work is securely held in proper alignment with the punch; a blow is then struck to bring the work into the condition shown at *B* in Fig. 1. The punch is now raised and the swinging part swung to one side; another blow is then struck which brings the punch into operation and heads the rivet as shown at *C*, in Fig. 1. The lever *G* secures the work and does away with the difficulty which the operator would experience in holding his work with one hand and pulling the press with the other. This method proved so successful that it has since been extended to a variety of other work.

Bournbrook, England GEORGE W. SMITH

ARRANGEMENT FOR TURNING PULLEYS

A few days ago, the writer visited an old-fashioned shop such as may be found only in the Midlands of England. The kind of tools used were rather ancient and obsolete, and the main principle upon which the shop was run seemed to be: "My father did things in this way, and so did his father before him, and I am going to do the same."



Old Lathe rigged up for crowning Pulleys

There was one thing to be seen, however, that attracted the writer's attention. An old turning lathe was provided with a device for crowning pulleys, as shown by the illustration. As is well known, it is necessary when crowning pulleys, to have the diameter at both sides of the pulley rim the same and to have the largest diameter exactly in the center of the pulley. To accomplish this result when crowning, an old support, *S*, was fitted with a new slide *A* and on top of this was placed another slide *B* which acted as a tool-holder. Slide *B* was provided with a cast boss *K* with an oblong hole machined in it, in which the eccentric *D* worked. In the slide *A* there was also a boss acting as a bearing for the eccentric *D*, which latter was connected to the fulcrum *G* by means of levers *E* and *F*. This fulcrum was attached to the support *S*.

Before starting the turning operation, the cutter was placed exactly at the highest point of the pulley and lever *E* was adjusted to what may be called the "dead" point. By moving slide *A* to the right or left, slide *B* would automatically be moved in, due to the action of the eccentric.

Wolverhampton, England A. WIND

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

CINCINNATI 12-INCH GRINDING MACHINE

This 12-inch plain cylindrical grinding machine, which is particularly adapted for manufacturing work, is a recent product of the Cincinnati Grinder Co., Cincinnati, Ohio. The machine has been carefully designed with the view of combining the greatest possible number of features for reducing labor and cost. It is adapted to grinding cylindrical parts—either straight or tapering—such as shafts, rolls, spindles, tubing and all other work within its range which can be revolved on dead centers. The rigidity of its construction makes this machine particularly suited for finishing the heavier classes of work that come within its range.

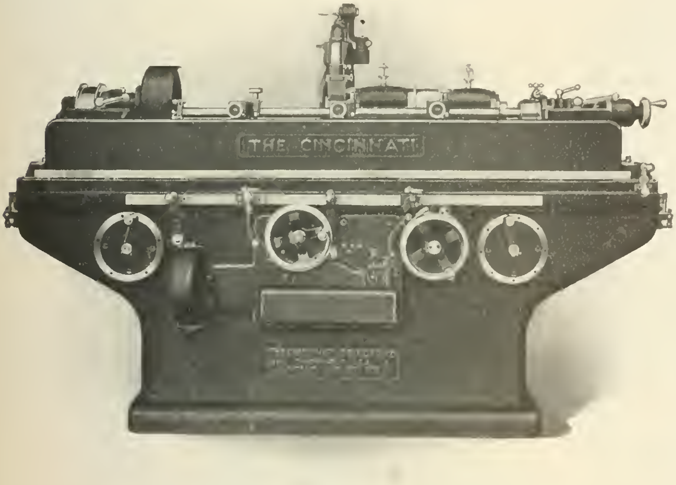


Fig. 1. Cincinnati 12-inch Plain Cylindrical Grinding Machine

The wheel spindle runs in phosphor-bronze boxes provided with means for compensating for wear. This spindle is made from a steel of special analysis and is ground and lapped to a final finish. The wheel head is amply proportioned to withstand the strain of severe classes of service and is held in position upon the ways of the wheel slide by gravity. The arrangement is such that there is no possibility of the head "jumping in" or sticking when delicate adjustments are made, or of lifting under the heaviest cuts. The wheel-head slide is secured to its supporting pedestal by means of heavy bolts and dowel pins. This pedestal extends to the floor and is cast integral with the water tank and base.

The automatic cross-feed covers a range varying from 0.00025 to 0.005 inch at each reversal of the table, so that it furnishes a diversity of changes, from a feed of sufficient fineness for producing an accurate finish on delicate work to one of suitable coarseness for removing stock rapidly on large diameters. The feed is automatically thrown out when the work has been reduced to the required size and is regulated by simply turning a thumb-screw on the front of the machine. The swivel table has its bearing upon the sliding table and pivots on a hardened and ground central stud; the table can be set at any angle to the ways, thus providing for grinding tapers without throwing the head- and foot-stock centers out of alignment. This table is graduated to read in both degrees and taper in inches per foot, adjustment being made by means of a rack and pinion at the end of the table. When it is desired to move the table through a greater distance than the graduation marks given on the scale, no disconnection is necessary, the adjusting device being designed to leave the table free to swing through an arc limited only by the wheel slide. The sliding table has a reciprocating motion on the ways of the main base casting and is controlled by adjustable dogs operating against the reversing lever; these dogs actuate a clutch of the load and fire type contained in the automatic feed-plate. This feed-plate is a complete unit in itself, which is bolted to the front of the machine so that it can be readily removed at any time. Travel is entirely independent of the work speed or the speed of the wheel and makes it possible to traverse the work the full width of the wheel at each revolution, which is a desirable feature when removing stock rapidly. The transmission of power is accomplished through worm-gearing which has been found to give the best satisfaction as regards smoothness and uniformity of motion. The reversing dogs provide a fine adjustment when grinding to shoulders and permit of traversing the table beyond the points of reversal without disturbing the initial setting. They readjust themselves after the table has been returned to its original position, thus preventing it from feeding too far and injuring the work.

The headstock slides on the ways of the swivel table and is locked in position by means of a large hook bolt sliding in an L-slot. The hollow headstock spindle is hardened, ground and lapped, and the hole is tapered at the front end to receive the work carrying center. The work is revolved through gearing which provides ample power. The provision of a supporting way directly on the work represents a complete departure from the undesirable overhanging type of headstock. Alignment is preserved through the use of an inverted V. The footstock is secured to and preserves its alignment on the swivel table by means of a hook bolt sliding in an L-slot and an invert-

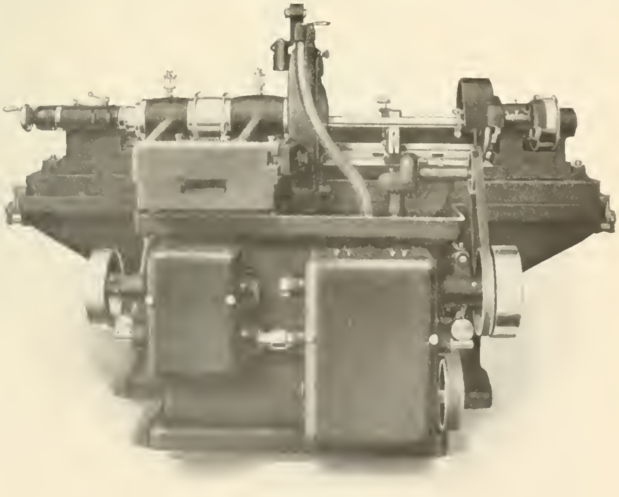


Fig. 2. Rear View of Cincinnati Grinder showing Gear-boxes

ed V, respectively; this method is similar to that used on the headstock. The footstock provides a convenient method of carrying the diamond tool-holder which permits truing the wheel without removing the work. The spindle is hollow and the hole at its front end is of the same taper as that of the headstock.

The back-rests for supporting long cylindrical shafts take up the reduction in grinding and make the highest uniformity in diameters possible. The back-rests are of rigid construction and capable of the most delicate adjustment; they are universal in their movements. The base has a three-point bearing which compensates for any unevenness of the floor and maintains perfect alignment. The base is made of box section thoroughly ribbed and braced and is cast integral with the water tank and wheel slide pedestal. This construction forms a massive unyielding unit which offers a maximum resistance to torsional strains. The pump is of the centrifugal type consisting of a fan revolving horizontally in a case, submerged at all times so that the necessity of priming is eliminated. The pump bearings do not come into contact with the water, and the water guards are amply proportioned and suitably placed to catch the spray and waste water when the machine is engaged in wet grinding; this water is returned to the settling tank and pump. The regular equipment of the machine includes a countershaft, work center, truing fixture, combination plain and universal back-rests, adjustable driving dogs, two grinding wheels and the necessary wrenches. The machine is built in sizes 12 by 36, 12 by 52, 12 by 72 and 12 by 96 inches.

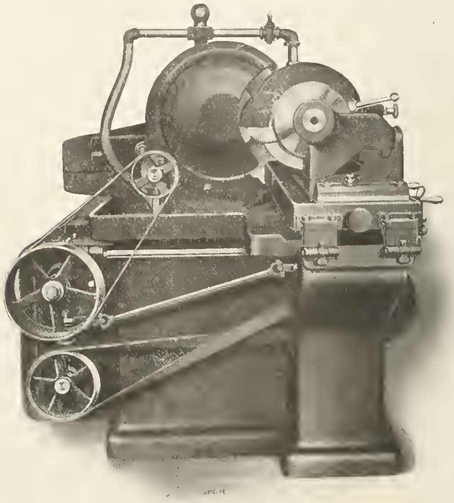


Fig. 3. View showing Gear Drive to Work Spindle

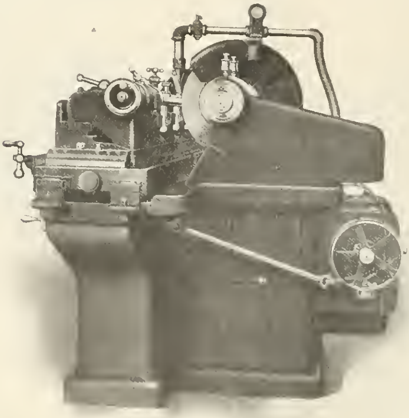
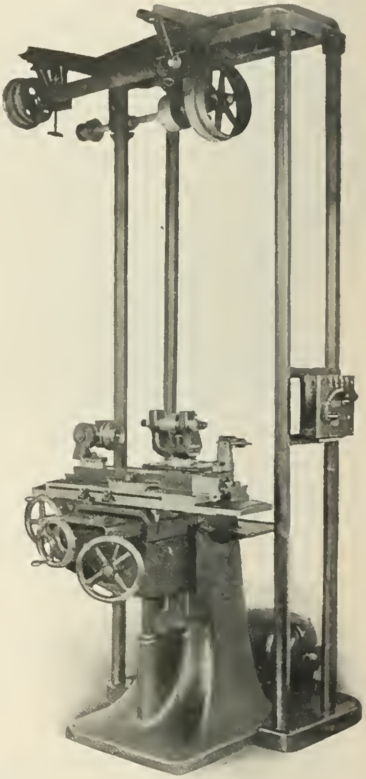


Fig. 4. Opposite View showing Arrangement of Wheel-head, Water Attachment, etc.

MOTOR DRIVE FOR OESTERLEIN GRINDER

The illustration shows a new method of applying motor drive to the No. 2 universal cutter and tool grinder made by the Oesterlein Machine Co., Cincinnati, O. The entire arrangement is self-contained. The base is in one piece, which consists of a cast-iron box frame with a number of intersecting strengthening ribs on the under side. The countershaft support is a ribbed cast-iron frame and the uprights, which are placed at the rear of the machine where they are out of the operator's way, are pipes threaded on both ends. The arrangement will be clearly understood by reference to the illustration, which shows the method of setting up very clearly.

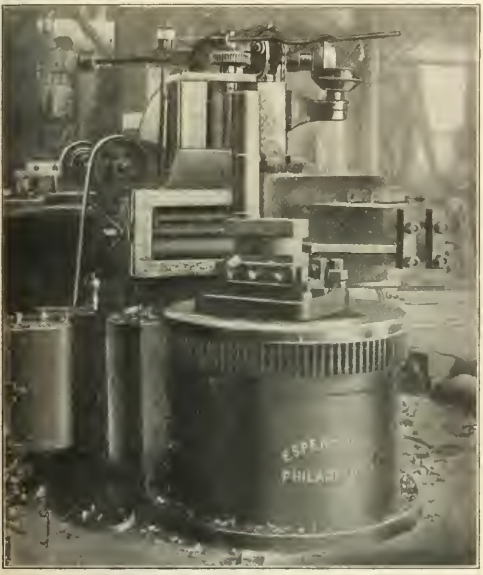


Oesterlein Grinder equipped with New Arrangement of Motor Drive

ESPEN-LUCAS CRANKSHAFT FORMING MACHINE

The crankshaft forming machine shown in the accompanying illustration has recently been placed on the market by the Espen-Lucas Machine Works, Philadelphia, Pa. This machine is adapted for rough-turning and finishing crankpins in multiple and single-throw crankshafts, without the use of the special jigs, fixtures or counterweights that are required in turning crankpins on the usual horizontal type of machine. The work is placed in a vise on the table, and held in a vertical position by the cheeks at a point immediately next to the pin, thereby avoiding the necessity of balancing the crankshaft by means of jigs or fixtures. As the crankshaft is held at the point that is being turned, a much heavier chip can be removed than is taken on the horizontal machines. Attention is called to the long ribbon-like turnings on the floor at the base of the machine.

The housing, table and base are made of gray iron castings with thick walls, and are braced with heavy webs. The table is made in one casting, with a forged 60-point carbon steel driving gear forced into place at its periphery. In addition to wide taper bearings, this table has bronze take-up bearing shoes. The tool-post is equipped with an adjustable steel tool-support, and automatic feed and quick adjustment in both directions. The cross rail carrying the tool-support is counterbalanced and has automatic feed in both directions and quick adjustment. All driving gears and shafts are made of steel and the bearings are bronze bushed. The machine is arranged for belt drive to a 1 to 3 variable speed 20 horsepower General Electric motor and weighs about 27,000 pounds.



Special Boring Mill adapted for turning Crankshafts

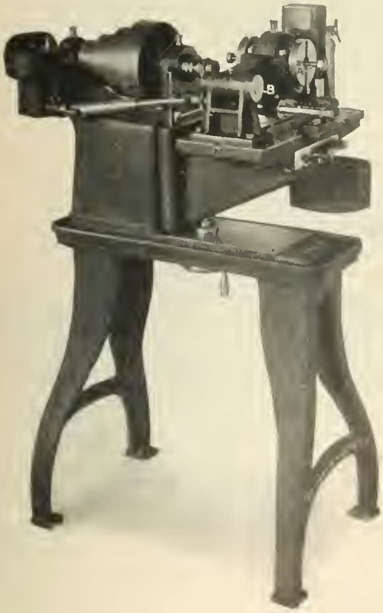


Fig. 1. Garvin 6-inch Cam Cutting Machine with Face-cam Cutting Attachment

GARVIN SIX-INCH CAM CUTTING MACHINE

The illustration shows a 6-inch cam cutting machine which has been placed upon the market by the Garvin Machine Co., Spring and Varick Sts., New York City. In Fig. 1, the machine is shown equipped with the fixture for cutting face-cams, the former being mounted on the outer end of the arbor *A* and the blank to be cut on the opposite end of the same arbor. This arbor is driven by the universal jointed power shaft through a worm and worm gear. The arm which carries the work arbor is pivoted at *B* and is guided by a roller-guide mounted on the table which engages with the former. In addition to its own weight, this arm is provided with detachable weights to offset the reaction of the tool and insure keeping it in contact with the roller. The removal of this face-cam fixture from the machine is easily effected, because the entire fixture constitutes a self-contained unit; consequently the entire slide can be drawn off from the top of the knee without being dismantled. The universal jointed power feed rod is readily detached for this purpose.

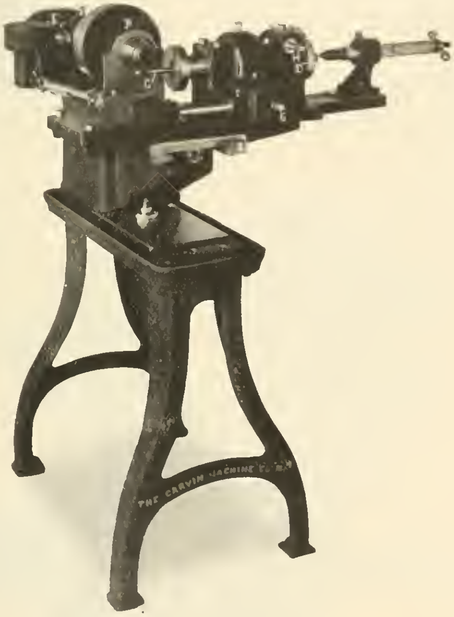


Fig. 2. Garvin 6-inch Cam Cutting Machine with Barrel-cam Cutting Attachment

Fig. 2 shows the machine equipped with the barrel-cam fixture. The feed rotates the work on the arbor *C*, the former being mounted at the rear end of the arbor at *D*, where it is kept against the roll by means of the adjustable spring tension rod *E*. In using the barrel fixture, there are times when quick returns are necessary and such quick returns require a quick let-up of tension contact between the former and the roll. Provision is made for this by the use of a crank on the pin *H* which eases off the spring pressure the required amount.

The feed in both attachments is disconnected by means of the clutch *F* giving hand control by means of a crank at *G*. The spindle of the machine takes cutters provided with No. 7 B. & S. taper shanks. All of the gearing is housed in, to provide against the possibility of injury to the operator or damage to the gearing itself. The weight of the machine is 850 pounds and it occupies a total floor space of 36 by 43 inches.

BATH UNIVERSAL GRINDING MACHINE

The Bath Grinder Co., Fitchburg, Mass., has made a number of improvements in the design of its universal grinding machine, with a two-fold purpose in view: namely, to insure durability of the alignment of the machine and to reduce the time required in changing from one operation to another to a minimum. The base and knee of the improved machine are essentially the same as the preceding design, except for the web braces, but the cross-slide has been provided with a tie-member which prevents that part of the cross-slide which straddles the column from spreading, and also acts as a guideway cover when the cross-slide is out to the extreme position. Fig. 1 shows a general view of the improved machine, and Fig. 2 shows a rear view in which the improved cross-slide and wheel drive are clearly illustrated. The screw which feeds the work into the wheel is provided with a stop for duplicating work and has a dial graduated to read to 0.00025 inch. The cross-screw nut is made adjustable to provide means of compensating for wear.

Both the headstock and footstock have been made heavier and more convenient. The headstock is provided with two pulleys, one for dead and one for live center work; the belt is easily shifted, and when doing dead center work the spindle is locked by a pin controlled by a spring. The footstock spindle is readily operated by a lever, and the tension of the spring which controls the spindle is adjusted by a handwheel. The table is controlled by adjustable dogs operating against the reversing lever, which actuates the load-and-fire type of clutch, or by a conveniently located hand-reversing lever, which provides means for automatically stopping the table at the end of its traverse by rotating the lever through part of a turn at any time during the traverse of the table. The work and traverse speeds are independent and can be instantly changed while the machine is running. The work is driven from an overhead gear-box, and the traverse from a gear-box mounted on the cross-slide. Both mechanisms are readily operated from the front of the machine. The water tank is made separate from the machine to provide for convenience in cleaning, and the pump requires neither priming nor packing.

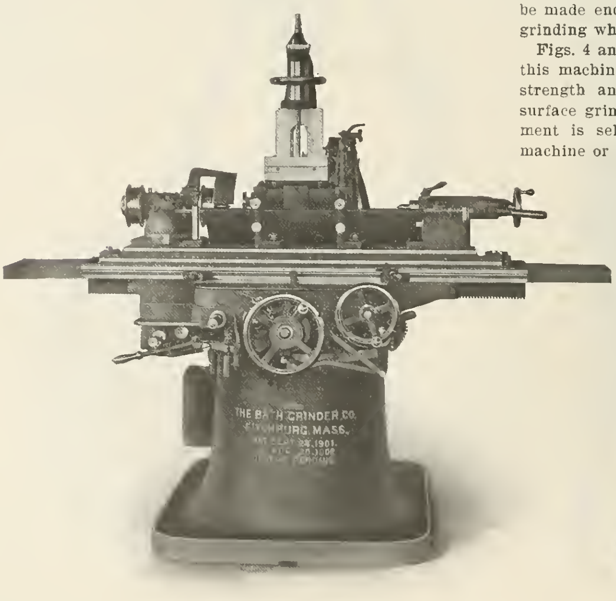


Fig. 1. The Bath No. 2 Universal Grinding Machine

As previously mentioned, the wheel drive is illustrated in Fig. 2. The spindle is driven from a four-step cone pulley overhead which is free to slide on the shaft for changing speeds and is operated by a rack and pinion by a handle just above the idler pulleys. The slack in the belt is taken up by two idler pulleys which are carried by an arm which pivots on a bracket extended from the base of the machine. The pulleys are also carried by a rocker-arm which is pivoted to the longer arm and provides for adjusting the belt on the pulley without altering the length of the belt. The arm is controlled by a ⅞-inch rod extending from the column, the rod being threaded at the outer end and provided with two nuts. By this arrangement, it will be seen that the lifting strain of the belt is taken by the two idler pulleys, and that the belt can be made endless, which is a particularly desirable feature on grinding wheel belts.

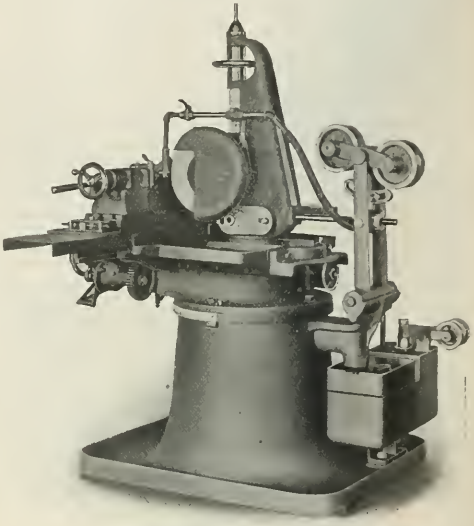


Fig. 2. Rear View showing Improved Cross-slide and Wheel Drive

Figs. 4 and 5 show the surface grinding attachment used on this machine. This attachment is designed to give it ample strength and rigidity for handling the heaviest classes of surface grinding without being unduly strained. The attachment is self-contained and can be readily attached to the machine or removed from it when required. The attachment spindle is screwed onto the main wheel spindle through which it is driven. The arm which carries the outer bearing is clamped to the grinding wheel head, the alignment being assured by a tongue and groove; this bearing is self-aligning being carried by a swivel head. The wheel fender will take a grinding wheel up to 8 inches in diameter by 1 inch face. The water supply pipe and water nozzle, which are self-contained,

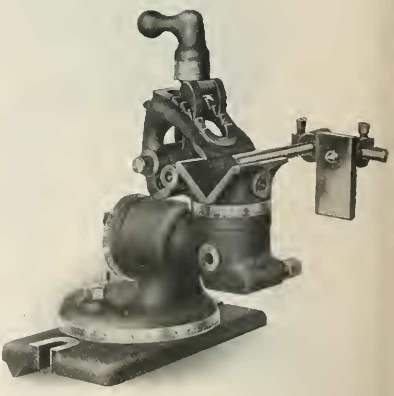


Fig. 3. The Universal Work-holder

are readily transferred from the cylindrical grinding wheel fender.

The universal work-holder that is illustrated in Fig. 3 adds materially to the range of work that can be handled by this machine. This attachment is of special value for holding inserted tooth mills up to 18 inches diameter, counterbores, large end mills, reamers, and similar classes of work with either straight or taper shank. By using the flange plate which is furnished with this attachment, gear cutters, flat form cutters, saws and similar classes of work can be conveniently held. The flat vise can also be clamped to this flange plate, thus providing a means for holding a large variety of work that is to be surface ground. The construction of this universal work holder is particularly rigid; it is clamped to the swivel plate by two bolts, and the base of the attachment has an inverted V which insures its alignment. The attachment is completely universal in operation, being provided with one vertical and two horizontal swivels, each of which has a dial graduated to 360 degrees. These dials make it an easy matter to clamp the work holder at any desired angle; the dials are provided with dowel pins for making positive locations at intervals of 90 degrees. The V-jaw is provided with an adjustable center stop for taking the thrust of the work and has a self adjusting work clamp which allows straight or taper work to be readily held; this jaw will take pieces with diameters varying from ⅛ inch to 2½ inches. The center stop, work clamp and V-jaw, are self-contained so that they may readily be removed to allow a flange plate to be inserted in their place.

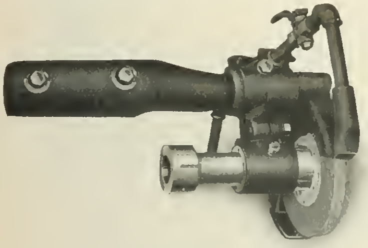


Fig. 4. The New Surface Attachment

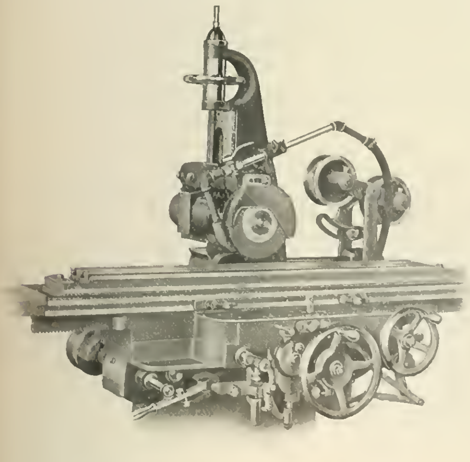


Fig. 5. Surface Attachment applied to the Machine

Fig. 6 shows the cutter bar attachment which forms a part of the complete equipment of the new Bath universal grinding machine. This attachment is especially adapted for holding small end mills, angular and straight cutters, etc., where a very sensitive movement is necessary. This attachment is clamped to the inverted V on the base. The base carries a sliding bar, on the end of which is a work-carrier provided with a vertical and a horizontal swivel. These swivels are accurately graduated to 360 degrees and provided with dowel pins for positive location at intervals of 90 degrees. The swivels can be readily clamped at any desired angle. This attachment is furnished with one straight and one taper bushing to receive the work.

The internal grinding water attachment shown in Fig. 7 provides means for using water when internal grinding operations are being performed. The attachment is self-contained and can be readily clamped to the headstock. The front half of the guard is free to be swung out of the way when gaging or clamping the work in place, and the water nozzle has a universal joint so that it can be set as required.

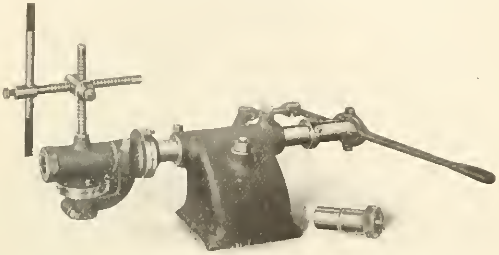


Fig. 6. Cutter-bar Attachment adapted for holding Small Mills and Reamers

The gear cutter grinding attachment used in connection with this machine is designed to insure grinding gear cutters with the teeth exactly radial. This attachment has a positive gage which swings over the cutter to facilitate setting, and a spring pawl carried by an adjustable holder which allows the pawl to be adjusted against the heel of the teeth. The attachment is made to be carried by the universal work holder.

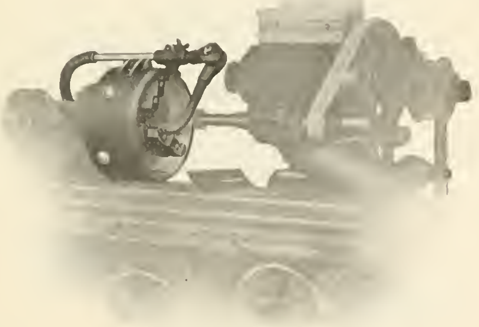


Fig. 7. Internal Grinding Water Attachment

WASHBURN NO. 2 HIGH-SPEED SENSITIVE DRILL

The Washburn shops of the Worcester Polytechnic Institute, Worcester, Mass., have recently placed a new ball bearing sensitive drill press upon the market. This machine is of the multiple spindle type and combines a number of new features; it is made with one, two, three, four or six spindles. The tension of the belts is adjusted by patented automatically locked tighteners which are operated by a rack and pinion. By means of this device, any desired tension may be obtained, or the belt on any spindle may be loosened so that it hangs free from the back cone pulley, thus allowing the drill of that spindle to be changed or to remain idle without requiring the entire machine to be stopped. The spindle bearings are continually flooded with oil and a retaining ring is cast concentric with the bearing so that a basin is formed which holds the oil and prevents it from spattering. The table is raised by a handwheel and coarse-pitch screw, the weight being carried on a ball thrust bearing. The width of the bearing on the column is 16 inches on the 3-spindle machine and 20 inches on the 4-spindle machine; the depth of the bearing is 1½ inch. The table is clamped in position by handles shown in the illustration which, it will be seen, are within easy reach of the operator.

These machines are furnished with either hand or power feed. The power feed is of an entirely new design which is simple in action, and combines principles which have been found successful by long usage. The power feed is engaged by the same movement of the lever which brings the drill into contact with the work. Referring to the sectional view of the head bracket shown in Fig. 2, the action of this feed may be explained as follows: The friction is of the well-known cone type in which the female member *B* is driven by the worm on the rod *A;* the male member *C* is keyed to the driving shaft *R* which has a pinion keyed to it; this pinion meshes with the rack sleeve *H* which carries the spindle. The drill is brought down to the work in exactly the same manner as in the case of an ordinary sensitive drill with hand feed, but as soon as the drill meets with the resistance of the work, a slightly further pull on the hand lever *I* forces the spring plunger *T* over a cam shoulder on the quill pinion *S* and permits the lever block *M* to advance on the thread. This lever block *M* is threaded to the quill pinion *S* and as the block advances on this thread, it engages with the shoulder at the right-hand end of shaft *R;* this forces the shaft over and engages the male and female members of the friction clutch and consequently throws in the power feed. The advance of the lever block is limited by a positive stop on the pinion *S* which engages with the spring plunger *T*. The release of the power feed is accomplished in exactly the same way; any resistance to the turning of the lever block unscrews it on its thread and carries it back to its original position. The plate *O*, which is attached to the lever block *M*, forces the shaft *R* to the left, thus providing a positive means for the disengagement of the friction clutch. The instant that the friction is released, the drill is automatically returned to its original position by means of the coil springs *L*, one end of which is fastened to the lever block and the other end to the head bracket. The coil spring *L* is fully encased, the casing being cast as a part of the head bracket. The depth of the hole is regulated by the adjustable stop ring *K* which may be set in any position by means of the thumb-screw *V;* the action of this stop ring is positive when the drill reaches the end of the run, as it trips automatically whether the stop ring is set or not. The action of the friction clutch is adjustable by means of the screw *E* which provides for bringing the male and female members closer together or setting them further apart; after making the adjustment the clutch is locked in position by means of the locking screw *D*.

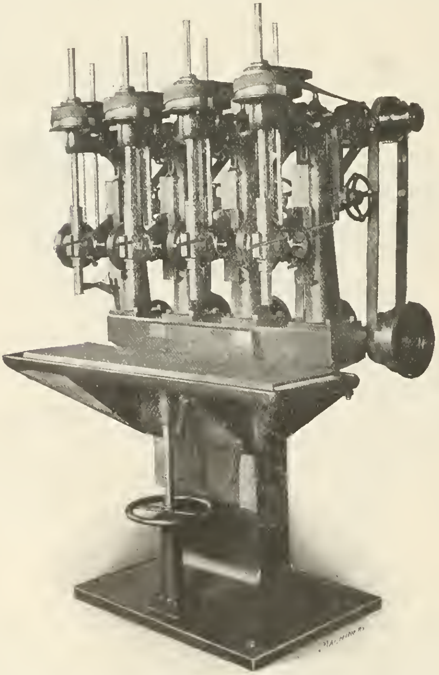


Fig. 1. Four-spindle Washburn High-speed Sensitive Drill Press

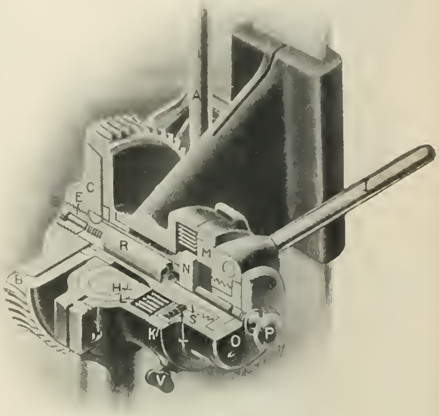


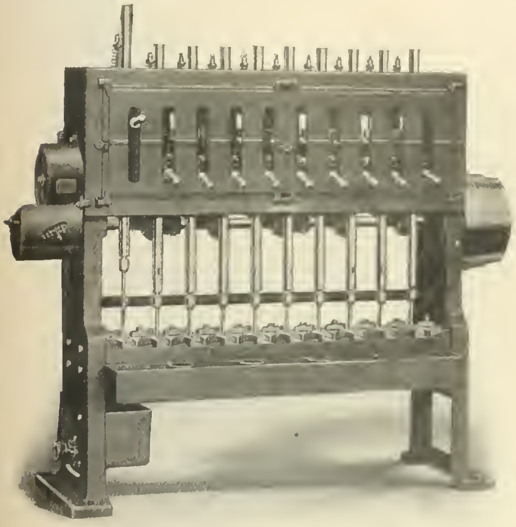
Fig. 2. Sectional View of the Head Bracket

When it is desired to use the machine with hand feed, the knob *P* is pulled out, causing the key *N* to lock the pinion and lever block; as the keyway in the pinion only registers when the lever block is in its highest position, this locking action cannot take place when the power feed is in operation. The machine has three feeds which are approximately, 0.0075, 0.010, and 0.015 inch per revolution, the changes being made by the star-wheel shown near the spindle pulley; this star-wheel turns the pinion which moves a sliding key. The spindle has a travel of 4 inches for the power feed and 5 inches for the hand feed and is No. 2 Morse taper. The vertical adjustment of the table is 14 inches. Driving the back-shaft at 610 R. P. M. gives spindle speeds of 610, 1016 and 1830 R. P. M.

NATIONAL NUT TAPPING MACHINE

The National Machinery Co., Tiffin, Ohio, has placed upon the market, the 1½-inch ten-spindle semi-automatic nut tapping machine shown in the accompanying illustration. This machine is designed on the same general lines as the 1-inch six-spindle machine which was illustrated in the June, 1911, issue of MACHINERY, but the present design embodies several important improvements. Among these may be mentioned the rapid change gear-box, which enables changes in the spindle revolutions to be made by merely shifting a hand lever, and such changes can be made while the machine is running. It was formerly necessary to change gears in the gear-box in order to effect these changes; this required a considerable amount of time and often tempted the operator to run the machine at other than the most desirable spindle speed. The ease with which speed changes can be made with the new machine insures having the speed adjusted as the taps are ground and the cutting teeth reduced in number, so that there is little or no idle tapping time.

The spindles of the new machine are raised and lowered by cams and this automatic spindle movement tends to have the machine "set the pace" for the operator. The operator is also entirely relieved from the fatigue due to raising and lowering the spindles with a treadle. Trials have shown that the average operator has no trouble in keeping up with the uniform pace of the machine throughout a working day. The system of raising and lowering the spindles by cams also tends to prolong the life of the taps, as accidents resulting from the operator accidentally allowing the spindle to drop and jam the tap in the nut, are eliminated. The spindle descends gradually to the work and is not subjected to sudden and excessive torsional strains as in the case of the foot lever machines. The cams which raise and lower the spindles have three steps, and by shifting the cam shaft the resting time of the spindles in the upper position can be altered to meet the requirements of different classes of work.



Ten-spindle National Semi-automatic Nut Tapping Machine

The spindles are set close together—the ten spindles being within a space of 69 inches—which is an important feature, as it facilitates feeding and enables the operator to successfully handle ten spindles; at the same time, the amount of floor space occupied by the machine is reduced. The nut holders of this machine are of a novel and simple design. The nut guides are wedge shaped chilled plates that are held in position by toe-clamps. The guides are backed up by stationary lugs, of corresponding angle, on the feed table, thus making the guides extremely rigid and insuring the parallelism of the guide faces as the latter are rigidly clamped against the stationary lugs. As the guides have no tendency to shift or spring, there is practically no binding action of the nuts when feeding. Openings are provided in the nut pans through which the operator can empty the nuts into boxes or kegs set beneath the machine where they are out of the way. The range and power of this machine are sufficient to enable it to tap two nuts of the smaller sizes simultaneously, and where such a practice is possible, a further increase in the capacity of the machine is effected. The machine will handle either rough hot pressed, or cold punched nuts.

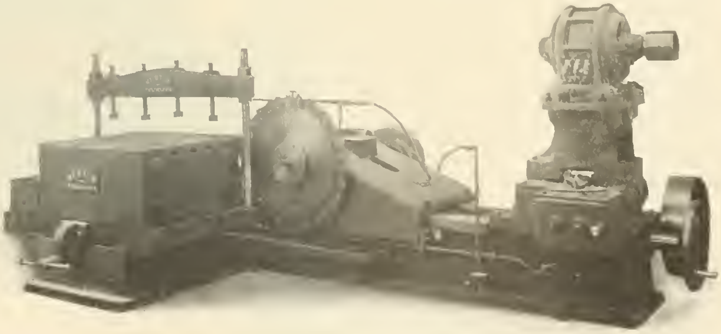
NEWTON HIGH-SPEED METAL SAW

The inserted tooth high-speed saw illustrated herewith, is a product of the Newton Machine Tool Works, Inc., Philadelphia, Pa. The blade of this saw consists of a hardened plate which has drop-forged high-speed steel teeth inserted in it; these teeth are hardened by a special heat treatment. The teeth are secured in place by a wedge arrangement which provides a particularly rigid connection between the teeth and the body of the saw.

The saddle of the machine has a large bearing on the shears and the operating side is equipped with hand-locking gibs which are cast solid; adjustments are made by means of taper shoes. The feed-screw is supported by a bearing at each end which assures having it operating under tension at all times; both this screw and the saw spindle and driving spur gears are of alloy steel. The driving worm-wheel is of solid bronze and the driving worm of hardened steel fitted with roller thrust bearings which are encased for continual lubrication. The driving spline shaft is fitted with auxiliary bushings that rotate with it in stationary bushings in the saddle; this prevents wear of the stationary bushings through contact with the spline and also prevents the escape of oil. The motor is mounted on a high pedestal to give a long belt center, and provision is made for adjusting the tension of the belt. The saddle is provided with reversing fast power traverse and six changes of positive geared feed. The saddle is also fitted with adjustable automatic feed trips and positive safety stops. The illustration shows a lever in the space below the pedestal on which the motor is mounted; this lever adjusts the gear feed box for the different feeds. The engagement of the fast traverse or feeds is controlled by the lever shown at the side of the bed of the machine near the right-hand end. The square lock bearing on the bed to which the saddle fits, and the troughs for draining the lubricant are also clearly shown in this illustration.

The top table is removable and the bottom table has a hand in-and-out adjustment for convenience in setting work for the required depth of cut. The removable V-block is shown beside the removable table. The top table can be placed with the T-slots at right angles to the travel of the saw blade when desired, or on its end or side to hold the structural shapes in the most advantageous position for cutting. Slots are also planed in the top table to provide for setting it on an angle to facilitate accurate mitering.

This machine is made in sizes in which the blades range from 20 inches to 48 inches in diameter. These capacities will cover all structural materials up to and including the largest Bethlehem shapes. An idea of the capacity of this machine may be gathered from the fact that it is possible to cut 15 inch I-beams on a square cut in two minutes, while other sizes can be cut in a proportional time. A particular advantage of this combination type of cold saw is that a rotary cutter head can be attached to the saw spindle in place of the saw blade, to permit finishing the ends of columns and similar work.



Newton Inserted-tooth High-speed Saw, particularly suited for cutting Structural Steel

WILSON-MAEULEN PORTABLE PYROMETER

The Wilson-Maeulen Co., 1 East 42nd St., New York City, has added to its line, the portable electrical pyrometer which is shown in the accompanying illustration. This instrument is operated by a platinum-rhodium couple, and is especially suited for indicating the temperature of furnaces used for the heat-treatment of high-speed steels. The platinum-rhodium couple is protected by a quartz tube which will stand sudden heating and cooling without danger of breaking; this quartz tube is generally put down through the top of the furnace, the depth of insertion being regulated by an adjustable tripod. An aluminum connection head at the open end of the quartz tube provides for making connection between the platinum-rhodium couple and leads to the instrument.

Wilson-Maeulen Portable Electrical Pyrometer

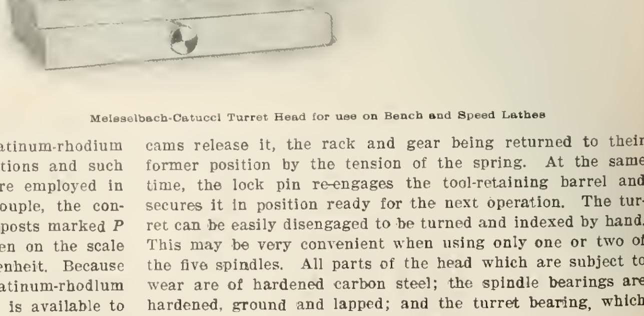
This instrument is not disturbed by vibration and does not have to be held more than approximately level because the moving system to which the pointer is attached is mounted on a single pivot at the center of gravity of the coil, so that the whole system is exactly balanced on its central and single pivot. This pivot is mounted in a jewel bearing which reduces mechanical resistance to a minimum, so that the relatively low current obtained from the platinum-rhodium couple has sufficient power to turn the moving system after it has first been passed through a high resistance coil. The introduction of this coil makes the electrical resistance of the entire pyrometer circuit so high, that changes in resistance caused by using shorter or longer wires from the couple to the indicator are negligible.

The important features of this pyrometer are that it is portable and will cover any temperature range that is required for any class of work handled in the hardening room. The indicator has two temperature scales and three binding posts; when using a base-metal couple, which is generally done for all annealing or for carbon steel hardening, connecting wires from that couple are attached to the two binding points marked *A* and + and readings are taken on the scale from 75 to 1800 degrees Fahrenheit. The use of the platinum-rhodium couple is recommended for carbonizing operations and such a couple is essential for the high temperature employed in hardening high-speed steel. In using this couple, the connecting wires are attached to the two binding posts marked *P* and +, and the readings in this case are taken on the scale covering a range from 75 to 3000 degrees Fahrenheit. Because of the high electrical resistance of the platinum-rhodium couple and its low voltage, very little current is available to operate the moving system of the measuring instrument, and this was the reason why early types of instruments using such couples were made with the moving system suspended on a flat fiber instead of having it mounted on pivots. Although this instrument is primarily for portable work, it may be used for stationary service, in which case the lid is slipped off the hinges. The graduated scale of the instrument is 7 inches long.

MEISSELBACH-CATUCCI TURRET HEAD

The illustration shows the five-spindle turret head adapted for use on a bench or speed lathe, which has recently been placed upon the market by the Meisselbach-Cattucci Mfg. Co., 29 Congress St., Newark, N. J. This head is mounted on a shoe that may be readily made to fit any lathe bed, and a lathe provided with one of these equipments is virtually converted into a screw machine particularly adapted to the requirements of clock, watch and instrument work. Cross adjustment of the turret is obtained by the knurled head screw in the shoe, and vertical adjustment by loosening the binding screw and then turning the barrel which carries the tool-spindles. These two adjustments provide a handy and rapid method of aligning the tool-spindles with the lathe-spindle. When the operating lever is thrown over to bring a tool into engagement with the work, it only moves one of the spindles against the tension of a spring. This action is considerably easier than the rotation of a revolving turret and as a result, the present design is considerably more sensitive.

A spider is mounted inside the turret head in such a position that one of its extremities affords a positive stop for each of the spindles. These spindles slide in hardened, ground and lapped bushings in the retaining barrel. After the tool has been advanced to the work, the turret head indexes automatically. As the operating lever moves to the right, the lock-pin is withdrawn from the barrel in which the tools are carried so that the latter is free to rotate. A cam is mounted on the end of the stud which carries the operating lever; this cam works in connection with two other cams and a lever to give the necessary traverse movement to the rack which meshes with the gear shown to the right of the tool-retaining barrel of the turret head. The arrangement of the cams and lever is such that the rack is given the necessary traverse movement to run the turret head through 72 degrees, which is the necessary angle to bring succeeding tools into alignment with the lathe-spindle. The indexing gear is connected with the tool retaining barrel by means of a ratchet and pawl; this ratchet and pawl secure the gear and sleeve together for forward rotation, but when the rack has reached the end of its forward travel, the cams release it, the rack and gear being returned to their former position by the tension of the spring. At the same time, the lock pin re-engages the tool-retaining barrel and secures it in position ready for the next operation. The turret can be easily disengaged to be turned and indexed by hand. This may be very convenient when using only one or two of the five spindles. All parts of the head which are subject to wear are of hardened carbon steel; the spindle bearings are hardened, ground and lapped; and the turret bearing, which is of phosphor-bronze, has means for taking up wear.


Meisselbach-Catucci Turret Head for use on Bench and Speed Lathes

GENERAL ELECTRIC REVERSING MOTOR DRIVE

The General Electric Co., Schenectady, N. Y., has recently developed a reversing, adjustable-speed, direct-connected motor drive designed for application to planers (as shown in Fig. 1) and other machine tools. This equipment has been carefully tested and tried out in service. Probably the most interesting application of this drive at the present time is to planers, but the use of the reversing motor equipment in its various forms is said to be almost unlimited. In fact, it is now employed not only for driving planers, but also screw, worm- and rack-driven slotters (see Fig. 3), turret lathes, wire- and tube-drawing machinery, and other classes of machines which were formerly reversed through clutches or shifting belts. A desirable feature of the General Electric reversing-motor drive is that it may be attached readily to machines already installed and in use, as well as to new machinery.

The motors for this service are mounted in any place on the machine or floor, convenient for mechanical connection. They are of the standard General-Electric commutating-pole type with a speed range of 250-1000 R. P. M. at 230 volts, up to and including 100 horsepower planer ratings. This range of speeds allows the motor, in most cases, to be coupled direct to the driving shaft of the machine. The control consists of a contactor panel and master switch. The contactor panel is usually mounted on the side of the planer housing, or in any convenient place on other machine tools to which the drive may be applied. The panel is made up of eight contactors, similar in appearance to a series contactor, but actuated by shunt, series or differential coils in such a manner as to eliminate entirely electrical disk interlocks. An additional precaution is taken by using mechanical interlocks to prevent the possibility of short circuits. The panel, field rheostats and all accessories are enclosed in a cast-iron box, the cover of which is hinged, so that when swung open as shown in Fig. 2, the contactors are easily accessible.

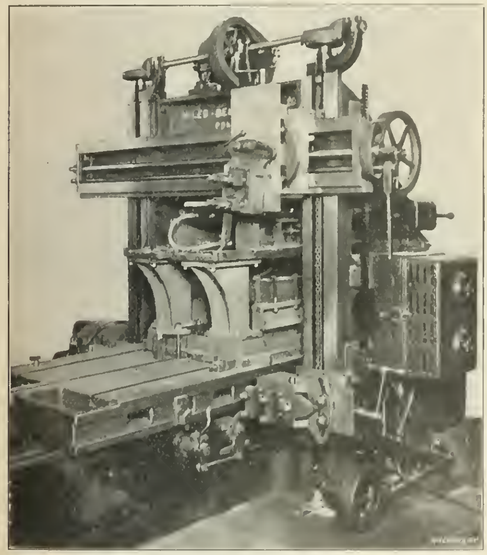


Fig. 1. General Electric Reversing Motor Drive applied to 48-inch by 12-foot Pond Planer

The box itself is pivoted in order that the rear of the panel may be swung into view for inspection. The leads enter through openings in the top or bottom pivots, which prevents them from chafing when the panel is swung out. The field rheostat handles are brought out through the cover of the enclosing case and are plainly marked, "Cut" and "Return." The pointers of these handles traverse a blank ring, which can be marked or graduated for cutting and return speeds in feet per minute.

The master switch is generally mounted on the side of the planer bed, or in any other convenient place. The switch has only four contact fingers (two forward and two reverse), one being used in common for both directions, and there are three segments on the drum. The sole function of the switch is to close the shunt coil circuits of the forward and return line contactors. The motor field is entirely external to the master switch. The panel is encased in a stout cast-iron box, so arranged that the parts and the wiring are accessible. The master switch is operated by dogs on the planer table in much the same way as is now employed for shifting belts. A special double-pole circuit breaker is also supplied, which provides for minimum voltage and overload protection. In case the breaker opens or current fails through any cause, it automatically stops the motor, preventing the platen from coasting off the ways.

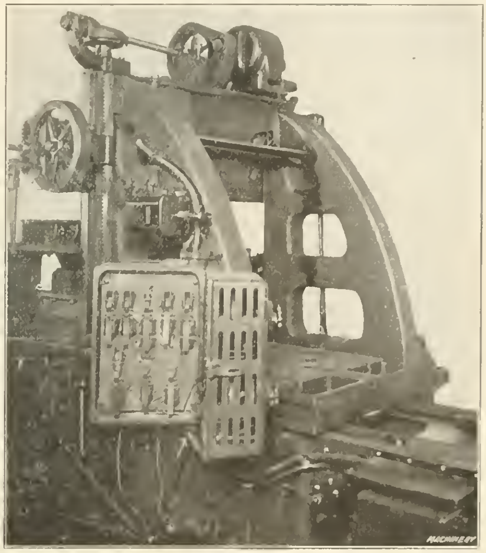


Fig. 2. Controller Panel of Reversing Motor swung open to show Interior Mechanism

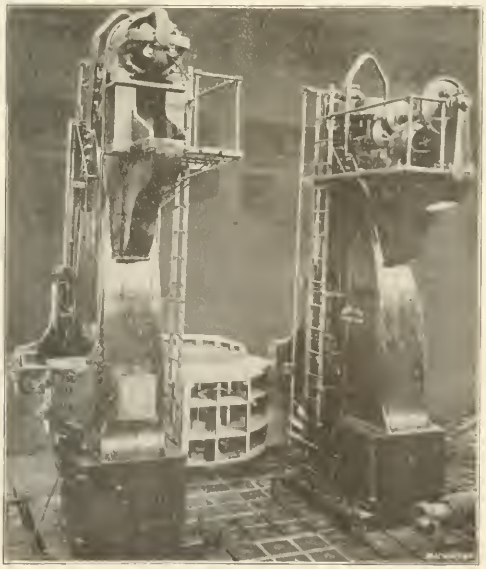


Fig 3. General Electric Reversing Motors applied to 96-inch Newton Slotters

By virtue of the commutating pole design of the motor, starting, stopping and reversing are accomplished with sparkless commutation. In order not to brake dynamically from high speed in one violent step, means have been taken to accomplish this in three distinct steps, braking down slowly from high speeds and then quickening the brake action at lower speeds. This could not be accomplished with one step of resistance, for at the lower speeds, the braking action becomes almost nil, dragging out the process unnecessarily. Thus, the entire braking is completed in the shortest possible time without undue shock. This feature, in addition to quickening the brake, will be recognized as a decided advantage in the maintenance of the machine. Reversing is effected without the delay incident to the use of sluggish relays. A noteworthy point in connection with the operation of this drive is that the planer table reverses extremely close to a line at the end of the cut.

After voltage failure with the master controller in the running position, the motor will start up in the regular way upon return of the voltage to the line, without complications, by closing the breaker. This operating characteristic is very desirable. The cutting and return speeds are entirely independent of each other, so that it is possible to use the slowest cutting speed and the highest return speed, or *vice versa*, in any combination not exceeding four to one. From thirty-five to seventy cutting speeds and the same number of return speeds, are available, the number depending on the size of the equipment.

COMPARATIVE TESTS OF PLANERS EQUIPPED WITH BELT DRIVE AND DIRECT-CONNECTED REVERSING MOTOR DRIVE

Machine		Type of Drive	Size Motor, H. P.	Input, Amperes	Cut, Inches	Stroke	Not Cutting		Cutting		Return		Cut Total Cycle, Seconds
Type	Size						Feet per Min.	Time in Seconds	Feet per Min.	Time in Seconds	Feet per Min.	Time in Seconds	
Planer	36" x 10'	Belt	10	33	3/8 x 1/16	8' 6"	31.9	16	28.3	18	72.8	7	25
Planer	36' x 10'	Reversing	10	51	3/8 x 1/16	8' 6"	53.2	9.6	52.7	9.8	91	5.6	15.4
Planer	36" x 10'	Belt	10	38.5	1/2 x 1/16	8' 6"	33.3	15.4	28	18.2	72.8	7	25.2
Planer	36" x 10'	Reversing	10	56	1/2 x 1/16	8' 6"	53.7	9.5	53.2	9.7	91	5.6	15.3
Planer	72" x 22'	Belt	40	95	1/2 x 1/16 1 x 1/16	10' 1"	22.9	26.4	17.1	35.4	599.3	10.2	45.6
Planer	72" x 22'	Reversing	35	120	1 x 1/16	10' 1"	34.8	17.4	34.4	17.6	73.7	8.2	25.8

Machinery

If the reversing motor is attached to machines already in use, the speed of the driving shaft on the majority of planers, will be low enough with the slowest cut to meet the motor speed of 250 R. P. M., and only a coupling and the necessary motor foundation will be needed. If, however, the planer gearing is of such a ratio that the speed of the driving shaft, when making the slowest cut required, is lower than the motor speed (250 R. P. M.) an intermediate gear and pinion have to be installed for the reduction. In the latter case, an outboard bearing should be provided, which can be taken care of either by a motor shaft extension, or, if the standard motor shaft be used, by a special pinion with shaft extension for the outboard bearing. Where the motor is coupled direct to a planer shaft driving through bevel or worm gearing, provision should be made for taking care of the thrust.

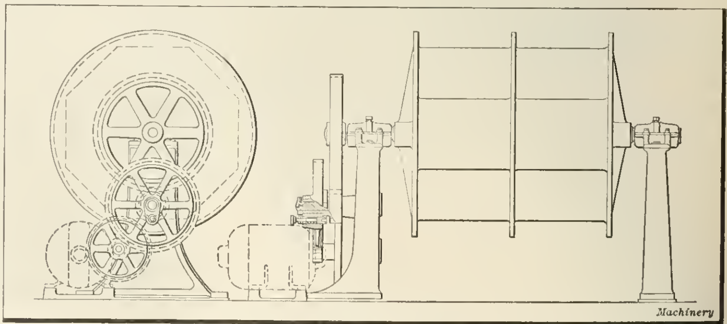
Suitable planer dogs are furnished with each equipment. If there should be a boss or web directly behind the operating lever, the bracket supporting the lever can be extended and mounted on a strap suitably bent for the purpose. The complete equipment comprises the circuit breaker, motor, contactor control, with pendant switch if desired, master switch, two dogs, main operating lever, auxiliary operating lever and bearings for the auxiliary shaft. On account of variance in location, bends and length in individual machines, the auxiliary shaft and the connecting rods from this shaft to the operating lever and master switch are not included.

It is interesting to note what has been accomplished with this type of reversing motor drive. As a general proposition, the saving arising from applying power direct to machine tools is in the frictional load which is eliminated. This often amounts to as much as 50 per cent, yet it is, in reality, only a small part of what may be realized, as proved by numerous tests. A belt driven planer, or other machine, of approximately 10 horsepower capacity, running at a cutting speed of 25 feet per minute, will drop in speed from 2½ to 5 feet or from 10 to 20 per cent, while cutting to a value of 10 horsepower, if the carrying capacity of the belt is approached, due to size, speed or slackness. If the cutting speed be increased to 50 per cent with the same depth of cut and feed, the speed will fall, while cutting, nearly to what it was originally, the power input increasing only slightly or to the limit of the belt capacity. The maximum slip will be reached when the machine is stalled, the power input remaining approximately constant and the loss being entirely due to friction from belt slippage. This slippage loss is demonstrated in the tabulation of tests made with a recording ammeter and given in the accompanying table. The motors used were all 230 volt capacity. The speeds noted are average feet per minute for complete cutting and return strokes.

Briefly summarized, the salient operating features claimed by the manufacturer for the reversing adjustable-speed direct-connected motor drive are: Maximum cutting speed sustained uniformly, affording greatly increased production; rapid acceleration on the return stroke; reversal close to a line at the end of the cut; economical operation and upkeep; any speed desired within a ratio of four to one; many speed combinations, allowing the slowest cutting and highest return speed to be combined; freedom from shocks, permitting the quickest reversals possible without jar; quiet operation; sparkless commutation; and positive and safe control within easy reach of the operator.

ABBOTT MOTOR-DRIVEN BURNISHING BARREL

The Abbott Ball Co., Hartford, Conn., has developed the motor drive illustrated herewith, to meet the requirements of customers who desire to apply electric motor drive in their burnishing departments. The novel feature of this equipment lies in the clutch mechanism in one of the gears which provides for disengaging the motor when it is necessary to turn the barrel over by hand to remove its contents. The clutch is



Motor Drive with Special Clutch Mechanism for Abbott Burnishing Barrel disengaged by means of the knurled head driving pin shown above the motor. This pin forms the connection between the gear and pinion on the second stud. The pin can be pulled out part way against the tension of a spring and then twisted so that the small cross-pin holds the end of the driving pin out of engagement with the second gear. This disconnects the drive and allows the barrel to be turned over by hand as previously mentioned.

AUTOMATIC THREADING LATHE

The Automatic Machine Co., Bridgeport, Conn., has recently brought out a threading lathe of improved design, especially adapted for threading both external and internal work of all kinds with V, square or Acme threads. The general appearance of this machine is indicated by Fig. 1. Briefly stated, the features of the machine comprise the driving shaft; the clutch shaft, which operates the four speed changes; the spindle, with its driving clutches; the lead shaft; the back-shaft, for reversing the direction of carriage travel and withdrawing the tools after the threading operation; the carriage, and the tailstock. The machine will swing work up to 14 inches diameter and the beds are built of any length required; the machine shown in Fig. 1 accommodates work up to 24 inches in length. As stated, there are four speed changes for the lead-screw, and by means of a two-speed countershaft, a total of eight speeds are secured. By setting up the machine with a proper gear train, threads of any desired pitch may be cut. Fig. 2 shows a view of the machine from the rear to illustrate the carriage-reverse and tool-withdrawing mechanism. Fig. 3 shows a special double cut screw threaded upon this lathe; the two halfnuts, one threaded right-hand and the other left-hand, were also cut upon one of these machines, fitted with special work-holding facilities. The piece shown cut externally was produced on the standard machine, and is cut with a right- and left-hand thread upon the same section. The two halfnuts cut with right- and left-hand threads, respectively, were cut upon the modification of this machine shown in Fig. 9. These two halfnuts and the threaded spindle form part of the steering gear of an automobile; the spindle remains in a fixed position, but turning it advances or withdraws the two halfnuts in opposite directions. In this special machine, which will be described more fully later on, there is no tailstock, the rear end of the work being supported in a follow-rest mounted upon the carriage.

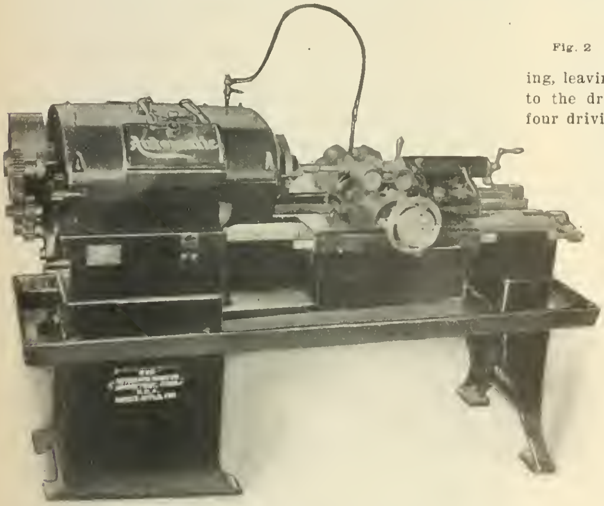


Fig. 1. General View of the Automatic Threading Lathe

The driving mechanism and its connections with the clutch shaft, spindle and back-shaft are all enclosed within the head of the machine. Fig. 4 shows a plan view of the head. Referring to this illustration, the driving shaft is shown at *A*, power being transmitted through the large pulley located outside of the head of the machine. It will be noticed that the belt pull is taken from the driving shaft by means of a special bushing shown at *B*, which is bolted to the frame of the machine. The bore of the pulley is counterbored to fit this bushing, leaving a small section at the end which is merely pinned to the driving shaft. Upon this driving shaft are mounted four driving gears *C* having 36 teeth, *D*, 30 teeth, *E*, 25 teeth, and *F*, 20 teeth. The extra width of driving gear *F* is necessary on account of the second drive which extends to the back-shaft. The bearings on this driving shaft, as well as those throughout the machine, are oiled by ring oiling chains, which may be seen at each end of this shaft.

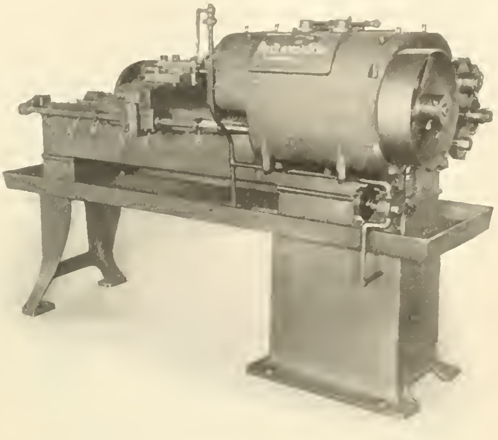


Fig. 2 Rear View showing Carriage-reverse and Tool-withdrawing Mechanism

From the driving shaft, rotation is transmitted to the clutch shaft *G*. Upon this clutch shaft are mounted four gears: *H* having 36 teeth, which mesh with gear *C*; *I* having 42 teeth, which mesh with gear *D*; *J* having 47 teeth, which mesh with gear *E*, and *K* having 52 teeth, which mesh with gear *F*. Normally, these gears are free to rotate upon shaft *G*, but by means of clutch *L*, which operates between gears *H* and *I*, and clutch *M*, which operates between gears *J* and *K*, either one of these gears may be made to transmit rotation to the shaft. These clutches *L* and *M* are operated by two levers, which may be seen upon the top of the enclosing case over the head. The clutches are of the double pin type and there is a locking device, semi-automatic in its action, so that two gears cannot be thrown into mesh simultaneously. The sprocket on the end of shaft *G* drives the oil pump which supplies cutting lubricant to the machine. The sprocket chain may be seen at the end of the machine in Fig. 2, and just to the left may be seen the oil pump. At opposite ends on the clutch shaft are mounted gear *N* having 22 teeth, and gear *O* having 57 teeth, which serve as the driving gears for the forward and reverse movements, respectively, of the spindle shaft.

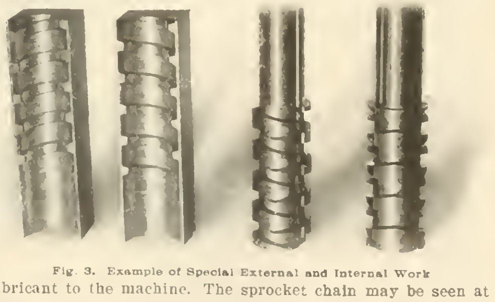


Fig. 3. Example of Special External and Internal Work

Next in order comes the main spindle shaft P that receives motion from the driving gear N on the clutch shaft, which, through an intermediate shaft, not shown, drives the corresponding gear Q having 88 teeth. This gear is located on the forward end of the spindle shaft, while at the opposite end there is the gear R having 59 teeth, which operates the reversal of the spindle when in mesh with gear O on the clutch shaft. By means of the clutch operating sleeve S, which slides upon the spindle shaft, the friction clutches T and U may be alternately expanded and thus cause the forward or reverse motions to be applied to the spindle shaft. These frictions are of the split rim type, being operated by the toggles V which cause the rims to expand and grip upon the inner surface of T or U.

The lead-screw is driven by means of a train of gears, which may be seen at the end of the lathe in Fig. 2; these gears are operated from the spindle shaft. The lead-screw is 1 15/16 inch in diameter and is of 2 pitch; it extends the entire length of the lathe, being located between and just below the ways. The right-hand bearing of the lead-screw may be seen in Fig. 8. The carriage is reciprocated upon the ways by means of a nut engaging with the lead-screw. As this nut has an extremely long bearing upon the coarse pitch lead-screw, there is very little danger of inaccuracies developing from wear of the nut or screw.

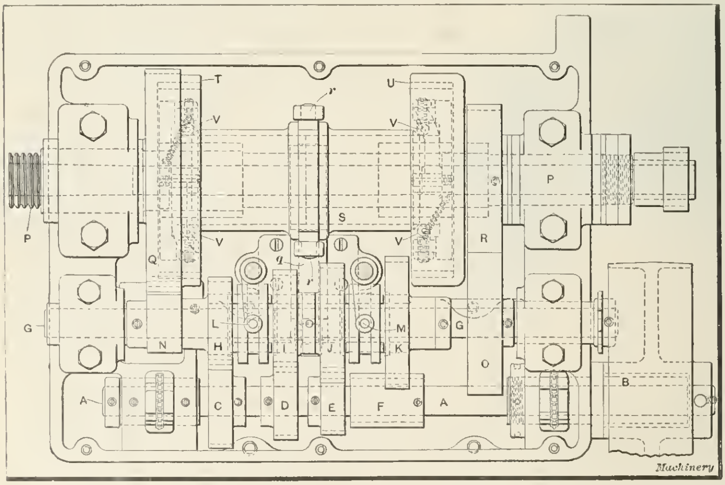


Fig. 4. Plan View of the Head of the Machine

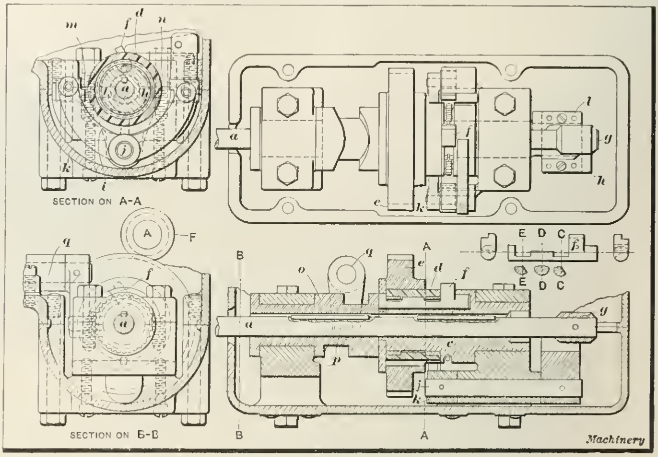


Fig. 5. Back-shaft Mechanism for reversing Carriage Travel and withdrawing Tools on Return Stroke

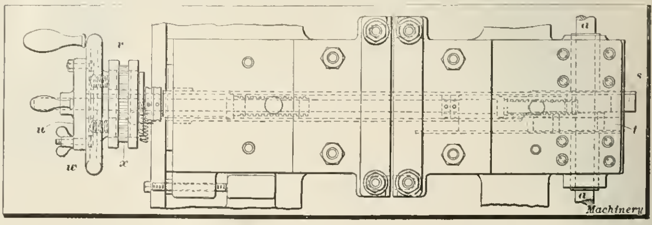


Fig. 6. Front and Rear Sections of the Carriage and its Mechanism

In Fig. 5 is shown the back-shaft mechanism for reversing the carriage travel and withdrawing the cutting tools for the return of the carriage. This mechanism all centers around the back-shaft, which is shown at a, in Fig. 2, and again in the line engraving, Fig. 5. Two stop collars b are adjustably held upon the back-shaft at the points at which it is desired that the carriage shall reverse its travel. The part of the back-shaft and surrounding mechanism that is located within the head of the machine may be seen in Fig. 5. Surrounding the back-shaft a, is a clutch sleeve c. This sleeve is provided with a keyway in which a key in the back-shaft is free to slide. At the forward end of the clutch sleeve is the hardened tool-steel clutch d which runs on bronze bushings located upon the clutch sleeve. This clutch is positively keyed to the driving gear e which receives its motion from the main driving shaft of the machine. This driving gear and clutch are in constant rotation around the clutch sleeve c, and by means of a series of internal clutch teeth, which are gripped by the clutch latch f when drawn into proper position, the driving gear and clutch communicate their motion to the clutch sleeve, and thence to the back-shaft. The action of throwing this clutch latch into mesh with the clutch is accomplished by the longitudinal movement of the back-shaft, occasioned by a side pressure of the carriage upon either collar b, Fig. 2. There is a bevel-ended collar g pinned to the rear end of the back-shaft, and when the collar is forced back by the longitudinal movement of the back-shaft, it pushes the plate h to the side. This plate is attached to one side of the arm i, and consequently the whole arm, which is pinned to auxiliary shaft j, moves away, thus rotating the auxiliary shaft and at the same time throwing rocker-arm k into position so that face m on the rocker-arm will trip the latch f as it comes around. The tripping of this latch f causes it to assume a vertical position with respect to the clutch sleeve, throwing its engaging section out of contact with the clutch. The latch f is held in this position by its contact with face m until the other extreme of the carriage travel has been reached. The engagement of the carriage with the other stop collar b causes the taper-end collar g on the opposite end of the shaft to be drawn forward, allowing plate h on i to drop in again and at the same time forcing i in the opposite direction by means of the contact of g with plate l. This causes rocker-arm k, which it will be remembered is pinned to the intermediate shaft j, to tip so as to bring face *n* into position to arrest latch *f*, which causes it to be drawn out of contact with the clutch and held until the opposite end of the carriage travel has been reached. Thus, it will be seen that during the length of the carriage travel, dog *f* is out of contact with clutch *d*, and at the end of each extreme of the carriage travel the back-shaft is clutched to the driving gear *e* by means of clutch *d* and allowed to make one-half of a revolution. The purpose of this half revolution will be explained later.

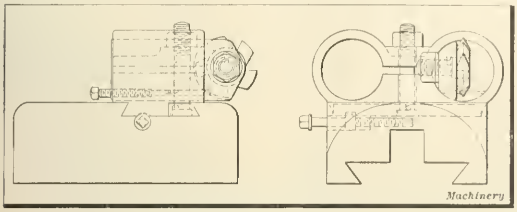


Fig. 7. Plan View of the Tool-slide

Keyed to the back-shaft, just ahead of the clutch sleeve *c*, is the back-shaft cam *o*, and each time the back-shaft makes its half revolution, by the means just described, it causes cam roller *p* to rock shaft *q* to one of its extreme limits. Referring again to the plan view shown in Fig. 4, this shaft *q* may be traced to its position just beneath the spindle shaft *P*, where it supports the double-ended rocker-arm *r* which serves to reciprocate the clutch operating sleeve *S*. By means of the gib connection between the spindle shaft and the lead-screw, the lead-screw is reversed simultaneously with the spindle shaft.

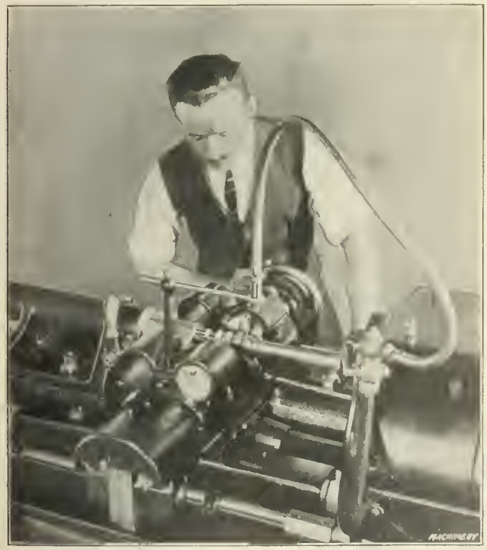


Fig. 8. Illustrating Operation of the Tool-slide

The turning of the back-shaft a half revolution at each end of the carriage travel serves a double purpose. First, by means of cam roller *p* it causes the spindle and lead-screw to reverse, and, second, it causes the cutting tools to be withdrawn from the work for the return stroke of the carriage and replaced at the commencement of the cut in the screw. By referring to Fig. 6, which shows the front and rear sections of the carriage and its mechanism, it will be seen that there is a long fork *s* and a short fork *t* which connect, respectively, with the front and rear toolslides. By reciprocating either of these forks, the corresponding toolslide is caused to reciprocate; and by means of eccentrics which work within these forks and are keyed to the back-shaft, the half revolution of the back-shaft causes the short fork to be pulled backward and the long fork to be moved forward, thus backing away the cutting toolslides during the return stroke of the carriage. The subsequent half turn of the back-shaft brings the tools together for the cutting stroke of the carriage. By means of the disk *u*, pinned to the small shaft which may be seen at the center, the rear toolslide may be operated independently by hand. The disk *v* is operated by the larger handle, and enables the forward toolslide to be operated independently of the rear toolslide. By releasing or tightening clamping nut *w*, the two toolslides may be operated in unison by hand. A ratchet *x* is mounted upon the toolslide feeding screw. The pawl is operated by a rod, and when a stop is struck at the end of the carriage travel, a feed of from one to six teeth may be secured. Each tooth is equivalent to 0.002 inch.

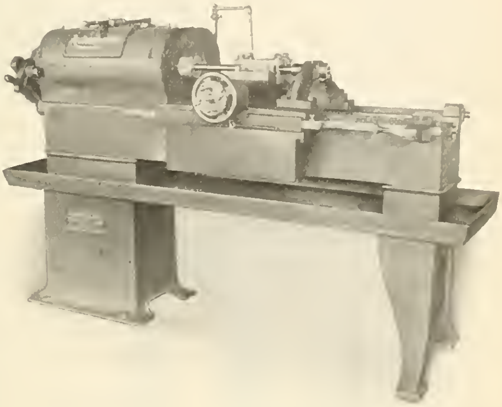


Fig. 9. Special Machine with Follow-rest for Internal Work

Coming to the toolslides themselves, which are best shown in the line engraving in Fig. 7 and the plan photograph, Fig. 8, it will be seen that there are four positions for holding the cutting tools. On external work, two tools are used, one on the forward and one on the rear toolslide. When cutting work close to a left-hand shoulder, the two left-hand positions are utilized, and where the work comes close to right-hand shoulders, the two right-hand stations are made use of. By using two cutting tools, it is possible to have one tool cut one wall of the thread while the other tool attends to the other wall of the thread. The advantage of this two-tool method over the use of a single forming tool is obvious, especially when cutting square threads, as with two tools plenty of chip clearance may be provided, and there will be no danger of choking as with a forming tool. The correct helix angles may be reached by turning the tool-holders in their seats. Provision is also made for minute side adjustment for either tool in the set-over screws, one of which is plainly shown in the toolslide in Fig. 7. While circular cutting tools are ordinarily used, forged tools may be used employing a special tool-holder to carry them.

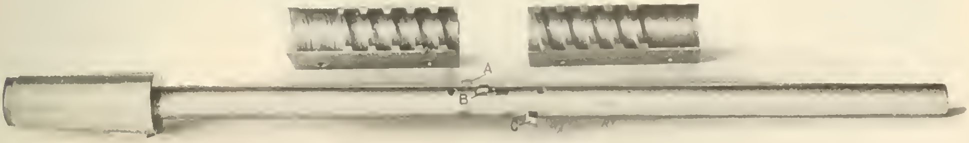


Fig. 10. Special Arbor for Internal Work with Roughing Tool A, Finishing Tool B, and Follow-tool C

A slight modification of the standard automatic threading lathe is shown in Fig. 9, where it will be seen that this particular machine has no tailstock but has a follow-rest mounted upon the carriage. It will also be noticed that the tool-holders are not present, this lathe being exclusively for internal work on halfnuts, as shown in the illustration, Fig. 10. In this case, the tools are held in a special arbor, one end of which is seated in the spindle of the machine and the other end is free to slide in the follow-rest previously described. Referring to Fig. 10, the roughing tool may be seen at *A*, finishing tool at *B*, and a follow-tool is shown at *C*. The purpose of this follow-tool is merely to hold the thread uniform at the last turns so that there will be no thick or thin threads at the end. The blank halfnuts are clamped on the forward and rear toolslides and the cutting is accomplished in the same manner as with external work.

KOKOMO 25-INCH UPRIGHT DRILLING MACHINE

The Superior Machine Tool Co., Kokomo, Ind., has added to its line a machine known as the Kokomo 25-inch high-speed drilling machine. The machine is illustrated in Fig. 1 and several of its new features are shown in the line engravings Figs. 2, 3, and 4. In order to provide for durability of alignment, all of the bearings of this machine are lined with Damascus bronze bushings that are machined ready for application. As no particular skill is required to replace worn bearings, this construction will enable the machine to be kept in accurate alignment at a comparatively small expense. Each of the main bronze-bushed bearings is provided with a sight-feed oil lubricator of sufficient capacity to carry lubricant enough for at least one day's run. All of the gears in this machine are of steel. The back-gears are bronze-bushed and the bearing of the crown gear, which receives the hardest service of any of the bearings, is provided with a tapered bronze bushing to enable wear to be taken up. The gears in the positive geared feed-box are of hardened nickel steel with bronze bushings; these gears are lubricated by the splash system.

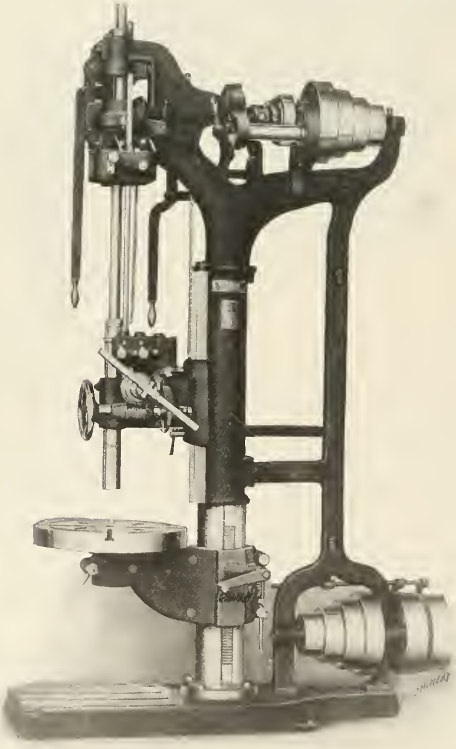


Fig. 1. Kokomo 25-inch High-speed Drill showing Upper and Lower Gear-boxes

This machine embodies a number of time-saving features in its method of operation. It is equipped with friction back-gears which are controlled by a lever placed within easy reach of the operator so that it is possible to change from the direct speed to the back-gear speed without shifting the belt or stopping the machine. This method also enables the operator to bring the spindle to a stop when the clutch is placed in the neutral position. In addition to the control of the spindle speed by means of the friction back-gear, the machine is equipped with a friction return lever which gives the operator absolute control over the feed of the spindle. Fig. 2 shows a cross-section of the friction quick-return mechanism. It will be noted from this illustration that the friction, which is of the expanding ring type, operates inside of the bronze worm-gear. The divided friction ring *F* is expanded by the vertical plungers *H*, the horizontal plunger rod *C*, the cam *B*, and the control lever *A*. A slight movement of the control lever *A* from the position shown will engage the friction, the drive being engaged or disengaged at the will of the operator. The adjusting nut *E* is provided for taking up wear in the friction, and the spring *I* throws plunger rod *C* to disengage the clutch when the operating lever *A* is released. Cam *B*, plunger rod *C* and plunger *H* are made of hardened tool steel.

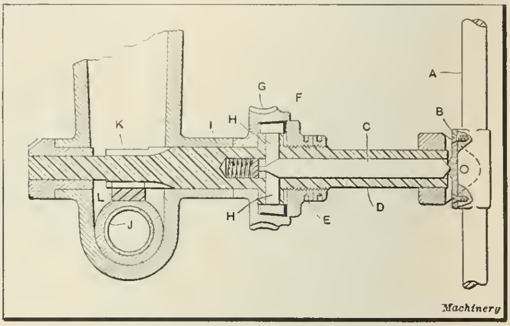


Fig. 2. Cross-section of Quick-return Mechanism

The machine is provided with two gear-boxes. The lower gear-box is mounted on the head and provides four changes of speed by shifting two handles on the gear-box; these four changes are compounded by means of the upper gear-box. Connection is made between the two gear-boxes by means of the shaft *A*. The lower gear-box is similar in design to the one which was designed in connection with the Superior drill press in the February, 1911, issue of MACHINERY. The arrangement of the gears in the upper box is shown in Fig. 3; the changes in this box are made by shifting one lever into either of the two positions. The eight positive gear feeds obtained by this combination are: 0.006, 0.008, 0.010, 0.013, 0.016, 0.023, 0.026, and 0.038 inch.

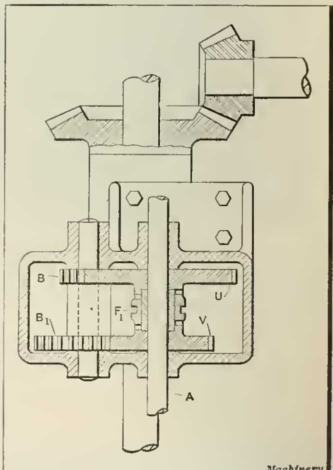


Fig. 3 Arrangement of Upper Gear-box

Fig. 4 illustrates the automatic stop with which this machine is equipped. The feature of this design is that the worm is not disengaged from the worm-gear when disengaging the power feed. The stop is controlled through hand lever *G* which governs the friction gear *C* and is tripped by the adjustable collar *H*, coming into contact with a trip trigger *I*, as shown. The friction gear *C* is brought into contact with the friction disk *D* by means of the collar *B*. This collar is actuated by the shaft *A*, a lever, connecting link *E* and the hand lever *G*. Any wear in the friction is taken up by means of the set-screw *J* placed in the end of the connecting link *E*; this set-screw also provides for making adjustment for releasing at different breaking strains. The automatic stop is positive in its action. It will be noted from this description that there are two frictions placed between the crown gear and the spindle; namely, the one used in connection with the automatic stop and the one in the quick-return mechanism.

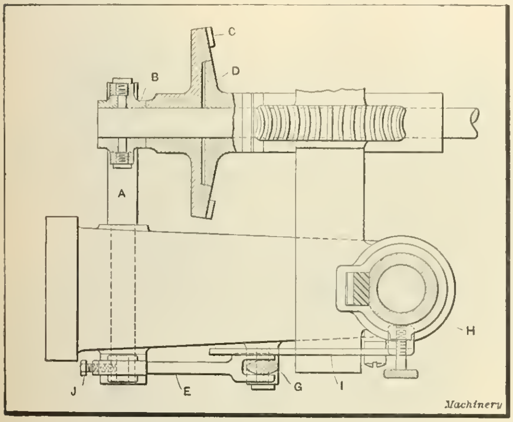


Fig. 4. The Automatic Stop showing Details of Tripping Mechanism

The tapping attachment with which this machine is furnished is similar to the design which has been used on this company's drill presses for some time. Instead of mounting the reverse gears on the main spindle, these gears are mounted in the form of a jack-shaft to the left of the spindle; this jack-shaft obtains power from spur gearing attached to the hub of the crown gear. The friction gears are loosely mounted on the jack-shaft and engage a clutch keyed to the jack-shaft which will rotate the spindle sleeve in either direction. The advantage of this construction is that it provides for the use of a longer driving key than would otherwise be possible, so that the entire power of the belt can be transmitted to the spindle without cramping or binding the key.

The table of the machine is of heavy construction and the table arm has a tongue which fits a corresponding groove in the bearing to provide for retaining alignment when the clamp bolts are released. The table is provided with both T and straight slots. The quill is fitted with removable Damascus bronze bearings so that they may be easily replaced when necessary. The spindle has ball thrust bearings and a pair of jamb nuts for adjustment. A speed plate is provided which gives the proper speeds of the tight and loose pulley and also the speed that will be obtained on the open or back-gear belt when running the belt from any one of the different steps of the cone pulley. The machine can be furnished with a plain round table, as illustrated; with a compound table with longitudinal and cross travel, actuated by screws provided with micrometer dials reading in thousandths of an inch; or with a square table which is equipped with a large oil groove and also a pump and reservoir for supplying oil or other lubricating fluid to the machine. Provision can be made for motor drive, the equipment for this purpose consisting of a constant-speed motor mounted on an extended sub-base and connected to the bottom shaft by means of gearing; the gearing used in connection with such equipment is completely enclosed.

THE WALCOTT ENGINE LATHE

A general idea of the design and construction of the Walcott engine lathe will be gathered from the illustrations of the front and end views of the machine, and of the apron and the taper attachment which are shown in the accompanying illustrations. The machine combines a number of valuable features, among which are the double apron in which all of the gears are of steel, the exceptionally wide bridge to the carriage, the improved quick-change gear mechanism for feeding and thread cutting, and the unusually large bearing surface on the bed. All of the shafts and studs are supported on both ends.

Both longitudinal and cross feeds are operated by friction and the feeds are reversed in the apron. The feed shifter interlocks with the lead-screw nut, so that the rod and screw feeds cannot be engaged at the same time. The frictions are of large diameter and all of the steel gears which run on studs are provided with bronze bushings. The construction of the saddle is particularly massive, and this is especially true of the bridge which is of unusual width and depth. The bridge is reinforced by having a bearing on the front tailstock way, this construction eliminating the tendency to spring under pressure of heavy cuts. Particular attention has been paid to the design of the bearings on the bed which are made of such a size that the tendency to wear is materially reduced; it is obviously impossible to provide means for correcting such wear, so that this is an important feature.

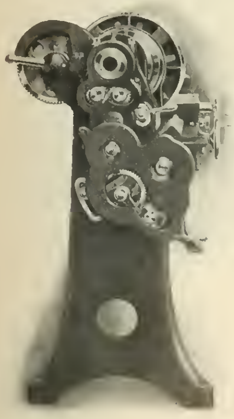


Fig. 1. End View of Walcott Lathe

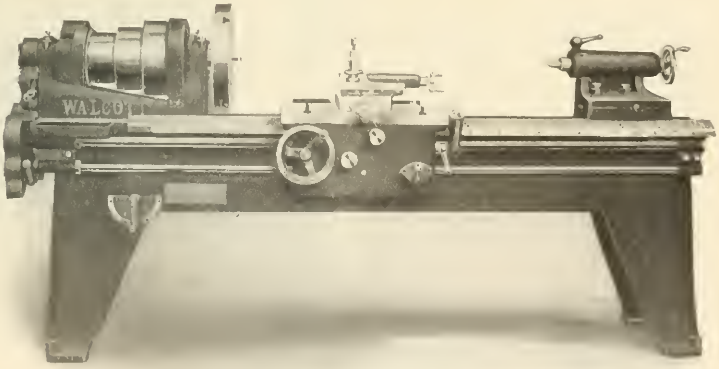


Fig. 2. Front View of Walcott 18-inch Lathe with Double Back Gears and Three-step Cone

Thirty-two changes of threads are provided which cover all standard pitches, including 11½. These changes are instantly obtained by the two levers shown on the front of the machine. In addition to this, special or extra fine or coarse threads may be cut by changing one gear on the end of the lathe, an extra gear being furnished for this purpose. The tumbler gear and cone of gears are used only for thread cutting and are not used when feeding. This simplifies the design of the gear-box on this lathe and retains the accuracy of the thread cutting gears. The quick-change gears are operated by the lever at the lower right-hand end of the gear-box which controls a sliding key inside the machine.

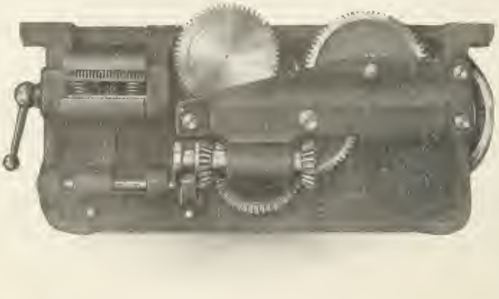


Fig. 3. Apron of the Walcott Lathe

The headstock spindle is of high-carbon steel and is mounted in bronze boxes which are provided with means for taking up wear. The nose of the spindle is provided with a long pilot for truing up the faceplate independently of the thread. The tailstock is of rigid design; it has an ample bearing surface on the bed and a spindle of large diameter. This lathe is made in 16-inch and 18-inch sizes. Fig. 2 shows the machine with a three-step cone pulley; it is also built with a four-step cone pulley and single back-gear. The Walcott & Wood Machine Tool Co., Jackson, Mich., is the manufacturer.

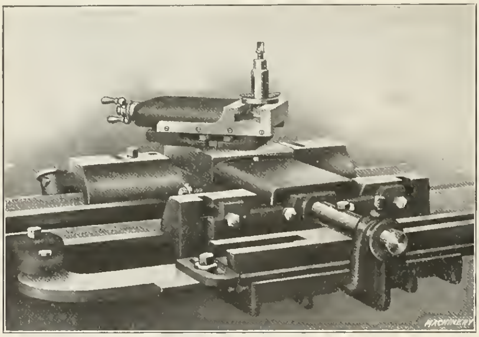
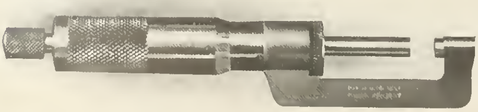


Fig. 4. The Taper Attachment

STARRETT CO.'S HUB MICROMETER

A new style of micrometer made by the L. S. Starrett Co., Athol, Mass., is particularly adapted for measuring the thickness of hubs on wheels and gears where extreme accuracy is of importance. Until recently, the usual method of measuring hub thicknesses has been to lay a straightedge on one side of the hub and put a steel rule through the bore, reading the thickness on the opposite side from the straightedge. Sometimes when the total diameter of the wheel or gear is small, a pair of calipers can be slipped over and the thickness of the hub calipered in the usual manner. This Starrett hub micrometer does away with liability of error common with the rule or caliper method, because the measurement is made direct and, therefore, the micrometer reading insures absolute accuracy.



Starrett Micrometer for measuring Thickness of Gear or Wheel Hubs

The feature of this micrometer is the frame, which, instead of flaring out in a semicircular form like the ordinary micrometers, is offset only slightly from the center line of the spindle. By making the frame narrow, it may be easily inserted in holes as small as ¾ inch diameter. The micrometer has the Starrett "speeded" thumb piece and ratchet stop, and also a lock nut for use when the micrometer is to be used as a gage.

SCHELLENBACH-HUNT EXPANDING BLADE REAMER

The shell reamer illustrated in Figs. 1 and 2 is manufactured by the Schellenbach-Hunt Tool Co., Cincinnati, Ohio, and is known as the "Acme" expanding blade shell reamer. This tool is of an improved design and has a number of features that add to its durability, economy and convenience. The expanding feature is intended to maintain the original size of the reamer and not to ream under-size or over-size holes. Referring to the cross-sectional view, it will be seen that the blades expand for their entire length, but more so at the outer end where the greatest wear occurs. The body of the tool is made of steel and the blades are of high-speed steel; these blades expand beyond the body of the reamer and outside of the expanding bolt, thus allowing for reaming square to the end of a hole or to the face of a lathe chuck.

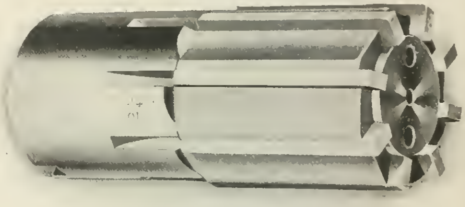


Fig. 1. The "Acme" Expanding High-speed Reamer

The blades are unevenly spaced and are made a tight, frictional fit in the body; they cannot be forced back from the set position by end pressure, because the shoulders on the inside of the blades abut squarely against the face of the counterbored wall, as shown in the sectional view, Fig. 2. The expanding bolt forces all of the blades out uniformly and a very fine adjustment can be quickly obtained. This type of reamer has an exceptional range of diametral expansion. The blades are the only part subject to wear and these blades can be renewed; the body of the tool will last almost indefinitely. The design of the body comprises few parts and has practically nothing to get out of order; ample chip clearance is provided which prevents the clogging of long holes. The shell reamers have Morse taper holes and the regular stock comprises sizes ranging from 1¼ to 5 inches in diameter. Special and metric sizes are made to order.

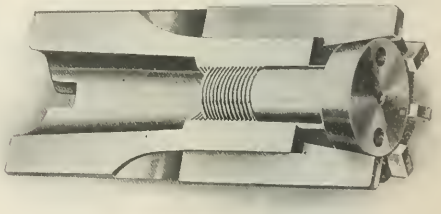
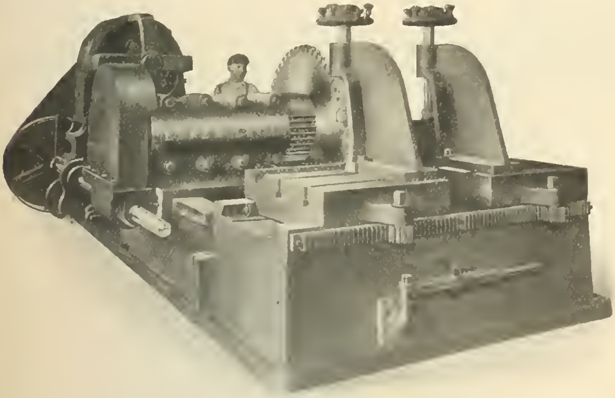


Fig. 2. Longitudinal Section of "Acme" Expanding Reamer

ESPEN-LUCAS COLD SAW

The accompanying illustration shows a new type of cold saw cutting-off machine, built by the Espen-Lucas Machine Works, Philadelphia, Pa., which is one of four machines recently built for the Erie Forge Co., of Erie, Pa. The machine is designed especially for handling all odd-shaped forgings, crankshafts and billets, and when equipped with a saw blade 40 inches in diameter, it has a capacity for sawing round and square bars up to 12-inch sections. The feed and speed variations are such that the machine will saw work of this character with an advance of 6 inches per minute. The drive is through a main shaft, and a phosphor-bronze worm-wheel and crucible steel worm running in oil. The spindle extends the entire width of the saw carriage, and the saw blade is bolted directly against the driving gear, thereby assuring rigidity and avoiding torsional strains between the gear and the saw blade. The saw carriage has a feed of from ½ inch to 6 inches per minute, which is obtained through friction plates controlled by a hand lever that locks automatically, and by means of which any change in cutting speed may be made while the machine is in operation. The saw carriage also has a quick return mechanism, which is controlled by the same lever. An automatic stop for controlling the carriage is also provided.


Espen-Lucas Cutting-off Machine

Any type of saw blade, including the inserted-tooth or solid high-speed steel types, can be used on this machine. Either compressed air or screw clamps are used, depending upon the requirements of the work. For the rapid handling of stock, where multiple cuts are to be made, the machine is equipped with a stock feeding attachment of sufficient capacity to handle bars 12 inches in diameter, and of any length up to 20 feet. The usual drip pan, generally located below the saw at the front of the machine, has been eliminated, and a reservoir has been substituted which is placed in the concrete foundation underneath the machine. The foundation proper forms a drain to the reservoir, which is located at a point accessible from the rear of the machine, so that it may be readily cleaned out when necessary.

In shop tests, as well as in practice, this machine has cut steel billets 10 inches square with 0.35 to 1 per cent carbon in four minutes fifty seconds; round billets, 5½ inches in diameter and with the same carbon content in fifty seconds; and steel bars containing 45 per cent carbon and 3½ per cent nickel, 9 inches in diameter, have been sawed off in three minutes twenty-seven seconds.

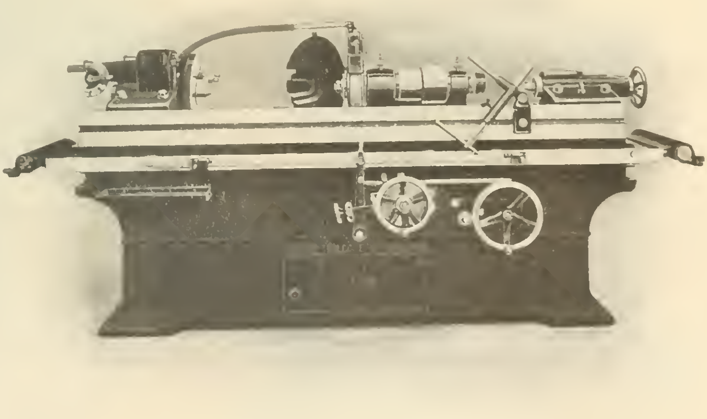
The machine shown in the accompanying illustration is driven by a 25 horsepower General Electric motor, and weighs about 30,000 pounds.

MODERN NO. 18 PLAIN GRINDING MACHINE

The Modern Tool Co., Second and State Sts., Erie, Pa., is now manufacturing the design of cylindrical grinder illustrated herewith. This is a plain type having a capacity of 16 by 72 inches. It has a geared headstock by means of which any speed within its range can be obtained without stopping the drive or shifting a belt; a cross-feed permitting positive adjustment while the machine is in operation; a table reversing mechanism without a "load-and-fire" spring, that positively reverses the table and is non-self-centering; a table handwheel that is stationary while the table is being traversed by power, and other noteworthy features.

The table driving and reversing mechanism is simple in construction and positive in its action. It consists of gears and clutches and is not liable to get out of order. This mechanism is carried in a self-contained bracket bolted to the outside of the machine. Power is transmitted to the sliding table through worm-gearing which imparts a steady movement. The table driving worm runs in an oil pocket, thus insuring good lubrication of the gearing There is a table tarrying device which permits a pause at each end of the stroke. This is located in the table rack pinion and is adjustable from the front of the machine, so that the length of the pause can be varied. The swivel table turns on a large hardened steel stud and it is provided with an adjusting screw. There are V and flat ways, which insure alignment between the headstock and footstock and an angle edge at the front containing a T-slot for attaching different fixtures.

The headstock is the all-geared type and, as previously mentioned, changes of speed can be made while running. Connection between the gears and shaft is effected by hardened steel balls and a plunger, and between each speed there is a neutral point, so that the work can be stopped by simply moving the change-speed lever (seen at the left of the headstock) to the neutral position. By simply shifting this lever, eight different speed changes can be obtained. The work speeds and table feeds are independent. The headstock gears run in oil.


No 18 Plain Cylindrical Grinder, built by Modern Tool Co.

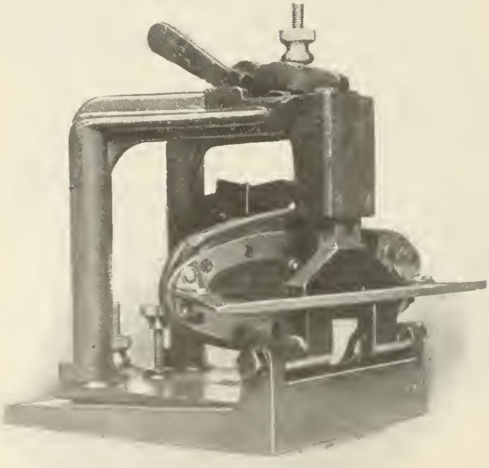
The wheel-slide base is bolted to the bed of the machine and is supported by a column extending to the floor. The wheel stand is gibbed to the base and has large bearing surfaces. It is prevented from creeping towards the work by means of an adjustable spring, the tension of which can be regulated to any desired degree. The tension will not vary during the full travel of the wheel slide (9 inches) and when once adjusted, requires no further attention. The wheel spindle is of tool steel, hardened, ground and lapped, and runs in adjustable phosphor-bronze bearings. The grinding wheel is moved to and from the work through a worm and worm-wheel, and all lost motion resulting from wear is taken up by the tension spring previously referred to.

The automatic cross-feed can be set to operate at either end or at both ends of the stroke, and it can be adjusted for any feed varying from 0.00025 to 0.010 inch. It is automatically disengaged when the work is ground to size, and by the movement of a single lever at the front of the machine, the feed can be instantly changed from fast to slow, without stopping. The cross-feed handwheel is graduated on its beveled flange, to correspond with the notches on the cross-feed dial, thus indicating the amount of stock the wheel is removing. The table control is by means of a lever located above the handwheel. The latter remains stationary when the power traverse is used, but when the power feed is thrown off, the handwheel becomes engaged.

This grinder has a submerged pump of the centrifugal type. The water, after being used, is first returned to a settling pan and from there to the tank, thereby removing the dirt and grit before using the water again. The water tank is cast integral with the base and extends back into the rear column. The lubrication of all moving parts within the body of the machine is obtained by individual oil tubes leading from the front of the bed. The oil holes are closed automatically by a slide, thus preventing the entrance of grit or water. This grinder takes a 2- by 20-inch wheel and its net weight is 9000 pounds.

DIAMOND SKATE GRINDING FIXTURE

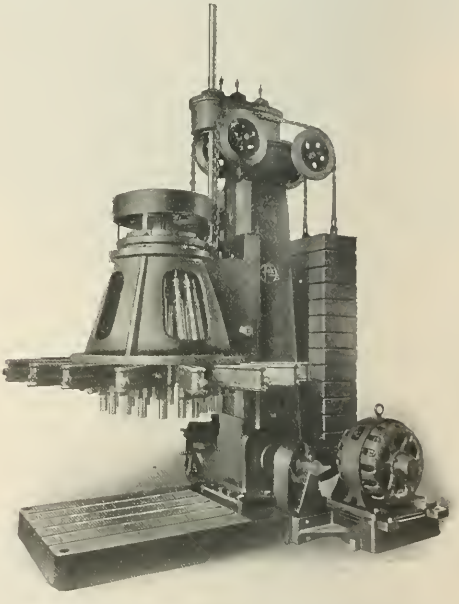
The feature of the skate grinding fixture shown in the accompanying illustration is that it enables hockey or speed skates to be ground while screwed to the soles of shoes. The fixture is also equally suited for grinding the ordinary club skates. This adaptability is secured by means of clamps which take hold of the blade of the skate; the clamps are controlled by means of the cam lever shown at the top of the skate holder. When the lever is thrown back, the clamps spring away from the skate holder so that they release the work automatically. Adjustment for different thicknesses of skate blade is made by means of the knurled thumb nut. The skate holder pivots on the base and can be adjusted by means of the two thumb screws to bring the blade into the proper relation to the wheel, so that it is placed in the correct grinding position at all stages of the wear of the wheel. This skate holder is mounted on a No. 3 Diamond grinding machine provided with a large planed table. The operator grasps the skate holder by means of the two handles, which affords a convenient means of advancing the blade of the skate to the wheel. This machine is a product of the Diamond Machine Co., Providence, R. I.



Fixture for grinding Hockey, Speed or Club Skates

NO. 6 FOX MULTIPLE SPINDLE DRILLING MACHINE

The illustration shows the No. 6 universally adjustable multiple spindle drilling machine recently placed upon the market by the Fox Machine Co., 16 N. Front St., Grand Rapids, Mich. This machine was designed for drilling valve flanges, but it is also available for a variety of similar work. The machine is provided with either the regular belt drive or with motor drive through a Morse silent chain and sprockets, as shown in the illustration. A 30 H. P. motor is required to operate the tool and the maximum horsepower consumed when using 1¼ inch drills and driving at the highest speeds and feeds, is in the neighborhood of 45 H. P. The main driving shaft of the machine runs at a constant speed of 600 R. P. M. and there are six drill speeds ranging from 120 to 400 R. P. M., the changes in drill speeds being obtained through the gear box located on the base of the machine at one side of the column. There are six changes of head feeds provided which vary from 1 inch to 4¾ inches per minute; these head feeds are entirely independent of the drill speeds. The gear box for changing the head feeds is located on top of the box containing the drill speed gears. The gears and bearings in these boxes are flooded with a constant stream of oil by means of a rotary pump.

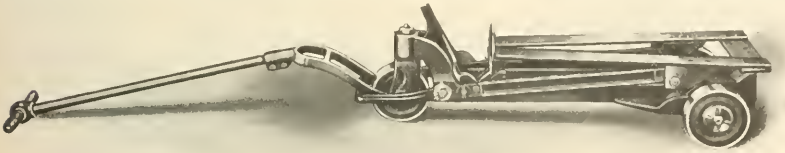


No. 6 Fox Multiple Spindle Drilling Machine with Motor Drive

The head of the machine is counterbalanced by chains and counterweights, and by means of a pilot wheel the head may be easily raised or lowered from the work. The drill spindle bearings and adjusting arms are of the Fox patented construction; the universal joints are also of special design. The friction surfaces in these joints are hardened and all parts which are subject to wear may be easily renewed. Tests were recently made with these machines, using a recording wattmeter in the circuit with the motor. In a case where the machine was driving twelve 1-inch Cleveland high-speed twist drills through plates of soft gray iron one inch in thickness at 390 R. P. M. with a feed of 4.625 inches per minute, the power consumed was 37 H. P.

COWAN AUTOMATIC LOADING TRUCK

The automatic loading truck illustrated herewith is a product of the Cowan Truck Co., Holyoke, Mass. This truck is used in connection with wooden platforms upon which the material to be transferred through the factory is placed. The low-hung design of the truck enables it to be backed under these platforms, the handle being held in a vertical position. When the handle is pulled forward into the natural position in which it is held in pulling the truck, a leverage system raises the platform from the floor so that it can be carried on the truck. When the material arrives at its destination, it is removed from the truck by simply raising the handle to the vertical position and then drawing the truck out from beneath the platform. The advantage of this system is that one truck can take care of a number of platforms. These platforms are inexpensive and it will be evident that each one takes the place of an expensive truck in factories where it is customary to stack material on the truck, pending its transfer to subsequent departments.



Automatic Loading Truck used in connection with Loading Platforms

GRANT ROTARY VIBRATING RIVETER

The riveting machine of ⅛-inch capacity, illustrated herewith, has recently been brought out by the Grant Mfg. & Machine Co., Bridgeport, Conn. It is particularly suited for operating in close corners and in places that cannot be reached by the regular rotating roll riveting machines built by this company. The spindle of the machine is operated through the medium of an eccentric and a vibrating hickory helve, a rubber ball being interposed between the top of the riveting spindle and the end of the helve. The spindle is positively rotated by means of a worm and gear, the worm having a four-step grooved cone pulley for a round belt mounted on its end, which is driven by a corresponding grooved cone pulley on the main spindle. The purpose of these grooved cone pulleys is to vary the rotating speed of the spindle which will enable the operator to produce very smooth work.

It sometimes happens that with a fixed number of blows per second at a certain rotating speed of the spindle, the vibrating spindle will always strike in the same relative position, thereby causing a series of indentations on the rivet which will present a bad appearance. The machine is driven by a 5/16-inch round belt from a grooved pulley on the countershaft to a loose friction driven pulley on the machine. The pulley on the machine is normally running idle and is brought into action through the medium of a friction disk by depressing a foot treadle which closes the friction disk by means of a ball-thrust bearing. As soon as the pressure on the foot treadle is released, the pulley runs idle on the shaft and a brake is automatically put upon the shaft which stops the machine almost instantly. The helve is operated by an eccentric and connecting-rod which, being cushioned with rubber collars on both sides of the rubber ball between the helve and spindle, makes the machine practically noiseless in operation except for a slight hum which is noticeable when a rivet is being headed.

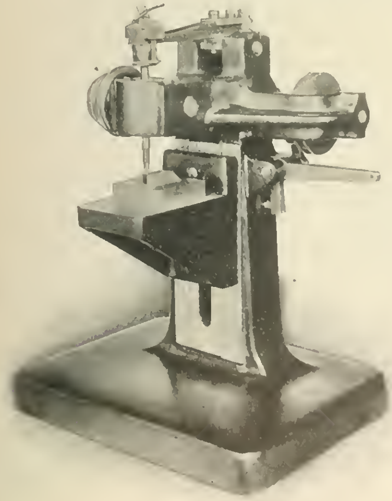


Fig. 1. Grant Rotary Vibrating Riveter

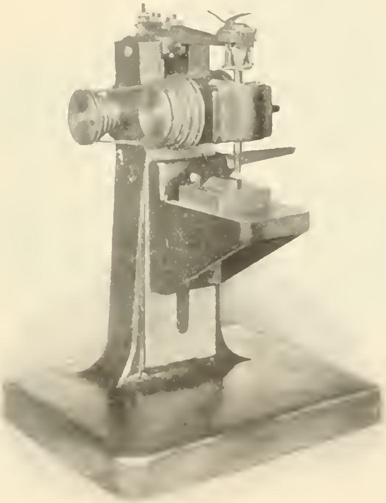


Fig. 2. View showing Cone Pulleys for rotating Riveting Spindle

STEWART BENCH SAW TABLE

The illustration presented herewith shows an improved design of bench saw table for working wood or metal, which is manufactured by S. A. Stewart & Co., Waltham, Mass. This machine is suitable for sawing metals of different kinds such as sheet brass, copper and electrotype plates, and also such

Stewart Improved Bench Saw Table with Cutting-off Gage and Splitting Gage materials as fiber or hard rubber. The use of one of these Stewart combination countershafts in connection with this machine, enables it to be run at a high speed for sawing wood.

The saw-dust box is one of the features of this machine as it keeps an excess amount of saw-dust off the bench. By simply swinging the apron, the saw-dust can be brushed out and caught in a receptacle placed in a convenient position, or by cutting a small slot through the bench provision is made for letting it run into a receptacle placed ready to receive it. A locking device is attached to the frame for holding the saw arbor while the nut is being adjusted. The table is 16 by 22 inches in size and is at a height of 5 inches above the bench. The largest size saw used is 7 inches in diameter. The cutting off gage can be set to any desired angle and the splitting gage is adjustable from 0 to 6 inches from the saw blade. The weight of the machine is about 60 pounds.

SLOCOMB MICROMETER CASE

The chief feature of the micrometer case shown in the illustration is its compact form. It has been a common fault of existing types of micrometer cases that their bulkiness has made them ill-suited to be carried in the pocket. This objection has been eliminated in the present case, which measures 5¼ inches in length by 2¼ inches in width with a thickness of only ⅞ inch, so that it is equally serviceable for carrying a micrometer in the pocket or as a case for the instrument to be kept in when in the tool-chest. In other respects, the case is practically the same as previous types, being velvet lined and covered with real morocco leather. This case is a recent product of J. T. Slocomb, Providence, R. I.

Micrometer Case suitable for carrying in the Pocket

NEW MACHINERY AND TOOLS NOTES

Engine Lathe: South Bend Machine Tool Co., South Bend, Ind. An 18-inch engine lathe with a 6-foot bed which takes 33 inches between centers and swings 18¼ inches over the bed and 13¼ inches over the carriage.

Gap Bed Engine Lathe: South Bend Machine Tool Co., South Bend, Ind. A 16-inch engine lathe with gap bed which is built in five sizes, ranging from 11¼ to 18¼ inches swing over the bed and 15 to 26 inches swing in the gap.

Cylinder Boring Machines: Newton Machine Tool Works, Inc., Philadelphia, Pa. This company has recently redesigned its entire line of cylinder boring machines which are adapted to boring motor frames, cylinders and similar parts.

Double Hook Monorail Crane: Northern Engineering Works, Detroit, Mich. A double hook monorail crane or hoist built in capacities ranging from 2 to 5 tons. This equipment is provided with two hoisting drums and is operated by two motors.

Duplex Hand Milling Machine: Garvin Machine Co., Spring and Varick Sts., New York City. A duplex milling machine consisting of two hand miller heads mounted on one base in such a way that two pieces may be milled simultaneously for one passage of the work table.

Combination Lathe Tool-Holder: John B. Slavik, Poughkeepsie, N. Y. A tool-holder having a head fulcrumed on the shank in such a way that vertical adjustment of the tool is secured. The seat for the tool in the head is V-shaped, the tool being held in position by a set-screw.

Rotary Shear: H. Collier Smith, Detroit, Mich. A rotary shear designed for irregular cutting operations on sheet metal up to ⅜ inch in thickness. This machine will cut practically any form of irregular curves, including reverse curves, and leaves the edges of the metal flat and smooth.

62-Inch Lathe: New Haven Mfg. Co., New Haven, Conn. A 62-inch lathe combining the features of rigid construction, powerful head drive and a wide range of speeds. The machine is designed for either motor or belt drive and swings 63 inches over the bed and 49 inches over the carriage.

High-Duty Box Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A motor driven box boring machine equipped with a 7½ H. P. motor and having available cutting speeds ranging from 40 to 80 feet per minute with a feed of 1/16 inch per revolution. The machine weighs 7824 pounds.

Roller Bearing: American Roller Bearing Co., Pittsburg, Pa. A roller bearing for use on pulleys and shafting, which operates without requiring lubrication. This advantage is secured through the use of a special combination of load carrying rolls and spacing rolls which reduces the friction to a practically negligible quantity.

Roll Grinding Machine: A. Garrison Foundry Co., Pittsburg, Pa. A grinding machine for finishing rolls in sizes up to 32 inches in diameter by 108 inches in length. The design of this machine is the outcome of a number of experiments which were conducted to determine the practicability of using a grinding machine in the roll finishing department.

Grinder: Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. A grinder in which special attention has been paid to overcoming friction. The spindle is of 30 point carbon steel, turned and ground accurately to size, and the spindle bearings are lubricated by a wick, both ends of which dip into an oil receptacle located in the head beneath the spindle.

Automatic Knife Grinder: Northampton Emery Wheel Co., Leeds, Mass. An automatic knife grinder having a heavy cup-wheel which is especially adapted for grinding paper cutter knives and shear blades. The automatic feed of the knife to the wheel is operated by a pawl and ratchet, actuated by a trip that may be adjusted to meet the requirements of different classes of work.

Gas-Fired Furnaces: Gilbert & Barker Mfg. Co., Springfield, Mass. A new design of gas furnace for the heat treatment of metals, in which cast iron has been replaced by sheet iron wherever it is possible. The reason for this construction is that sheet iron will stand expansion and contraction much better than cast metal is able to do. The sheet metal is reinforced with angle iron.

Mechanical and Electrical Time Recorders: Industrial Instrument Co., Foxboro, Mass. The pen arm of the mechanical recorder is attached to and supported by the shaft or axis. An arm, attached to the shaft, passes through the case and an extension with adjustable clamps serves to facilitate the adjustment of the motion to secure the travel of the pen on the chart. The chart is rotated by clock movement. The electric recorder is operated by electric contact, and is adapted for use in many places where the recorder itself is desired to be at a considerable distance from the source of motion or operation.

Milling Machine with New Over-Arm Construction: Kearney & Trecker Co., Milwaukee, Wis. This company's No. 3-B plain milling machine has recently been equipped with a new design of over-arm construction which establishes a precedent in machine tool design. This over-arm construction consists of two arms provided with a simple device to clamp them to the column and arranged so that both arms fit the arbor supports. The two arms are of the same size and are located at some little distance apart so that the connections between the arms and the arbor form the outline of a triangle. The device for clamping the arms consists of two blocks, the lower corners of which are machined to fit the arms. These blocks are tightened by collar nuts and have short springs located under them so that the blocks are forced out of engagement with the arms when the nuts are released. The advantage of this arrangement is that when an arm is taken out of the machine, the blocks are held up out of the way so that it is an easy matter to replace the arm in position. These clamping blocks for holding the arms are placed at each end of the top surface of the column. This twin arm construction provides a particularly rigid support for the arbor so that the tendency for it to be sprung, broken, or for the bearings to be worn is materially reduced.

* * *

The German Albatross Aeroplane Works, at Habsheim, have received many orders from the Balkan states. The contracts include a stipulation that every aeroplane shall be accompanied by an aviator and two mechanics. The aviators will be paid $1250 a month and the mechanics, $250.

WILLIAM F. M. GOSS

William Freeman Myrick Goss, the new president of the American Society of Mechanical Engineers, was born in Barnstable, Mass., October 7, 1859. His boyhood was spent in Barnstable. In the fall of 1877 he entered the then recently established mechanics arts course at the Massachusetts Institute of Technology. This two-year course was duly finished. In September, 1879, he was appointed instructor in practical mechanics at Purdue University, and at once began there the work of establishing shop laboratories. His first class of five students was given instruction in those lines of work in which he, himself, had been trained at the "Tech." From a meager beginning, the outlook broadened rapidly. The equipment was extended, the number of students increased, and new shop laboratories were built. In 1883 he became Professor of Practical Mechanics, a title which he held for seven years. When he began, there was no college west of the Allegheny Mountains giving systematic courses in shop practice, and there was no manual training work in any American high school. He devised courses of practice and developed courses of lectures by means of which principles established in the shops could be given wider application. It was a day when school officials were becoming interested in training students in the manual arts, and many distinguished visitors came to see the work of the Purdue laboratories. The cities of Chicago, Toledo, Louisville and Indianapolis each in turn sought their aid in the establishment of its first manual training school. Certain forms of equipment, especially forges and lathes, originally designed and constructed at Purdue, were made and supplied as complete equipment to school boards in distant localities where new courses of shop practice were being organized. In many such ways the work at Purdue had an important part in ushering in an educational movement of unusual significance.

In 1889, after ten years of this work, Prof. Goss was given a leave of absence. In the spring of 1890, in anticipation of his return to Purdue, he was appointed Professor of Experimental Engineering, and he undertook the active duties of his new office in the fall of that year. Having developed laboratories for elementary training, it was now his task to build laboratories for advanced engineering work. A modest steam engineering laboratory equipped with a compound Corliss engine and a few testing machines was soon in operation. Plans for an extensive engineering building (Purdue's present engineering laboratory) were developed, and by the fall of 1891 a portion of the building was constructed. A significant part of the equipment of the new laboratory was a locomotive testing plant designed to serve in an experimental study of locomotive problems in much the same way that an experimental stationary plant could be used in studying the problems of design affecting the performance of stationary engines. This locomotive testing plant was the first of its kind. It was designed in the summer of 1891 while the building which was to contain it was in the process of erection, and was in successful operation in the late fall of the same year. An incident in the process of installing this plant was that of transporting a 100,000-pound locomotive over the corn-fields and highways which intervened between the nearest track and the laboratory, a distance of about a mile and a half.

A description of this locomotive testing plant was made the subject of a paper which was presented at the San Francisco meeting of the American Society of Mechanical Engineers. The opportunities thus made available to the university at once attracted the attention of motive power men and of steam engineers. So meager was the information concerning the performance of locomotives that every fragment of truth, however simple or easily obtained, at once became a matter of public interest. The evaporative capacity of the locomotive boiler, its efficiency at different rates of power, the power and efficiency of the cylinders, and the effect upon power and efficiency of changes in speed or cut-off were all matters which, previous to the introduction of this plant, had been but little understood, even by those best informed. The behavior of the various parts of the machine as a mechanism and especially the effects produced by the action of the counterbalance in the locomotive drive-wheels were all matters concerning which people had theories, but which were first actually determined by the accurate processes of the laboratory at the Purdue plant. Associations of railroad men gave their encouragement and sometimes financial assistance in increasing the output of the plant. The Master Car Builders' Association made the Purdue laboratories its official testing station and was instrumental in installing there a considerable amount of useful and expensive apparatus. The laboratory became an active center for testing not only locomotives, locomotive fuels and locomotive lubricants, but also details of car construction such as wheels, axles, draft-gears, couplers and brake-shoes.

The problems awaiting solution were always numerous, and the professor in charge was kept busy outlining the means to be employed in solving them. In the beginning he was responsible not only for the effective use of the railroad equipment to which reference has already been made, but also for the development of laboratories and courses in materials testing, in hydraulics and in the general field of theoretical and applied thermodynamics. He built buildings, purchased and installed equipment, and in many cases the equipment installed was of his design, and he was required to meet the reasonable expectations of an ever increasing body of students. Hundreds of men who were students at Purdue in the early nineties can testify to the variety of the activities which in their day were in progress in the engineering laboratories.

In all of this early work the task was singularly a personal one. The first work of establishing shop laboratories included the laying of a floor in the proposed shop, and ten years later, in the early operation of the locomotive testing plant, a janitor, who had once been a locomotive engineer, and the Professor of Experimental Engineering were accounted a sufficient staff to provide for the operation of the plant. It was necessary at every step to prove a need before it could be satisfied, and the development of an organization of men was in the pioneer days the last thing to which college trustees could be persuaded to give attention. But by 1899 a young and vigorous staff had been brought into existence, routine work in every direction had been provided for, and the Professor of Experimental Engineering was again granted a year's leave of absence which he spent in travel and study abroad, chiefly in Germany. Upon his return he was appointed Dean of the Schools of Engineering, an office which he continued to hold throughout the remaining eight years of his residence at Purdue. In 1907 he resigned his position at Purdue, after twenty-eight years of service, to take up what seemed to him the larger and more responsible duties of his present office, namely, that of Dean of the College of Engineering of the University of Illinois.

Prof. Goss was given the honorary degree of Master of Arts by Wabash College in 1888 and the honorary degree of Doctor of Engineering by the University of Illinois in 1904. His contributions to technical literature have been numerous. Probably his best known work is that which deals with the locomotive. His books on "Locomotive Performance" and "Locomotive Sparks," are records of personal researches which are known to most railroad men.

ANNUAL MEETING OF THE A. S. M. E.

The thirty-third annual meeting of the American Society of Mechanical Engineers was held in the Engineering Societies' Building, New York, December 3-6, inclusive. The program comprised many and varied technical articles on power plants, textiles, gas power, machine shop practice, railways, cements, fluid flow administration, etc.

Dr. W. F. M. Goss of the University of Illinois, Urbana, Ill., was elected president, succeeding Dr. Alexander C. Humphreys of Stevens Institute, Hoboken, N. J. The entertainment differed materially from those provided in previous years; the grand ball at the Hotel Astor was omitted, and instead of a semi-popular lecture on Wednesday evening, a dinner was given to Prof. John E. Sweet of the Straight Line Engine Co., Syracuse, N. Y., in honor of his eightieth birthday. The dinner was attended by about two hundred and fifty persons.

The sight-seeing trips comprised visits to the Grand Central Terminal, Waterside station of the New York Edison Co., the tower of the Metropolitan Insurance Company's office building; the Ellis Island Immigration Station; the Aquarium; the power house of the Interborough Rapid Transit Co.; Fourth Avenue Subway, now in process of construction; Keller Mechanical Engraving Company's plant, in Brooklyn; the power station of the Brooklyn Rapid Transit Railway; the new fifty-five story Woolworth Building, now nearing completion; the Brooklyn Navy Yard; August Griffoul's Bros. Co.'s plant in Newark, N. J., etc.

The technical program was substantially as follows:

"Dimensions of Boiler Chimneys for Crude Oil," by C. R. Weymouth.

"Tests of a 1000-H. P. 24 Tubes High B. & W. Boiler," by B. N. Bump.

"Air in Surface Condensation," by George A. Orrok.

"Properties of Saturated and Superheated Ammonia," by Wm. Earl Mosher.

"Physical Properties of Anhydrous Ammonia," by L. S. Marks and F. W. Loomis.

"Experiments with North Dakota Lignite in a Steam Power Plant and a Gas Producer," by Calvin H. Crouch.

"The Baltimore Sewerage Pump Valve," by A. F. Nagle.

"The Principles of Valuing Property," by Henry K. Rowell.

"The Power Plants of Textile Mills," by John A. Stevens.

"Recent Development of Gas Power in Europe," by H. J. Freyn.

"Heavy Oil for Use in Internal-Combustion Engines," by Irving C. Allen.

"The Vauclain Drill," by A. C. Vauclain and Henry V. Wille.

"Developments in Machine Shop Practice during the Last Decade." (Report of Sub-Committee on Machine Shop Practice, Fred E. Rogers, chairman.)

"Efficient Production of Cylindrical Work," by C. H. Norton.

"Increase of Bore of High-speed Wheels by Centrifugal Stress," by Sanford A. Moss.

"Investigation of Efficiency of Worm Gearing for Automobile Transmission," by Wm. H. Kenerson.

"The Strength of Gear Teeth," by Guido H. Marx.

"Case Carbonizing," by Marcus T. Lothrop.

"Lighting of Passenger Equipment in Steam Railway Service," by H. A. Currie and B. F. Wood.

"Factors in the Selection of Locomotives in Relation to the Economics of Railway Operations," by O. S. Beyer, Jr.

"Some Remarks on the Depreciation Factor in the Cost of Producing Portland Cement," by Frederick H. Lewis.

"The Prevention of Missed Fires in Blasting," by W. H. Mason.

"The Deterioration and Spontaneous Combustion of Gas Coal," by Perry Barker.

"Measurement of Air in Fan Work," by Chas. H. Treat.

"The V-Notch Weir Method of Measurement," by D. Robert Yarnall.

"The Centrifugal Blower for High Pressures," by Henry F. Schmidt.

"Measurement of Natural Gas," by Thos. R. Weymouth.

"The Present State of the Art of Industrial Management." (Report of Sub-Committee on Administration, James M. Dodge, chairman.)

"Axioms Concerning Manufacturing Costs," by Henry R. Towne.

"Measuring Efficiency in Manufacturing," by Edward B. Passano.

* * *

AN UNUSUAL SHAPER JOB

BY CHESTER L. LUCAS

An instance of the way in which the modern shaper is handling work which was formerly considered impossible to do except by a planer, is shown by the job in the accompanying illustrations. This work, which was photographed at the shop of Herman F. Behrendt, Newark, N. J., was performed upon a 20 inch Eberhardt "High Duty" shaper, made by the Gould & Eberhardt Co., of Newark, N. J.

The casting upon which the work was performed is shown held in the shaping fixture *A*. The piece is the main casting for a jeweler's foot-press and is very unwieldy and awkward to hold upon a planer. Moreover, on account of the height of the working faces from the tip end of the casting, a large planer was required—far out of proportion to the character of the machining which consisted of cuts only 15 inches long.

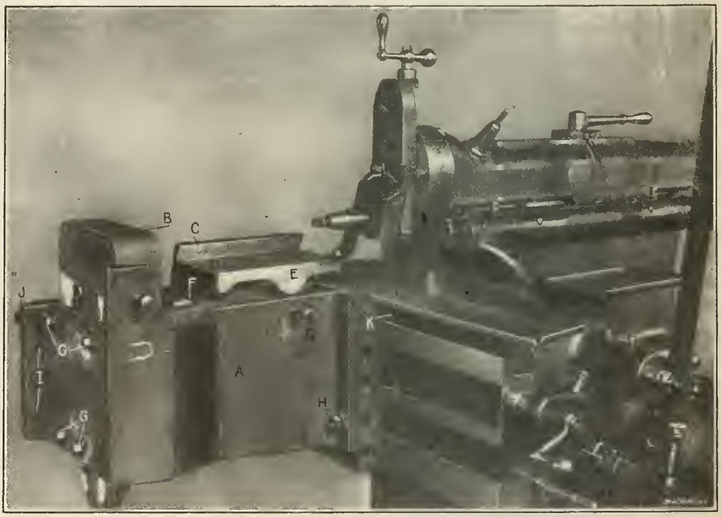


Fig. 1. The Fixture in Position for Shaping the Ways of the Press Casting

The work done comprised the machining of the face *D*, the side *E*, as well as the opposite side of the piece. The inclined face *C* also had to be shaped to the correct angle and the top of this section was faced off. In addition, the front face of section *B*, which forms the bed of the press, had to be machined and the throat between the base and the ways of the press, including the slot *F*, were required to be machined to complete the work. It will thus be seen that it was necessary to hold the work in two settings to accomplish the machining and as it was essential that the work done at the first setting be absolutely true with the machining at the second setting, the planing method was at an added disadvantage.

For handling the work on the Eberhardt shaper, a fixture *A* was constructed which was mounted on the shaper in place of the table, being attached by bolts, one of which is shown at *H*. The casting was held within the fixture by means of screws *G* and while in this position, the faces *C*, *D* and *E* as well as the opposite side of the top of the casting were machined. All this work was done while in the position shown in Fig. 1. This part of the work being done, the bolts *H* were removed, the fixture being held by a chain hoist while it was turned and relocated upon the shaper by means of bolts passing through holes *I*. A corresponding pair of holes is provided at

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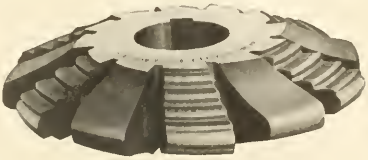
* Associate Editor of MACHINERY.

One of the difficulties of cutter making



is that of hardening. Long experience and good judgment are very essential in this work. The possession of these elements by workmen in our hardening department, together with the care that is exercised during the process, are accountable for the correct and uniform temper of all

B. & S. CUTTERS

We have hardened cutters for over fifty years and the knowledge gained in that time enables us to successfully overcome practically all difficulties in the process.

Accuracy is also an important feature of B. & S. Cutters. The rigid inspection to which every cutter is subjected insures against customers receiving cutters that are imperfect.

The B. & S. line of Cutters comprises 40 styles and over 3800 sizes. There are cutters for all classes of regular milling and for many special jobs. Where the character of work to be done requires cutters that cannot be supplied from our stock we are prepared to make them special.

Send for our cutter list.

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Mfg. Co.

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U. S. A.

the opposite end of the fixture. Tongue *J* fitted into the position formerly occupied by tongue *K*. Fig. 2 shows the second position of the fixture and casting and while in this position the front face of base *B* was finished as well as the throat of the press and the slot at the bottom of it. In addition, the top and bottom ends of the ways were faced in the second position. After machining the ways of one casting, the fixture was turned to allow the base to be machined. This being done, screws *G* were loosened, the casting removed, a second one substituted and the base of this casting machined before turning the fixture. Thus it was only necessary to turn the fixture once for each casting.

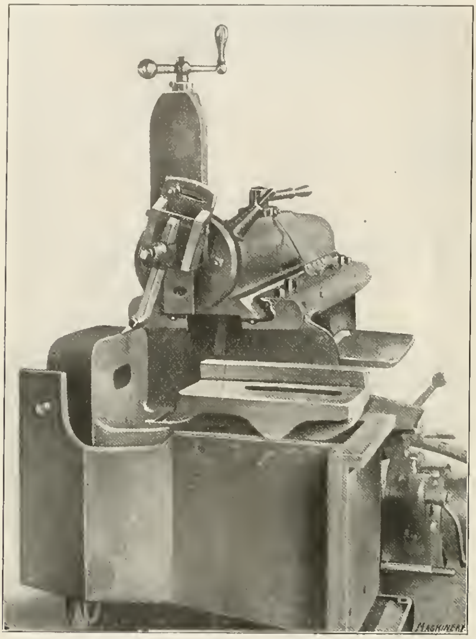


Fig. 2. The Fixture in Position for shaping the Base and Throat of the Casting

* * *

PERSONALS

R. M. Hawkins, assistant purchasing agent of the Standard Welding Co., Cleveland, Ohio, has resigned.

R. T. Hodgkins, for several years manager of the chain block department of the Yale & Towne Mfg. Co., 9 Murray St., New York, has resigned to enter the employ of the Studebaker Corporation.

L. H. Mesker, manager of the St. Louis branch of Manning Maxwell & Moore, Inc., has resigned his position and will be connected in a similar capacity, with the Ferro Machine & Foundry Co., Cleveland, Ohio, after January 1.

Howard E. Adt, general manager of the Geometric Tool Co., New Haven, Conn., returned on the *Baltic* December 15 from a trip to Germany, France, England and other European countries, in the interests of the company's business.

Kingston Forbes, formerly connected with the drafting, experimental, production and testing divisions of the Locomobile Company of America, has taken a position as assistant engineer, with the Palmer & Singer Mfg. Co. of Long Island City, New York.

Amasa Trowbridge, who for several years past has been factory manager of the Veeder Mfg. Co., Hartford, Conn., has resigned to become general manager of the new corporation to be known as the Rhodes Mfg. Co. of Hartford, which will manufacture shapers and other tools.

Miss J. Arminson MacIntyre, who for over ten years was manager of the publicity department of the C. W. Hunt Co., West New Brighton, N. Y., has resigned her position to take effect January 1. Miss MacIntyre has made no definite plans, but for the near future will spend a few months in travel.

Frank A. Haughton, who has been works manager of the Remington Arms Co.—Union Metallic Cartridge Co.'s works at Ilion since January 15, 1912, has been placed in general charge of the management and operation of the Ilion plant, and Mr. F. O. Hoagland is given charge of the Bridgeport works in a similar capacity.

Cyril J. Atkinson, mechanical engineer and inventor of the Atkinson gas producer and a number of special devices pertaining to gas producers, has resigned from the Dornfeld-Kunert Co., of Watertown, Wis., and has associated himself with Fairbanks, Morse & Co., of Chicago, which concern has acquired a number of Mr. Atkinson's patents and will incorporate them in Fairbanks-Morse's gas producers.

Charles W. Beaver, who for many years has been connected with the chain block department of the Yale & Towne Mfg. Co., 9 Murray St., New York, first as salesman and later as assistant manager of the department, and who for the past two years has acted as the company's special representative in Europe, has been appointed manager of this department to fill the position made vacant by the resignation of Mr. R. T. Hodgkins. Mr. Beaver will assume his new duties about February 1.

C. C. Tyler, general manager of works of the Remington Arms Co.–Union Metallic Cartridge Co., of Ilion, N. Y., and Bridgeport, Conn., has resigned his position. Mr. Tyler will continue his connection with the company in an advisory capacity and with the title of "advisory works manager." He will be consulted in the larger problems connected with the work, both at Ilion and Bridgeport. Mr. Tyler came to Ilion in March, 1908, to take charge of the plant of the Remington Arms Co., and continued in the capacity of manager until December, 1910, when he was appointed general manager of works in charge of the administration and operation of the Remington Arms Co. at Ilion and the Union Metallic Cartridge Co. at Bridgeport.

F. E. Bright, the new president of the Hess-Bright Mfg. Co., Philadelphia, Pa., is well known in the machinery field. For years prior to 1897 he resided in Cleveland where he was identified with various mechanical and engineering enterprises. In 1893 he invented certain improvements in the linotype machine which were acquired by Ludwig Loewe & Co., of Berlin, Germany. Mr. Bright personally designed and superintended the manufacturing equipment of the linotype equipment for Ludwig Loewe & Co., and from this began the intimate association between Mr. Bright and the company, which has continued through the organization of the Deutsche Waffen-und Munitions Fabriken and the founding and developing by Mr. Hess and Mr. Bright of the Hess-Bright Mfg. Co. Mr. Bright will direct the Hess-Bright Mfg. Co.'s policies to the end of securing still further benefits from the unequalled facilities of the Loewe industrial family.

* * *

OBITUARIES

Henry Schneider, the oldest German resident of Worcester, Mass., and a machinist who had been in the employ of the Richardson Mfg. Co. of Worcester for fifty years, died November 22, after a short illness, aged eighty-two years.

Arthur G. Scott, representative in Great Britain of the Norton Co., Worcester, Mass., died in London November 22, aged forty-two years. Mr. Scott entered the employ of the Norton Co. ten years ago and was made the company's British representative in 1909.

John J. Keefe, southern representative of the Independent Pneumatic Tool Co., of Chicago, at the company's Atlanta, Ga., office, died November 20 from an attack of typhoid fever, aged forty-seven years. Mr. Keefe was born in Susquehanna, Pa., and during his early business life was associated with the railroads, having served for a number of years in the mechanical department of various roads until about ten years ago, when he entered the railway supply field and continued in that line up to his death. He leaves a widow and one son.

* * *

COMING EVENTS

January 11-18.—National Association of Automobile Manufacturers show of pleasure vehicles at Madison Square Garden, New York. M. L. Downs, secretary, 7 East 42d St., New York.

January 20-25.—National Association of Automobile Manufacturers show of auto-truck and delivery cars at Grand Central Palace, New York. M. L. Downs, secretary, 7 East 42d St., New York.

February 25-27.—Convention and exhibit of the New England Hardware Dealers' Association in the new municipal auditorium, Springfield, Mass.

May 26-29.—Annual convention of the Master Bolier Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

NEW CATALOGUES AND CIRCULARS

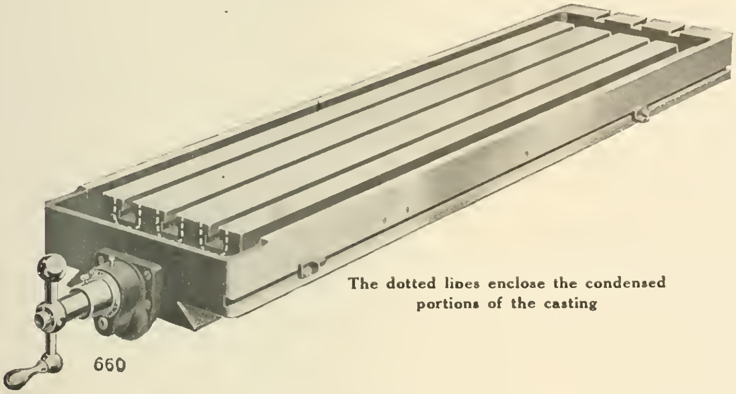
SUSPENSION ROLLER BEARING CO., Sandusky, Ohio. Catalogue of the Boyer suspension bearings for lineshafts, automobiles, etc.

MODERN TOOL CO., 2nd and State Sts., Erie, Pa. Bulletin No. 18 on the Modern semi-self-contained plain grinding machine.

The Durability and Reliability of a Machine depend largely upon the Quality of the Materials of which it is made

Our iron castings are made in our own foundry by special processes devised to produce for each important part that quality of casting best adapted for the work it has to do.

For example, the iron in our tables is condensed around the T slots making them strong and durable. There is no sponginess. The metal at the bottom of the slots is as good as at the top.



The dotted lines enclose the condensed portions of the casting

The Spindle Driving Gears of our High Power Machines are all steel forgings.

Most of them are nickel steel. These are hardened by a special heat treatment which leaves the centres soft and prevents distortion.

They are stronger than ordinary hardened gears.

We use only those that meet our exacting scleroscope inspection test.

Cincinnati Millers last longer, hold their accuracy better and cost less for maintenance than any others subjected to the same heavy duty of which ours are capable.

THE CINCINNATI MILLING MACHINE COMPANY, Cincinnati, O., U.S.A.

EUROPEAN AGENTS—Alfred H. Shutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

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S. A. Stewart & Co., Waltham, Mass. Leaflet illustrating the Stewart improved bench saw table for sawing wood, metal and other materials such as sheet brass, copper, electrotype plates, fiber, hard rubber, etc.

Adam Cook's Sons, 708-710 Washington St., New York. Booklet entitled "The Sooth-Sayer," advertising the product known as "Albany grease" made by the company. Also folder entitled "Some Don'ts for Buyers of Lubricants."

F. E. Wells & Son Co., Greenfield, Mass. Circular of the Wells two-spindle drilling lathes of the opposed spindle type; also circular of the Wells motor-driven lathe for manual training schools and other users requiring speed lathes.

Carter & Hakes Co., Sterling Place, Winsted, Conn. Catalogue No. 2 on Lincoln milling machines with automatic quick return, hand milling machines, bench milling machines, collets and cutter arbors, screw and lever vises, small index centers and special machinery.

Webster & Perkins Tool Co., Springfield, Ohio. Catalogue of grinding and polishing machinery, comprising bench and floor grinders, plate edge grinders, wet tool grinder, polishing and buffing lathes, belt strapping attachment, plain surface grinding attachment, wheel guards, etc.

Eugene Dietzgen Co., 218 E. 23 St., New York. Circulars of the "multiplex" slide rule and a low-priced drawing outfit, printed on the Dietzgen cylindrical, self-contained electric blueprinting machine as illustrations of the possibilities of this machine in reproducing copy sharply and distinctly.

Otis Elevator Co., Eleventh Ave. and 26th St., N. Y. Booklet entitled "Elevator Service," devoted especially to lubricants and oils used for elevator parts and accessories such as worm gear lubricants, motor bearing oils, plunger lubricants, brake magnet oils, traction bearing oils, guide lubricants, etc.

Montgomery & Co., 105-107 Fulton St., New York. Catalogue No. 31 entitled "The Tool-Monger" on tools, supplies and machinery for all branches of the mechanical trade, containing 394 pages and comprising a large variety of tools and supplies used in machine shops, mills and factories, and therefore of interest to mechanics in general.

Temco Electric Motor Co., 99 Sugar St., Leipsic, Ohio. Catalogue of automatic portable electric tools comprising breast drills of various designs, operating on alternating or direct current; breast drill with reverse for tapping; emery wheel attachment for sharpening drills and other cutters; valve grinder attachment and buffing attachment.

Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind. Leaflet on "Diamond" chain with nickel steel rivets, illustrating a chain drive in the company's factory which has been running at the rate of 1100 feet per minute for four years, during which time the chain has traveled 135,000 miles. It is still in excellent condition.

Goodwin Hollow Set-Screw Co., Cheshire, Conn. Circular of the Goodwin safety hollow set-screw for pulleys, countershafts, collars, etc. This set-screw is made with six longitudinal grooves in the socket, to which is fitted a bent wrench, both ends of the wrench being fitted so that the long end can be used for screwing at the bottom of deep cavities if required.

Standard Tool Co., Cleveland, Ohio. Catalogue No. 20 on twist drills, reamers, milling cutters, taps, chucks, taper pins and special tools, comprising price-lists, illustrations, descriptions, and much valuable data. This well-known catalogue now contains 416 pages and is a valuable reference book for toolmakers, machinists, foremen, superintendents and others using twist drills and small tools.

G. M. Yost Mfg. Co., Meadville, Pa. Catalogue of Yost vises, comprising solid jaw stationary and swivel base machinists' vises, heavy chipping vises, adjustable jaw stationary and swivel base machinists' vises, coachmakers' vises, universal double swivel vises, pipe vises, "Stephens" quick action lever cam and toggle joint vises, jewelers' vises, woodworkers' vises, drilling machine vises, gas soldering furnaces, etc.

Firth-Sterling Steel Co., McKeesport, Pa., has prepared an interesting little booklet called "The Relation of Tool Steel to Manufacturing Costs." The data included in this booklet deals with the resultant cost of production where a high-grade tool steel is used, as against the cost involved in using a cheaper grade. The company will gladly send one of the booklets to any address upon request, if Machinery is mentioned.

Davis Boring Tool Co., 3722 Forest Park Blvd., St. Louis, Mo. Circular illustrating and describing the Davis expansion boring tools, showing 26 different styles and giving a brief, concise description of each tool. Reference to the kind of work for which each type is especially adapted is made, so as to enable the prospective purchaser to decide which style is of most advantage for his particular work.

C. F. Pease Co., 166 W. Adams St., Chicago, Ill. Booklet entitled "Everything for Blueprinting," on the Pease "Peerless" continuous electric blueprinting machines of various designs, the Pease direct line apparatus, the Pease "Simplex" coating machine, unsensitized blueprint paper, coating chemicals, sheet washers and drying machines, drying ovens, blueprint wringers, trimming shears, hand cutting and trimming tables, etc.

Max Ams Machine Co., Mount Vernon, N. Y. Catalogue A of series 3 on Ams power presses and special machinery for working sheet metals, comprising small open-back presses with and without legs, inclinable power presses, inclinable double-action presses, double-action presses, horning and wiring presses, punching presses, open-back presses, arch presses, straight sided presses, double-crank presses, knuckle-joint presses, notching presses, dial feeds, special feeds, dies, body makers, double seamers, etc.

Eclipse Fuel Engineering Co., 7 South Water St., Rockford, Ill. Booklet on "The Heat Treatment of Steel in Gas Furnaces," by Garnet W. McKee, containing valuable data and information for steel workers. The contents comprise carbon contents, heat treatment of high carbon or tool steel, forging, annealing, hardening, cooling baths, tempering, temper temperatures, heat treatment of low carbon or soft steel, heat treatment of high speed steel, defects in steel, etc.

Atlas Ball Co., 203 Glenwood Ave., Philadelphia, Pa. Booklet entitled "Atlas Balls," containing a description of the process of making steel balls, beginning with the steel used, and briefly describing the forging, annealing, rough-grinding and smooth-grinding processes, the hardening and tempering, the final or precision grinding, polishing and final inspection. A table of allowable loads for alloy steel balls is included, as well as a table of weights of steel balls of different diameters.

Elwood Haynes, Kokomo, Ind. Booklet on "Stellite" lathe tools describing the characteristics of "Stellite" (an alloy discovered by Mr. Haynes in 1899) and giving some records of tests made of lathe work produced with "Stellite" tools. These records indicate that the speed of the lathe can be more than double as compared with the allowable speed with the best high-speed tools, and that the number of grindings is greatly reduced, only one grinding per day being required for "Stellite" tools.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 71 describing the Foxboro Durand radial planimeter. This company has made arrangements for the exclusive handling of the Durand planimeter in the United States. This instrument is based upon the geometrical principles of a form of planimeter or averaging instrument presented in a paper before the A. S. M. E. in 1908 by Prof. W. F. Durand. The instrument itself is manufactured in Switzerland by the well-known firm of Amsler, Laffon & Co.

Standard Machinery Co., Providence, R. I. Catalogue of presses, comprising arch presses, double-acting presses, single-acting gap presses, single-action back-geared back presses, double-acting presses with stationary dial plate, cam presses, transfer or cut-and-carry presses, foot presses, sprue cutters, adjustable bed presses, knuckle-joint and coining presses, double crank presses, inclinable presses, double-acting cam presses, crank reducing presses, adjustable stroke drawing and broaching presses, screw presses, drop hammers, etc.

TRADE NOTES

Prentiss Tool & Supply Co., 149 Broadway, N. Y., will move its Boston salesroom from 145 Oliver St. to the John Hancock Bldg., 49 Federal St. about January 1.

Toledo Bridge & Crane Co., Toledo, Ohio, announces that Mr. Arthur Appleton, 52 Broadway, will represent the company in the New York territory, succeeding Mr. H. L. Drullard.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., report that the new forging shop of the Wright Wrench & Forging Co., Canton, Ohio, is being fitted up with Tate-Jones natural gas furnaces.

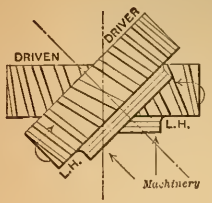
Industrial Instrument Co., Foxboro, Mass., is now represented in Birmingham Alabama, by Jonathan Haralson, electrical and mechanical engineer, whose office is at 2116 South Tenth Ave.

Hendee Mfg. Co., Springfield, Mass., maker of "Indian" motorcycles, has made preparations for building 35,000 motorcycles for 1913. The company built about 19,000 machines for the 1912 trade.

SPIRAL GEARS WITH SHAFTS AT ANY ANGLE—IV

Contributed by James H. Carver

Shafts at Any Angle, Ratio Unequal, Center Distance Exact



The sum of the spiral angles of the two gears equals the shaft angle, and the gears are of the same hand, if each angle is less than the shaft angle. The difference between the spiral angles equals the shaft angle, and the gears are of opposite hand, if either angle is greater than the shaft angle.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C = center distance.
3. P_n = normal pitch (pitch of cutter).
4. α_a = approximate spiral angle of gear.
5. β_a = approximate spiral angle of pinion.
6. R = ratio of gear to pinion = $N \div n$.
7. n = number of teeth in pinion nearest $\dfrac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{R\cos\beta_a + \cos\alpha_a}$
8. N = number of teeth in gear = $R\,n$.

To find:

1. α and β, exact spiral angles, found by trial from $R\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{n}$.
2. D = pitch diameter of gear $= \dfrac{N}{P_n\cos\alpha}$.
3. d = pitch diameter of pinion $= \dfrac{n}{P_n\cos\beta}$.
4. O = outside diameter of gear $= D + \dfrac{2}{P_n}$.
5. o = outside diameter of pinion $= d + \dfrac{2}{P_n}$.
6. T = number of teeth marked on cutter for gear $= N \div \cos^3\alpha$.
7. t = number of teeth marked on cutter for pinion $= n \div \cos^3\beta$.
8. L = lead of spiral on gear $= \pi D \cot\alpha$.
9. l = lead of spiral on pinion $= \pi d \cot\beta$.

Example

Given or assumed (Angle of shafts, 60 degrees):

1. See illustration.
2. $C = 40$ inches.
3. $P_n = 4$.
4. $\alpha_a = 20$ deg.
5. $\beta_a = 40$ deg.
6. $R = 3$.
7. $n = \dfrac{2\,C\,P_n\cos\alpha_a\cos\beta_a}{R\cos\beta_a + \cos\alpha_a} = \dfrac{2 \times 40 \times 4 \times 0.9397 \times 0.766}{(3 \times 0.766) + 0.9397} = 71$ teeth.
8. $N = R\,n = 3 \times 71 = 213$ teeth.

To find:

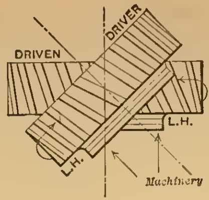
1. α and β from $R\sec\alpha + \sec\beta = \dfrac{2\,C\,P_n}{n} = \dfrac{2 \times 40 \times 4}{71} = 4.507$. By trial $\alpha = 22° 24' 30''$ and $\beta = 37° 35' 30''$.
2. $D = \dfrac{N}{P_n\cos\alpha} = \dfrac{213}{4 \times 0.92449} = 57.599$ inches.
3. $d = \dfrac{n}{P_n\cos\beta} = \dfrac{71}{4 \times 0.79238} = 22.401$ inches.
4. $O = D + \dfrac{2}{P_n} = 57.599 + \dfrac{2}{4} = 58.099$ inches.
5. $o = d + \dfrac{2}{P_n} = 22.401 + \dfrac{2}{4} = 22.901$ inches.
6. $T = N \div \cos^3\alpha = 213 \div 0.79 = 270$ teeth.
7. $t = n \div \cos^3\beta = 71 \div 0.497 = 143$ teeth.
8. $L = \pi D \cot\alpha = \pi \times 57.599 \times 2.4252 = 438.8$ inches.
9. $l = \pi d \cot\beta = \pi \times 22.401 \times 1.2989 = 91.41$ inches.

No. 162, Data Sheet, MACHINERY, January, 1913

SPIRAL GEARS WITH SHAFTS AT ANY ANGLE—III

Contributed by James H. Carver

Shafts at Any Angle, Ratio Unequal, Center Distance Approximate



The sum of the spiral angles of the two gears equals the shaft angle, and the gears are of the same hand, if each angle is less than the shaft angle. The difference between the spiral angles equals the shaft angle, and the gears are of opposite hand, if either angle is greater than the shaft angle.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = center distance.
3. P_n = normal pitch (pitch of cutter).
4. R = ratio of gear to pinion = $N \div n$.
5. α = angle of spiral on gear.
6. β = angle of spiral on pinion.
7. n = number of teeth in pinion nearest $\dfrac{2\,C_a\,P_n\cos\alpha\cos\beta}{R\cos\beta + \cos\alpha}$ for any angle, and $\dfrac{2\,C_a\,P_n\cos\alpha}{R + 1}$ when both angles are equal.
8. N = number of teeth in gear = $R\,n$.

To find:

1. D = pitch diameter of gear $= \dfrac{N}{P_n\cos\alpha}$.
2. d = pitch diameter of pinion $= \dfrac{n}{P_n\cos\beta}$.
3. O = outside diameter of gear $= D + \dfrac{2}{P_n}$.
4. o = outside diameter of pinion $= d + \dfrac{2}{P_n}$.
5. T = number of teeth marked on cutter for gear $= N \div \cos^3\alpha$.
6. t = number of teeth marked on cutter for pinion $= n \div \cos^3\beta$.
7. L = lead of spiral on gear $= \pi D \cot\alpha$.
8. l = lead of spiral on pinion $= \pi d \cot\beta$.
9. C = actual center distance $= \dfrac{D + d}{2}$.

Example

Given or assumed (Angle of shafts, 60 degrees):

1. See illustration.
2. $C_a = 12$ inches.
3. $P_n = 8$.
4. $R = 4$.
5. $\alpha = 30$ degrees.
6. $\beta = 30$ degrees.
7. $n = \dfrac{2\,C_a\,P_n\cos\alpha}{R + 1} = \dfrac{2 \times 12 \times 8 \times 0.86603}{4 + 1} = 33$ teeth.
8. $N = 4 \times 33 = 132$ teeth.

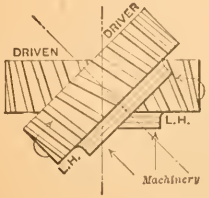
To find:

1. $D = \dfrac{N}{P_n\cos\alpha} = \dfrac{132}{8 \times 0.86603} = 19.052$ inches.
2. $d = \dfrac{n}{P_n\cos\beta} = \dfrac{33}{8 \times 0.86603} = 4.763$ inches.
3. $O = D + \dfrac{2}{P_n} = 19.052 + \dfrac{2}{8} = 19.302$ inches.
4. $o = d + \dfrac{2}{P_n} = 4.763 + \dfrac{2}{8} = 5.013$ inches.
5. $T = N \div \cos^3\alpha = 132 \div 0.65 = 203$ teeth.
6. $t = n \div \cos^3\beta = 33 \div 0.65 = 51$ teeth.
7. $L = \pi D \cot\alpha = \pi \times 19.052 \times 1.732 = 103.66$ inches.
8. $l = \pi d \cot\beta = \pi \times 4.763 \times 1.732 = 25.92$ inches.
9. $C = \dfrac{D + d}{2} = \dfrac{19.052 + 4.763}{2} = 11.9075$ inches.

No. 162, Data Sheet, MACHINERY, January, 1913

SPIRAL GEARS WITH SHAFTS AT ANY ANGLE—II

Shafts at Any Angle, Ratio Equal, Center Distance Exact



The sum of the spiral angles of the two gears equals the shaft angle, and the gears are of the same hand, if each angle is less than the shaft angle. The difference between the spiral angles equals the shaft angle, and the gears are of opposite hand, if either angle is greater than the shaft angle.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C = center distance.
3. P_n = normal pitch (pitch of cutter).
4. α_a = approximate spiral angle of one gear.
5. β_a = approximate spiral angle of other gear.
6. N = number of teeth nearest $\frac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a}$.

To find:

1. α and β = exact spiral angles, found by trial from $\sec\alpha + \sec\beta = \frac{2\,C\,P_n}{N}$.
2. D = pitch diameter of one gear $= \frac{N}{P_n \cos\alpha}$. 3. d = pitch diameter of other gear $= \frac{N}{P_n \cos\beta}$.
4. O = outside diameter of one gear $= D + \frac{2}{P_n}$. 5. o = outside diameter of other gear $= d + \frac{2}{P_n}$.
6. T = number of teeth marked on cutter for one gear $= N \div \cos^3\alpha$.
7. t = number of teeth marked on cutter for other gear $= N \div \cos^3\beta$.
8. L = lead of spiral for one gear $= \pi D \cot\alpha$. 9. l = lead of spiral for other gear $= \pi d \cot\beta$.

Example

Given or assumed (Angle of shafts, 50 degrees):

1. See illustration. 2. C = 10 inches. 3. P_n = 10. 4. α_a = 20 deg. 5. β_a = 30 deg.
6. $N = \frac{2\,C\,P_n \cos\alpha_a \cos\beta_a}{\cos\alpha_a + \cos\beta_a} = \frac{2 \times 10 \times 10 \times 0.93969 \times 0.86603}{0.93969 + 0.86603} = 90$ teeth.

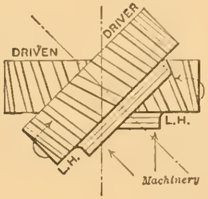
To find:

1. α and β from $\sec\alpha + \sec\beta = \frac{2\,C\,P_n}{N} = \frac{2 \times 10 \times 10}{90} = 2.222$. By trial α and β, respectively, = 19° 20′ and 30° 40′.
2. $D = \frac{N}{P_n \cos\alpha} = \frac{90}{10 \times 0.94361} = 9.537$ inches.
3. $d = \frac{N}{P_n \cos\beta} = \frac{90}{10 \times 0.86015} = 10.463$ inches.
4. $O = D + \frac{2}{P_n} = 9.537 + \frac{2}{10} = 9.737$ inches.
5. $o = d + \frac{2}{P_n} = 10.463 + \frac{2}{10} = 10.663$ inches.
6. $T = N \div \cos^3\alpha = 90 \div 0.84 = 107$ teeth. 7. $t = N \div \cos^3\beta = 90 \div 0.64 = 141$ teeth.
8. $L = \pi D \cot\alpha = \pi \times 9.537 \times 2.85 = 85.39$ inches.
9. $l = \pi d \cot\beta = \pi \times 10.463 \times 1.686 = 55.42$ inches.

Contributed by James H. Carver
No. 162, Data Sheet, MACHINERY, January, 1913

SPIRAL GEARS WITH SHAFTS AT ANY ANGLE—I

Shafts at Any Angle, Ratio Equal, Center Distance Approximate



The sum of the spiral angles of the two gears equals the shaft angle, and the gears are of the same hand, if each angle is less than the shaft angle. The difference between the spiral angles equals the shaft angle, and the gears are of opposite hand, if either angle is greater than the shaft angle.

Given or assumed:

1. Hand of spiral, depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. α = angle of spiral of one gear.
5. β = angle of spiral of other gear.
6. N = number of teeth nearest $\frac{2\,C_a\,P_n \cos\alpha \cos\beta}{\cos\alpha + \cos\beta}$.

To find:

1. D = pitch diameter of one gear $= \frac{N}{P_n \cos\alpha}$. 2. d = pitch diameter of other gear $= \frac{N}{P_n \cos\beta}$.
3. O = outside diameter of one gear $= D + \frac{2}{P_n}$.
4. o = outside diameter of other gear $= d + \frac{2}{P_n}$.
5. T = number of teeth marked on cutter for one gear $= N \div \cos^3\alpha$.
6. t = number of teeth marked on cutter for other gear $= N \div \cos^3\beta$.
7. L = lead of spiral for one gear $= \pi D \cot\alpha$.
8. l = lead of apiral for other gear $= \pi d \cot\beta$.
9. C = actual center distance $= \frac{D + d}{2}$.

Example

Given or assumed (Angle of shafts, 30 degrees):

1. See illustration. 2. C_a = 5 inches. 3. P_n = 10.
4. α = 20 degrees. 5. β = 10 degrees. 6. N = 48.

To find:

1. $D = \frac{N}{P_n \cos\alpha} = \frac{48}{10 \times 0.9397} = 5.108$ inches. 2. $d = \frac{N}{P_n \cos\beta} = \frac{48}{10 \times 0.9848} = 4.874$ inches.
3. $O = D + \frac{2}{P_n} = 5.108 + \frac{2}{10} = 5.308$ inches. 4. $o = d + \frac{2}{P_n} = 4.874 + \frac{2}{10} = 5.074$ inches.
5. $T = N \div \cos^3\alpha = 48 \div 0.83 = 58$ teeth. 6. $t = N \div \cos^3\beta = 48 \div 0.96 = 50$ teeth.
7. $L = \pi D \cot\alpha = \pi \times 5.108 \times 2.747 = 44.08$ inches.
8. $l = \pi d \cot\beta = \pi \times 4.874 \times 5.671 = 86.84$ inches.
9. $C = \frac{D + d}{2} = \frac{5.108 + 4.874}{2} = 4.991$ inches.

Contributed by James H. Carver
No. 162, Data Sheet, MACHINERY, January, 1913

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Supplement to MA

Tables for Article in this

MACHINERY

FEBRUARY, 1913

AUTOMOBILE BEVEL DRIVE GEARS[*]

FORGING, MACHINING, HEAT-TREATING, INSPECTING AND ASSEMBLING

BY DOUGLAS T. HAMILTON[†]

THE main drive employed in transmitting power from the engine to the rear wheels of an automobile comprises several gears and parts which are difficult to make. The two gears (excluding the transmission and equalizing or compensating gears) which receive the greatest care and attention at the hands of the progressive automobile manufacturer, are the main bevel gear and pinion. It is safe to say that these two parts have caused more trouble than probably any other part about a car. Extreme care has to be exercised from the time the material is purchased until the gears are completed and working satisfactorily in the rear axle housing. The slightest defect in any of the manufacturing processes is likely to unfit these gears for use, necessitating scrapping them, probably when they are almost ready to be put into place; hence, it is absolutely necessary that each step be followed closely, and the gears "checked-up" after each important operation. In the making of these two gears most manufacturers differ to a slight extent, so that it may be of interest to explain here, briefly, how these two parts are produced by the White Co., Cleveland, Ohio, for use in its various motor cars.

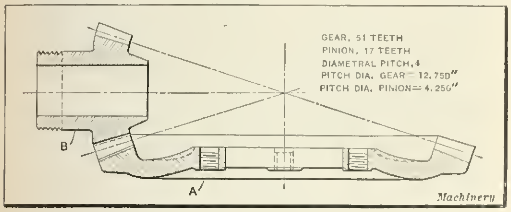

Fig. 1. Main Bevel Drive Gear and Pinion in Mesh

Forging Operations

After the steel has been tested and found to be O. K., the flat bar (containing 5 per cent nickel and from 14 to 18 points carbon), used for making the main gear, is cut up into blocks of a length sufficient to fill the impressions in the dies and also allow for a tang by which the blank is held when being drop-forged. The block is first taken to a power hammer where one end is reduced, making a tang by which the operator can grip the block with the tongs. The block is again heated, and by successive tools held in a power press, is split in the center and expanded into a ring. The object in doing this is to make the "grain" of the steel follow in a circle as much as possible, making it easier to harden without twisting. For the bevel drive gear *A*, shown diagrammatically in Fig. 1, the block is about 4 inches thick, and slightly greater than half the finished diameter in width to start with. Then after being formed into a ring, it is heated and passed through a breaking-down die, which rough-forms it ready for the final drop-forging operation.

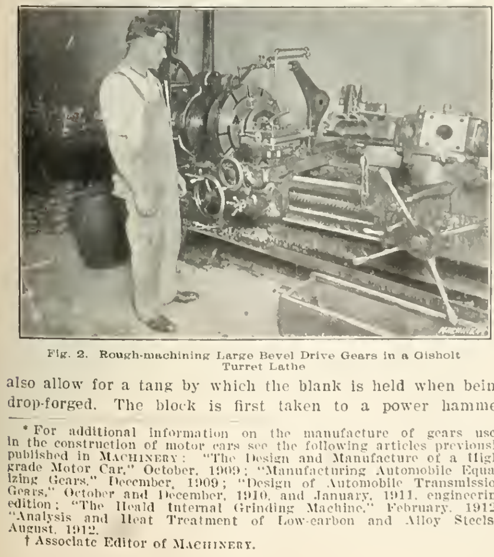

Fig. 2. Rough-machining Large Bevel Drive Gears in a Gisholt Turret Lathe

For the final forging operation, the bevel gear blank is heated to a bright red in a muffle furnace, and upon reaching the desired temperature is removed by the operator and placed under the steam hammer shown in Fig. 3. It requires two men to attend to this work; one man looks after the heating of the blanks while the other operates the drop hammer. The drop-forging dies for the final operation are held in a 10,000-pound Chambersburg steam hammer, where the blanks receive from two to three blows. The number of blows required depends upon the material, temperature to which the blank is heated, and the character of the work. This particular gear blank is given two blows, then the flash is trimmed in the power press shown to the right of the illustration, after which the blank is given a final blow and thrown down in the sand to cool off. A heap of finished forgings is shown in the immediate foreground, where the general contour of the gear blank is clearly shown. The tank is sheared off in a power shear after the forgings are cold.

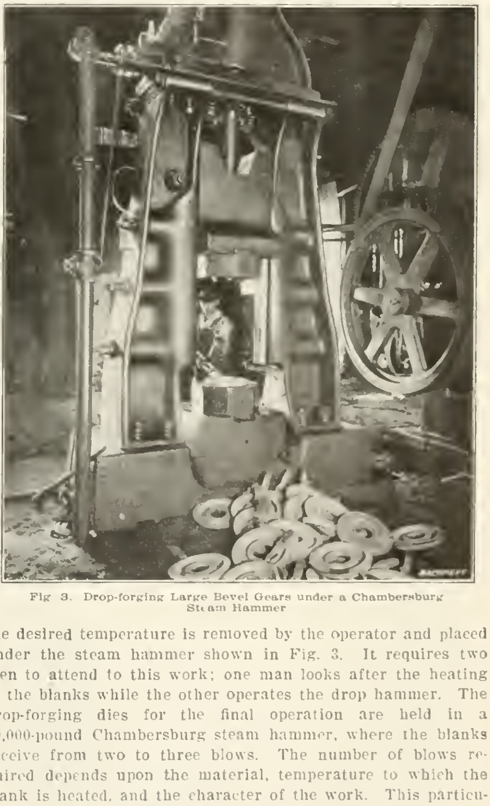

Fig 3. Drop-forging Large Bevel Gears under a Chambersburg Steam Hammer

The bevel pinion is more easily and quickly made. It is cut from a round bar and formed into the desired shape by two drop-forge die impressions, one for breaking down or rough-forming and the other for finish-forming. The flash formed during the drop-forging operation is removed in a trimming die. The amount of metal required to fill an impression is generally determined by trial, but the operator soon becomes so proficient in this work that he generally "hits" the correct amount of stock the first time. When a part of a similar shape and size is obtainable, the amount of stock can be ascertained by weighing the stock and blank, allowing a slight excess to form a tang and to provide for the amount of material lost in "flashing." [For additional information on drop-forge dies, see the articles on "Drop-forge Die-sinking," which appeared in the September, August and July, 1911, numbers of MACHINERY, and other articles there referred to.—EDITOR.]

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[*] For additional information on the manufacture of gears used in the construction of motor cars see the following articles previously published in MACHINERY: "The Design and Manufacture of a High-grade Motor Car," October, 1909; "Manufacturing Automobile Equalizing Gears," December, 1909; "Design of Automobile Transmission Gears," October and December, 1910, and January, 1911, engineering edition; "The Heald Internal Grinding Machine," February, 1912; "Analysis and Heat Treatment of Low-carbon and Alloy Steels," August, 1912.

[†] Associate Editor of MACHINERY.

Machining—Turret Lathe, Engine Lathe, and Gear-Cutting Operations

Before the gear blanks are brought to the machining department, they are taken to the hardening department and "air treated." This operation consists in placing the blanks in a muffle furnace, and heating them to about 1700 degrees F. The gear blanks are then removed from the furnace and allowed to cool gradually in the air. In the following description attention will be given to the processes employed in machining the main bevel gear, but practically the same methods are used in producing the pinion, with the exception, of course, that fixtures especially adapted for holding it are employed.

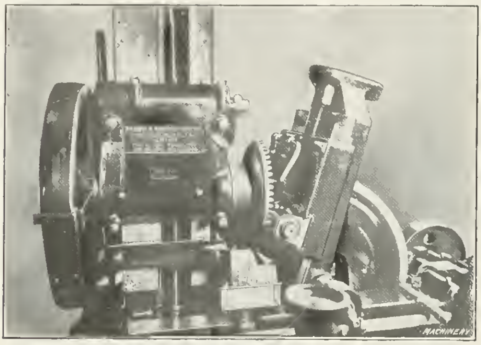


Fig. 4. Gashing the Teeth in the Large Bevel Gear in a Brown & Sharpe Automatic Gear-cutter

For the first machining operation, the large bevel gear is gripped in a chuck in a Gisholt turret lathe, the hole is bored and reamed and the boss faced. The next machining operation is illustrated in Fig. 2. Here the partly machined gear is clamped to the fixture *A* by bolts passing through the four bolt holes which have been drilled previous to this operation. The fixture *A*, which is held to the faceplate of a Gisholt turret lathe, is provided with a boss fitting into the hole in the gear, and is also supplied with four spring studs *B*, supporting the rim of the gear. Because of the shape of this gear, it is necessary that the rim be supported to resist the thrust of the cutting tools, which is considerable.

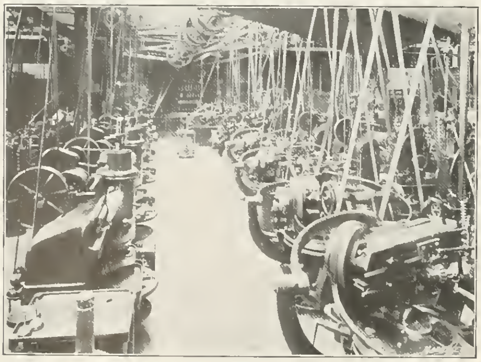


Fig. 5. Portion of the Gear-cutting Department in the White Co.'s Plant, Cleveland, O.

The operations performed on the bevel gear in the set-up shown in Fig. 2 are of a roughing nature only, and consist in taking a roughing and finishing cut from the bevel face, inside face, and rear bevel. The front bevel face is roughed out with a tool held on the cross-slide, and finished with two tools held in a holder fastened to the turret. One of these tools in the turret finishes the inside face. One-quarter inch of material is removed from the front face, and ⅛ inch from the inside face. The back face is machined with a tool held in the tool-post, removing ⅛ inch of material. The roughing operations on this gear are handled very expeditiously in the Gisholt turret lathe, the time being 4¼ minutes for one gear, approximately.

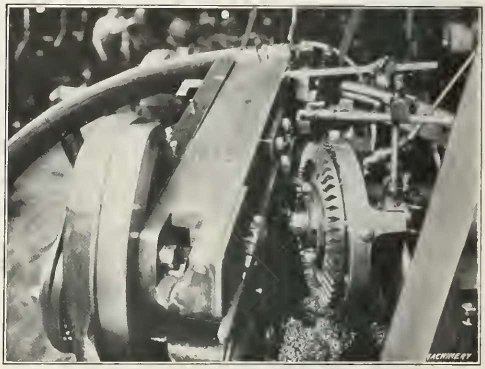


Fig. 6. Finish-cutting the Teeth of the Large Bevel Gear in a Gleason Bevel Gear Generator

From the turret lathe the large bevel gears are taken to the Brown & Sharpe automatic gear-cutter shown in Fig. 4, where the teeth are roughed out, or "gashed" as this operation is generally called. A regular bevel gear stocking cutter is used for this operation, which leaves just enough material (about 1/64 inch on a side) for finishing up on the Gleason bevel gear generator. While being "gashed" the gear is clamped by a washer and nut to a special fixture fitting on the nose of the spindle.

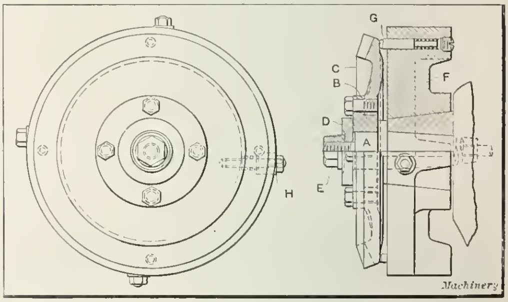


Fig. 7. Fixture used on the Gleason Bevel Gear Generator for holding the Large Bevel Gear when cutting the Teeth

Upon the completion of the "gashing" operation, the gears are taken to the hardening department, where they are annealed to relieve the strains set up in forging and machining. Annealing previous to rough-machining would not relieve the strains set up in the blank, owing to the fact that the outer or hardened surface produced in drop-forging acts as a binder and does not allow the grain of the steel to "set" properly. The gears are packed for annealing in charcoal and placed in iron boxes. These are then placed in the furnace shown in Fig. 9, which is heated by coke, a temperature of about 1600 degrees F. being attained. The gears are left in this furnace for a period ranging from three to four hours, when the boxes are taken from the furnace, and allowed to cool in the air without removing the contents. This treatment removes all forging and machining strains, bringing the structure of the steel to its normal condition.

The bevel gears are taken to the lathe department after annealing, where light finishing cuts are taken from all machined portions of the gears. The face and back angles are at this time machined to the correct angles, and the hole in the gear reamed to the exact size. Upon the completion of these operations, the gears are ready to have the teeth finished to their final shape in the Gleason bevel gear generators, a general view of which appears in Fig. 5. This illustration shows a section of the gear-cutting department. The bevel gear generator shown to the right in the immediate foreground is at work finishing the teeth in the bevel pinion, while the machine immediately behind this one is finishing the teeth of the large bevel gear. This illustration also shows a row of Fellows gear shapers, which are employed principally in producing transmission gears.

Generating Bevel Drive Gear Teeth

The rotary cutter method of producing bevel gears is used to a large extent for slow-running gears, but for gears which must rotate at high speeds and where noise is objectionable, this method is not advisable. The bevel gears used in an automobile not only rotate at high speeds, but also transmit power under a great variety of conditions, and if not properly made and hardened soon become noisy and inefficient. To eliminate noise, it is necessary that the tooth curves or "rolling circles" be correctly formed and that the teeth be of an equal thickness at the pitch line. There are also other factors, such as the shape of the teeth, method of mounting, etc., which contribute to the production of noise.

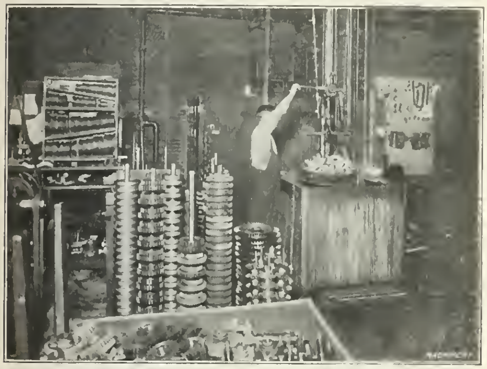


Fig. 8. Washing Gears in a Hot Soda Water Bath

Now the problem confronting the automobile manufacturer is not only to be able to produce quiet-running bevel gears, but to produce gears in large quantities, interchangeable, and as cheaply as possible. The method generally pursued is to rough out the teeth in an automatic gear-cutter, and do the finishing in a bevel gear generating machine. The automatic machine made by the Gleason Works is used largely by the automobile manufacturers for this purpose. A close view of one of these bevel gear generating machines at work on a bevel drive gear is shown in Fig. 6.

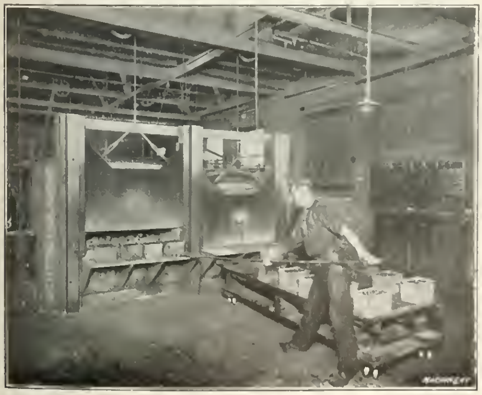


Fig. 9. Coke Fuel Furnace used in carburizing Gears and Other Parts

The principle on which this machine works, described briefly, is as follows: Assuming that the bevel gear (the teeth of which have previously been rough-formed) is fastened to the work spindle in the proper manner, and that the machine has been properly adjusted in its preliminary position, the tool-slide and head on which it is mounted is swung around so that the tools clear the work. The machine is now started, whereupon a cam swings the cutter-slide head inward until the tools reach the proper depth. This cam movement now rocks the semi-circular arm extending around the front of the machine, upward, rotating the work spindle carrying the blank, and at the same time, through the segmental crown and master gears, rocking the tool-slide until the two shaving tools have been rolled out of contact in one direction, and thus partially forming the gear tooth. The semi-circular arm is now rolled back to the central position, continuing downward to the lower position until the tools are rolled out of contact with the gear tooth, and in this movement completely forming the gear tooth.

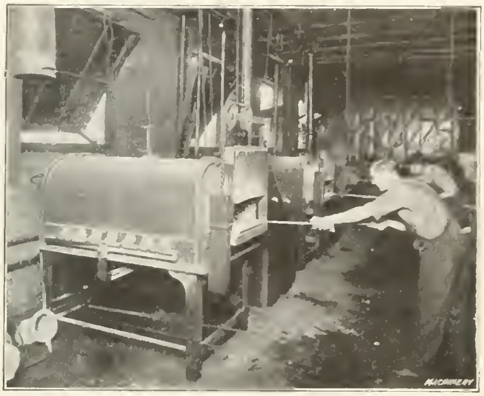


Fig. 10. American Muffle Furnaces for heat-treating Gears and Other Parts

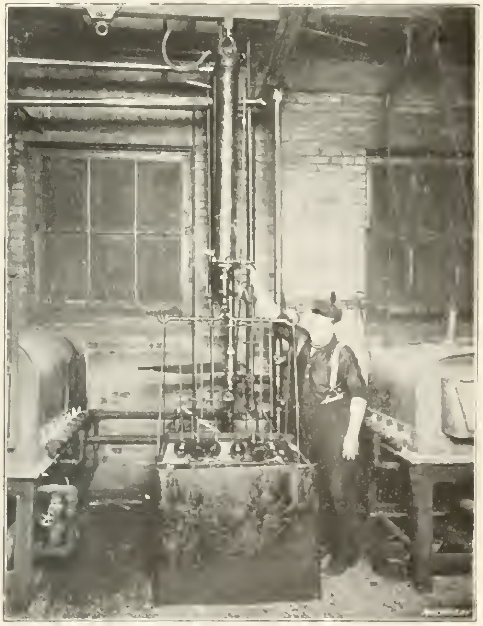


Fig. 11 Cooling Gears for hardening in Oil Bath—Compressed Air Arrangement used for agitating Oil

To bring the machine into the indexing position, the cam then rocks the semi-circular arm back to the central position, where the cutter-slide head is swung back to clear the tooth, and the work spindle is indexed, after which this cycle of operations is repeated for the succeeding teeth. By following this principle of operation, it is evident that the two cutters which are used are passed twice over each tooth. They start from the center of the tooth, go to each extreme and return, so that each tooth of the gear receives a roughing and finishing cut. The use of two tools—one on each side of the tooth—presents a number of advantages. Not only does it increase the working capacity of the machine, but it also balances the thrust of the cutting action on the two sides of the tooth and reduces chatter and vibration to a minimum, giving greater accuracy. The slides in which the tool blades are carried are adjustable to accommodate different sizes of teeth. This machine is entirely automatic in its operation, and as it works on the molding-generating principle, receiving its shape controlling action from a crown and master gear in mesh, it is possible to produce a theoretically correct-shaped tooth, which is very essential in bevel gears that must transmit power at high speeds. [The Gleason bevel gear generating machine was described in the August, 1908, and July, 1906, numbers.—Editor.]

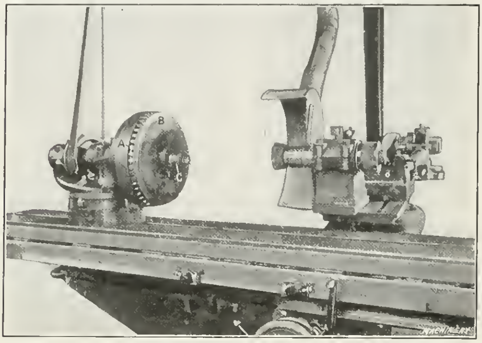


Fig. 12. Grinding Back Face of Large Bevel Gear in a Brown & Sharpe Universal Grinding Machine

In finish-machining the large bevel drive gear, particular care is taken to see that the hole and front inner face or boss are accurately machined and true with each other, as these two points are used in all important machining operations for locating purposes. Special fixtures are therefore used in the succeeding operations for holding the gear, the latter always being located from these two points.

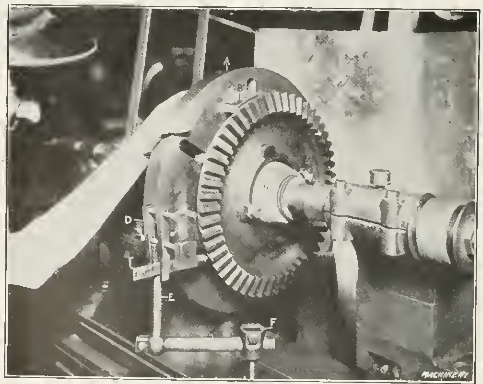


Fig. 13. Grinding the Hole in the Large Bevel Gear in a Brown & Sharpe Universal Grinding Machine

The special fixture used in holding the large bevel gear when generating the teeth in the Gleason bevel gear generator is shown in the close view of this machine in Fig. 6 and also in detail in Fig. 7. Referring to the latter illustration, the fixture consists of the spindle *A* fitting in the tapered hole in the spindle of the machine, and carrying the shoulder plate *B* on which the gear *C* is held by cap-screws fitting in the bolt holes. The spindle *A* is hardened and ground all over, and those portions of the shoulder plate which come in contact with the spindle or gear are ground. The plate *B* is held up against the shoulder on the spindle *A* by a slotted washer *D* and nut *E*.

Retained on the tapered nose of the machine spindle by a set-screw is the cast-iron plate *F*, in which four spring pins *G* are held for supporting the rim of the gear against the thrust of the cutting tools. The nuts binding the clamping washers *H*, which press against the spring plungers, are released after the gear has been clamped on the spindle, allowing the springs behind the plungers to force the latter out against the rear face of the gear; then the nuts are tightened to clamp the plungers in this position. The chief object of securing the gear in this manner is to approximate as closely as possible the actual position in which the gear is held to the compensating case. Two shoulder plates similar to that shown at *B* are made, so that when one gear is being finished, the operator can be clamping a rough gear to the other plate, getting it ready for the machine.

Heat-treating

After the teeth have been finished, the gears are taken to the hardening department where all oil and fine chips are removed from them by immersion in a bath of hot soda water. This operation is illustrated in Fig. 8, where a basket full of transmission and bevel pinions are being washed. A compressed air device connected to the basket is used for moving the latter up and down in the bath, which action agitates the fluid and assists in removing all oil and fine chips quickly. After three or four immersions the gears are removed from the basket and allowed to dry.

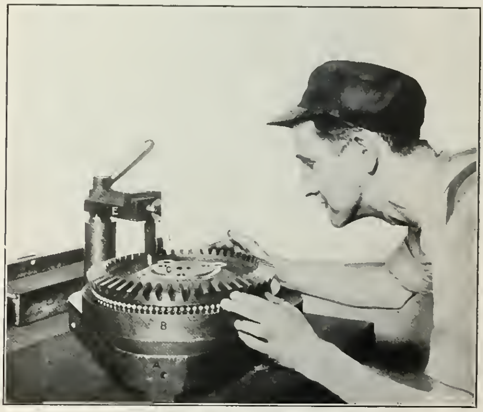


Fig. 14. Fixture used in testing Large Bevel Gears for Truth after grinding Back and Front Inner Faces

Following the washing of the gears they are packed in boxes in a carburizing compound (composed chiefly of granulated bone), these, in turn, being placed in the carburizing furnaces shown in Fig. 9. The temperature in these furnaces is raised with coke fuel to 1650-1700 degrees F., and the boxes are allowed to remain in the furnace for from ten to twelve and one-half hours. They are then removed from the furnace, and allowed to cool gradually in the air, the contents not being removed until cold.

The next step after carburizing is to wash the gears in hot soda water, using the arrangement shown in Fig. 8, after which the gears are packed in boxes with charred leather, the latter being placed in the American muffle furnaces illustrated in Fig. 10. These furnaces are heated by gas to a temperature of 1600 degrees F., and the gears are allowed to remain in the furnace until they attain this temperature. The boxes are then removed from the furnace and the gears taken out, after which they are clamped by a key in a special fixture and quenched in oil. This fixture, which holds the gear, prevents it from becoming distorted during the cooling operation. For quenching, the gears are placed in the basket shown in Fig. 11 which is moved rapidly up and down by the compressed air arrangement shown.

The operator opens the valve controlling the compressed air hoist, which carries the basket and gears up and down in the oil bath, cooling the gears and at the same time agitating the oil to assist in uniform cooling. In Fig. 11, the gears shown suspended from the arm are some of the gears used in the transmission case. When cold, the gears are unfastened from the fixture and tested to see whether they have become distorted during the hardening process. If distorted no attempt is made to straighten them by mechanical means alone, but the gears are again placed in the furnace, brought to the proper temperature and cooled as previously described. This treatment seldom fails to bring a distorted gear back to its original shape. Usually the temper of the gears is drawn after hardening; this operation is accomplished in an oil bath heated to a temperature of from 300 to 325 degrees F., and in which the work is allowed to remain for about one hour, being then cooled off gradually. [For a fuller description of the methods used in heat-treating automobile parts made from low carbon and alloy steel, reference should be made to the article on this subject in the August, 1912, number of MACHINERY, entitled "Analysis and Heat-Treatment of Low Carbon and Alloy Steels."—EDITOR.]

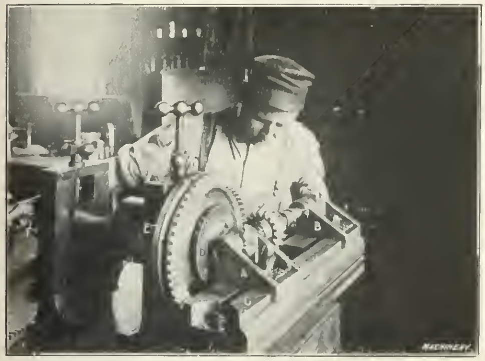


Fig. 15. Running Test on Bevel Gear and Pinion, accomplished by Hand to test for Noise

Grinding Operations

The next important operation on the main drive gear is the grinding of the back face in a Brown & Sharpe universal grinding machine as shown in Fig. 12. To accommodate this gear, the greatest diameter of which is almost thirteen inches, it is necessary to pack up the internal grinding head and also the headstock so that the gear can be swung. For this grinding operation, the gear is located from the pitch line of the teeth by 24 steel balls—one placed every second tooth space—and located in a circular groove in a special plate A. Gear *B* is held up against the balls in the groove of plate *A* by a hardened and ground shouldered sleeve *C*. This sleeve is located on the special arbor fitting in the spindle of the headstock, and fits the hole in the gear, the shoulder bearing against the back face. The sleeve is pinned to the arbor by a removable pin, and is acted upon by a block *D* backed up by a nut and washer. This nut and washer are held on a pull rod which passes completely through the headstock spindle and is used for drawing the gear up against the steel balls.

To remove the gear from the fixture, the tension of the pull rod on block *D* is released, when the latter, which is slotted, is removed, as is also the removable pin. When this is done the steel balls drop out from between the lower teeth of the gear, then the fixture is rotated until all of the balls have dropped out and have been caught in the operator's hand. Sleeve *C* and the gear are now removed and a rough gear put on. The pin and block are then put in place, the pull rod drawn up slightly and the balls dropped in between the teeth from the top, the fixture meanwhile being rotated by hand to replace all of the balls. The pull rod is now drawn up tightly and the back face of the gear ground true with the "pitch circle" of the gear by the bevel cup-wheel *E* held on the internal grinding spindle in the usual manner.

The next grinding operation on the main drive gear is in the hole. To accomplish this, a special faceplate is fitted to the headstock of a Brown & Sharpe universal grinder as shown in Fig. 13. The faceplate *A* is provided with four lugs *B*, the faces of which have been accurately ground. The previously ground face of the gear (which operation is illustrated in Fig. 12) is held against lugs *B* by two nuts threaded on two bolts passing through from the back of the faceplate and fitting in the bolt holes in the gear. These clamping bolts are smaller in diameter than the bolt holes in the gear, thus enabling the clamping to be done by the nuts. As in the case of the previous grinding operation, the headstock and the internal grinding head are raised by special blocks to accommodate this gear. The gear is trued up from the outside beveled edge by the test indicator *C*, held by the clamp *D* to the swinging arm *E*, retained in stud *F* which is pivoted in the platen of the grinder. The hole is ground to size and true with the outside and back face, by the bevel cup-wheel *G*, held on the internal grinding spindle. After this, the front inside face is ground true with the hole and back face, the gear being held on a fixture somewhat similar in construction to that shown in Fig. 13 for this operation.

Testing and Inspecting

Now that the grinding operations have all been accomplished on this gear, the next step is to ascertain whether these operations have been correctly performed or not. The inspecting fixture used in determining whether or not the back face and inside front face are true with the "pitch line of the teeth," is shown in Fig. 14. This fixture consists of a cast-iron base *A* to which a hardened and ground steel ring *B* is fastened. A circular groove for retaining a "ring" of steel balls is provided in the top face of this ring, and on these balls the back face of the gear rests. The gear is located from the hole by a hardened and ground stud *C* which is fastened to the cast-iron base.

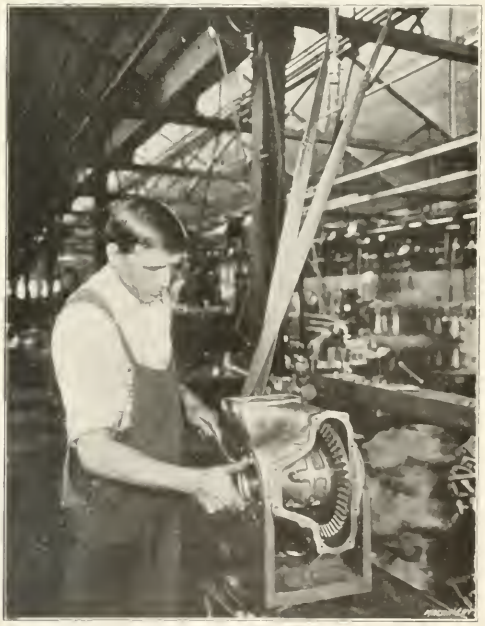


Fig. 16. Adjusting Main Drive Gear to Pinion, when assembled in the Rear Axle Housing

The test for truth is accomplished with the test indicator *D* held in the bracket *E* by a clamp and thumb-nut. Bracket *E* is retained on a stud projecting up from the fixture, and is free to swing on this stud when the clamp shown is released. The inspector in testing for truth, rotates the gear on the balls with his hands, as shown, and at the same time watches the movement of the indicator needle to see if any inaccuracy has taken place in the grinding operations. One of these inspecting fixtures is also kept in the grinding department, and is used by the grinding machine operator (the one who grinds the inside face of the gear) to determine whether the final grinding operation has been successfully accomplished or not before the gears leave his department.

Assuming now that the bevel pinion, on which the machining operations have been similarly conducted, is completed, this and the large bevel gear are taken to the inspection fixture shown in Fig. 15, where they are run in mesh and tested for noise. The testing fixture is applied to a Lincoln type milling machine, and is composed of two brackets held on the table, and a special holder for the large gear. The brackets *A* and *B* which carry centers retaining the pinion arbor are held to the special table *C* by T-bolts and nuts. The bracket *A* is provided with a wing-nut so that it can be easily moved to insert and remove the work.

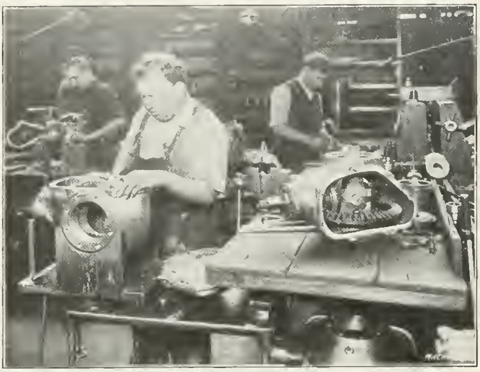


Fig. 17. Assembling Drive and Compensating Gears in the Rear Axle Housing

The large gear is held in a similar manner to that employed in the Gleason bevel gear generator, being located from the front inside face by a shoulder plate *D* to which the gear is bolted. Spring pins located in the special faceplate *E* are also used to support the rim of the gear, as was the case in the fixture shown in Fig. 7. This old type of Lincoln miller, see Fig. 15, is provided with a special hardened and ground spindle on which the fixture is retained. The spindle is hollow and a pull rod passing through it is used to clamp the gear and shoulder plate *D* up against the fixture. To the rear end of the spindle the handle *F* is attached, which is used to rotate the large gear meshing with the pinion held on the arbor. The operator brings the gear and pinion into proper contact, and then rotates the handle slowly, listening carefully to find out at which points of the rotation any noise is produced, or where the teeth bear hard.

Assembling

The gear and pinion are not mated until ready for the noise test, and if they pass this satisfactorily they are then ready for assembling. Before the bevel gears can be assembled it is necessary that the compensating gears, also known as "differentials," be assembled on the spider and fastened in the compensating case. The large bevel gear is then fastened to the compensating case as shown in Fig. 16. The compensating case and gear are then put inside of the rear axle housing, the ball bearing put into place, and the spanner nuts screwed in, retaining the entire mechanism. After this the bevel pinion (for the smaller sizes this is made integral with the shaft) is assembled on the shaft and located in its proper position in the rear axle housing, the ball bearings first being put into place. The spanner nuts are now tightened and the entire mechanism lined up. An assembled rear axle drive is shown to the right of the illustration in Fig. 17.

Before the spanner nuts holding the various members in the rear axle housing are tightened up, the main drive gear is adjusted to the pinion. This is accomplished as shown in Fig. 16, where the assembler is shown in the act of adjusting the spanner nuts retaining the ball bearings and compensating case. The case is moved back and forth by the spanner nuts, and the bevel pinion is rotated by a belt running on a pulley on the bevel pinion shaft. The pinion is also adjusted up and down (in relation to the large gear) until the teeth of both are flush at the back. When these operations have been accomplished, this unit of the power plant is complete.

In the preceding paragraphs only a brief description is given of the manufacture of this interesting part of an automobile, but from this can be obtained some idea of the ingenuity and skill necessary to build a successful motor car. The writer wishes to express his appreciation of favors bestowed by Mr. James A. Harris, Jr., advertising manager of this company, in furnishing the information and photographs presented in this article.

* * *

TO DETERMINE THE SIZE OF RAIL NECESSARY TO CARRY A GIVEN LOAD

BY R. H. CREVOISIE

Frequently it is necessary to determine the size of wheel or rail required to carry a given load. In such cases, the following formulas may be employed. Let

A = the width of the head of the rail in inches;

B = width of the tread of the rail in inches;

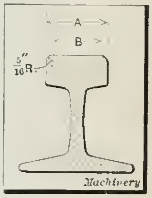
C = the wheel-load in pounds;

D = the diameter of the wheel in inches.

Then the width of the tread of the rail in inches is found from the formula:

$$B = \frac{C}{1250D} \qquad (1)$$

The width A of the head equals $B + \frac{5}{8}$ inch.



Section of Rail

The diameter D of the smallest track wheel that will safely carry the load is found from the formula:

$$D = \frac{C}{A \times K} \qquad (2)$$

in which

K = 600 to 800 for steel castings;

K = 300 to 400 for cast iron.

As an example, assume that the wheel-load in a given case is 10,000 pounds and that the diameter of the wheel is 20 inches, and the material steel casting. Determine the size of rail necessary to carry this load. From Formula (1) we find:

$$B = \frac{10{,}000}{1250 \times 20} = 0.4 \text{ inch.}$$

Hence the width of the rail required equals $0.4 + \frac{5}{8}$ inch = 1.025 inch.

Determine also whether a wheel 20 inches in diameter is large enough to safely carry the load. From Formula (2) we find:

$$D = \frac{10{,}000}{1.025 \times 600} = 16\tfrac{1}{4} \text{ inches.}$$

This is the smallest diameter of track wheel that will safely carry the load; hence a 20-inch wheel is ample.

* * *

CELEBRATION OF DISCOVERY OF LOGARITHMS

The Royal Society of Edinburgh, Scotland, is considering the celebration of the anniversary of the tercentenary of the discovery of logarithms, which occurs in 1914. John Napier, who is generally credited as being the discoverer of logarithms, was born near Edinburgh in 1550. His work on logarithms was published in 1614. The importance of logarithms in mathematical computations can hardly be overestimated. They undoubtedly constitute the greatest time- and labor-saving system ever discovered in the realm of mathematics. The slide-rule, so generally used by engineers for making calculations, depends upon the properties of logarithmic scales for its usefulness.

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* Address: Wickes Boiler Co., Canton, Ohio.

STANDARDS IN DIE WORK*

In the construction of dies, the design depends, of course, upon the general character of the work, and for each new form a little valuable experience is usually obtained. In designing various kinds of dies, it is impossible to state specifically just how each one should be constructed, but it is practicable to have some standard parts and rules that can be relied upon and are based upon the fact that they have been tested in actual practice and found satisfactory. For example, it has been found by experience that die-beds for presses, when built of gray iron, get out of square, in time, and sometimes crack, whereas the die-bed does not deteriorate when made of semi-steel. It is the practice of large firms to so design blanking and cutting dies that the minimum of steel is used, probably because of the cost, and to back the steel by welding a wrought iron plate to it. The wrought iron plates that seem to meet most of the requirements for all-around work are of the following sizes: 4 inches by 8½ inches, 5 inches by 9 inches, 6 inches by 9½ inches, 7 inches by 10½ inches, 8 inches by 11½ inches, 10 inches by 13 inches and 12 inches by 15 inches. The corners of these plates as a rule are cut at a 45-degree angle.

The cutting edges of blanking dies are made of steel of some stock size, which varies from ¾ to 1¼ inch in height and from ¼ to 1 inch in thickness, depending upon the use and application of the die. It has been found cheaper, for many dies, to weld steel edges to wrought iron in preference to screwing or bolting them to cast iron. To prevent heavy stresses, especially at the starting point, the designer should provide plenty of shear. In blanking dies, the punch should never touch the die, and a clearance of 5 per cent of the thickness of the metal to be cut should be allowed; for example, with material 0.03 inch thick, allow 0.0015 inch all around.

It is customary to shear the face of the die when possible, but there are instances when it is advisable to shear the punch. The shear is given to the punch when the material removed is to be scrapped and the outside piece used. The face of the die is sheared when the piece punched out is the product. The amount of shear necessary depends upon the thickness of the stock and the size of the cut. A general rule is to allow 1/16 inch shear up to 2 inches diameter; 3/32 inch up to 4 inches diameter; 1/8 inch up to 6 inches diameter; 5/32 inch up to 8 inches diameter; 3/16 inch up to 10 inches diameter; 7/32 inch up to 12 inches diameter; 1/4 inch up to 14 inches diameter; 9/32 inch up to 16 inches diameter; and 5/16 inch up to 18 inches diameter. The shear of the die usually begins at the center and extends toward each end, the number of high spots depending upon the class of work, etc. In stripping work from blanking dies, a standard stripper is commonly used. This is simply a piece of steel rod with one end squared and bent at right angles, and the other end forced into the die plate close to the outer edge of the steel, with the bent edge turned toward the cutting edge so as to strip the work.

For clamping dies, right-angle slotted plates are used extensively. These are from 1¼ inch to 2⅛ inches in height, 3½ inches to 7 inches in length and 2½ inches to 3 inches in width. The thickness varies from ⅝ inch to 1 inch, with a slot averaging ⅞ inch in width and about 2 inches long. Standard round dies are used to a great extent, ranging from ⅛ inch to ⅞ inch, in the following approximate dimensions: for dies varying in size from 1/8 inch to 9/32 inch: diameter, ¾ inch; height, ¾ inch; depth of cutting edge, ¼ inch; clearance, 3 degrees; and relief under the cutting edge, 1/32 inch. On sizes from 11/32 inch to ⅞ inch, the diameter is from 1 inch on the small sizes to 1½ on the largest sizes, and the height, 1 inch. The relief averages 3/32 inch; the clearance 3 degrees; and the cutting edge, ½ inch. These dies are held in position by a set-screw bearing against the side of the die, or by a die-screw which depends upon the projecting head of the screw for its holding power.

The die governs the size of the work passing through it and the punch governs the size of the work it passes through, so that the clearance governs the result. In blanking dies, the die is made the size of the work wanted, but in perforating, the punch is made the size of the work wanted and the die larger. In boiler work, the practice for the clearance of punches is to make the punch 1/64 inch below the nominal size and the die 1/64 inch above the nominal size, thus giving 1/32 inch clearance for all sizes up to 1¼ inch. For all sizes above 1¼ inch, the punches are left the nominal size and the dies made 1/32 inch larger. The taper on dies below 1¼ inch, is 1 inch in 12 inches, and above 1¼ inch, the taper is ½ inch in 12 inches.

There are two types of standard punches for the standard round dies; namely, the straight shank and the headed punch. The straight shank is used with standard punch-holders, which are either screwed or clamped into the press slide. Punches varying from 5/32 inch to 7/16 inch in diameter have shanks from 1/2 to 11/16 inch in diameter, length of from 2¼ inches to 3¾ inches, and a clearance varying from 0.002 to 0.005 inch. The headed type has a bead 1/8 inch larger than the shank and 1/8 inch thick. This type is used a great deal when the punches are held to a cast-iron punch-holder by means of a steel plate screwed to the holder. In some cases where there are a great number of punches, or the thrust is excessive, a steel plate is inserted behind the punches to prevent them from working through the holder.

The lubricant used with dies is a very important factor and many times good tools are ruined by using the wrong lubricant. For brass and steel, use any heavy animal oil, and when drawing steel shells, use equal parts of oil and black lead or heavy grease with a small percentage of white lead. For copper and German silver, cover the material with a thin coat of lard or sperm oil before punching, and for drawing brass or copper, use a solution composed of 15 pounds of Fullers soap to a barrel of hot water (used hot) or soap strong in resin or potash. For zinc, use hot water, while for aluminum, use lard oil, melted Russian tallow and vaseline applied on both sides of the metal.

The speed of presses for re-drawing work should average from 50 to 60 revolutions per minute and the pressure should vary from 200 to 400 pounds. The ordinary cutting speeds for dies in quick-running presses range from 50 to 200 strokes per minute, and the average, 100 strokes per minute on shearing and punching metals not over ¼ inch thick. Safe cutting pressures in pounds per square inch are as follows: Mild steel, 60,000; wrought iron, 50,000; bronze, 40,000; soft brass, copper, and cast iron, 30,000; aluminum, 20,000; zinc, 10,000; tin, 5000, and lead, 5000.

* * *

CONCRETE BUILDING IN RECORD TIME

The unloading of sheet steel in a new concrete building nine days after the contract for it was let, the installing in it of punch presses weighing from twelve to nineteen tons twelve days later, and the operating of ten big punch presses on twenty carloads of material just a month from its inception, is the record achieved by the Crocker-Wheeler Co. of Ampere, N. J. Mr. W. J. Warder, Jr., was appointed works manager of this concern on October 1, 1912, and the necessity for acquiring a new punch press department to take care of the tremendous influx of orders which has been common to all manufacturers this fall was quickly realized. A concrete building 80 by 80 feet and 15 feet high, with a monitor roof down the center to accommodate a five-ton crane was planned. At noon of the day following the decision of the officers of the company to build, the contract was let. Nine days later the long strips of sheet steel, the material to be punched, were being unloaded into the building. Twelve days later the heavy punch presses, the biggest of which weigh nineteen tons, were being placed on the concrete floor. Exactly one month from the inception of the building twenty carloads of sheet steel were in it being punched by the ten big punch presses, a full equipment of dies and grinders for the dies was installed, and the installation was operating at maximum capacity as an integral permanent unit of the Crocker-Wheeler plant.

* * *

Be just as free to answer questions as to ask them. The best way to learn is through a fair exchange of ideas.

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* Abstract of a paper presented before the American Society of Engineer Draftsmen, by Mr. Charles A. Clark.

LUCAS JACKS, PROPS AND BRACES

An ingenious and simple unit system of jacks, props and braces is used with general satisfaction by the Lucas Machine Tool Co., Cleveland, Ohio, on planers, boring machines, boring mills and other machine tools.

The system comprises eight varieties of units; these can be assembled in an almost endless number of combinations and lengths of jacks, heels for straps in close places, braces, etc. The system is not only simple and efficient but it very materially reduces the investment in work clamping accessories, as compared with those usually provided for planers and similar machines. It is scientific in design and meets one of the requirements of scientific machine shop management.

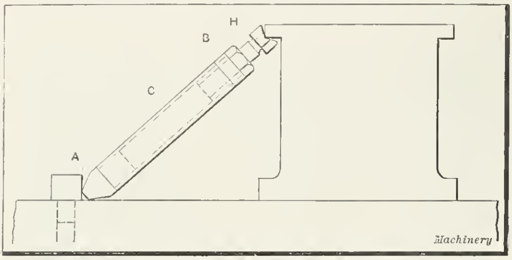

Fig. 1. Combination employed as a Brace in planing a Machine Bed

Fig. 1 shows a typical combination employed as a brace for a machine bed. It is composed of the parts *A*, *C*, *B* and *H*, all of which are shown in detail in Fig. 2; this view also shows alternate parts at *E*, *F*, *D* and *G*. Unit *C* is 1¼ inch pipe cut in lengths, varying by 4 inches; *B* and *F* are alike excepting in length, one being 2 inches longer than the other. These are used alone for short lengths and in the end of the pipe units *C* for longer lengths. The fact that part *F* is 2 inches longer than *B* makes it possible to have a difference of length of 4 inches in the pipe units and still have a series of over-all lengths of the combinations varying by 2 inches. This saves one-half the number of pipe units that would be necessary if only one length of part *B* or *F* were provided.

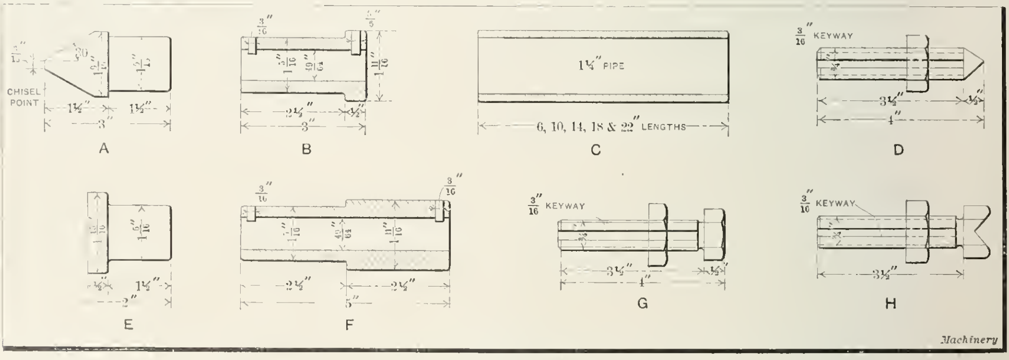

Fig. 2. Eight Units that can be combined to form a Variety of Braces, Jacks and Other Clamping Accessories

Three forms of screw points are furnished for use with *B* or *F*, these being shown at *D*, *H* and *G*. Pins are provided to engage the keyways and hold the screws from turning when they are used as jack-screws. The pins are put in both ends of *B* and *F* so that the screws may be used in either end, the screw being preferably placed in the small end when making up a short jack-screw combination. The units *A* and *E* are placed in the pipe ends opposite the jack-screws, and provide pointed or flat end support as the case may require.

* * *

Moving pictures will be used by the Central Georgia Railroad to teach the elements of railroading to employes, many of whom are illiterate. It is believed that in this way comparatively ignorant men can be taught to perform their duties more intelligently.

GERMAN SILVER

German silver is a white alloy consisting of nickel, copper, and zinc, the best quality being made up of four parts copper, two parts nickel, and two parts zinc. This quality, however, is the most difficult to work. It is known under probably a greater number of names than any other alloy. In this country and England it is known as nickel silver, packfong, white copper, silveroid, Nevada silver, and electrum. It is very ductile, and can be hammered, rolled, stamped, and drawn; at the same time it possesses the properties of being hard, tough, and not easily corroded.

Iron, lead, and tin are frequently found as impurities in German silver. Iron alloys perfectly with it, increasing the strength, hardness, and elasticity of the alloy, at the same time making it whiter. Tin, on the other hand, does not enter into the alloy in the same way as iron, but forms a mixture which renders it brittle and unfit for rolling. Even when present in small quantities it gives the alloy a yellowish color. Lead does not alloy with German silver, but separates out as metallic lead. When the alloy is to be cast and subsequently turned upon a lathe, from 2 to 3 per cent of lead is added, as it enables the lathe to be worked at a higher speed, and gives a better finish to the work.

German silver is made by melting the metals in graphite crucibles. In order to produce a more homogeneous alloy and to lessen the oxidation of the zinc, the separate metals are not melted together, but alloys of copper and nickel, and copper and zinc are used, and shortly before pouring a small quantity of zinc is added to overcome the effect of the volatilization of the zinc and to insure a thorough deoxidation of the alloy.

The metal is cast in iron molds previously heated and coated with oil or mixtures of charcoal and oil, or rosin and oil. The temperature of casting is a very important point. If the temperature is too high, the metal will be full of blowholes and will crack in rolling. If, on the other hand, it is cast at too low a temperature it tends to solidify as it touches the mold, with the result that there is imperfect cohesion of the metal. As the melting point of German silver is higher than that of brass, it must be cast rapidly, or the crucible must be returned to the furnace and be reheated. If the metal is to be rolled into sheets, molds from 16 to 18 inches long, 4 to 5 inches wide, and 1 to 1¼ inch thick are used. When intended for wire the molds are 4½ to 5 feet long, 3¼ inches wide, and 1¼ inch thick.

German silver, besides being used for many scientific instruments, is frequently used as a base in cheap grades of silver-plated ware. German silver, containing 60 per cent copper, 14 per cent nickel, 24 per cent zinc, and 1 to 2 per cent tungsten, is used under the name of platinoid for electrical resistances. It has also been alloyed with silver for jewelry and subsidiary coinage. Aluminum and magnesium have also been alloyed with German silver, but owing to the high cost, these alloys have never found extended uses.

German silver can be readily soldered. The usual composition of German silver solder is: Copper 47 per cent; nickel, 11 per cent; and zinc, 42 per cent.—*Things Technical.*

VAN WAGNER MFG. CO.'S DIE-CASTING PRACTICE–2

THE CASTING MACHINES AND DIES USED IN PRODUCING PRESSURE CASTINGS

BY CHESTER L. LUCAS

Next to the casting machine, the dies or molds are the most important necessary factor. The Van Wagner Co. takes special pride in its diemaking equipment, and a general view of this department is shown in Fig. 16. In order to gain a proper conception of the work required in producing a high-grade die-casting mold, we will follow the different steps which are necessary in making the mold. The first and most important step is the proper planning of the die. Before any work at all can be done, it is necessary to plan the die, *i. e.*, to decide just where the parting lines will come; just what method will be used for ejecting the piece; what alloy will be used; where the casting will be gated; and a hundred and one minor points, all of which have a direct bearing upon the performance of the finished dies. All these decisions have to be made by the diemaker, and in Fig. 21 he is shown, micrometer in hand, computing the shrinkage allowances that he will make in the dies. This is a very important factor on accurate work as the shrinkage varies from 0.001 to 0.004 inch, according to the alloy and the general shape of the piece.

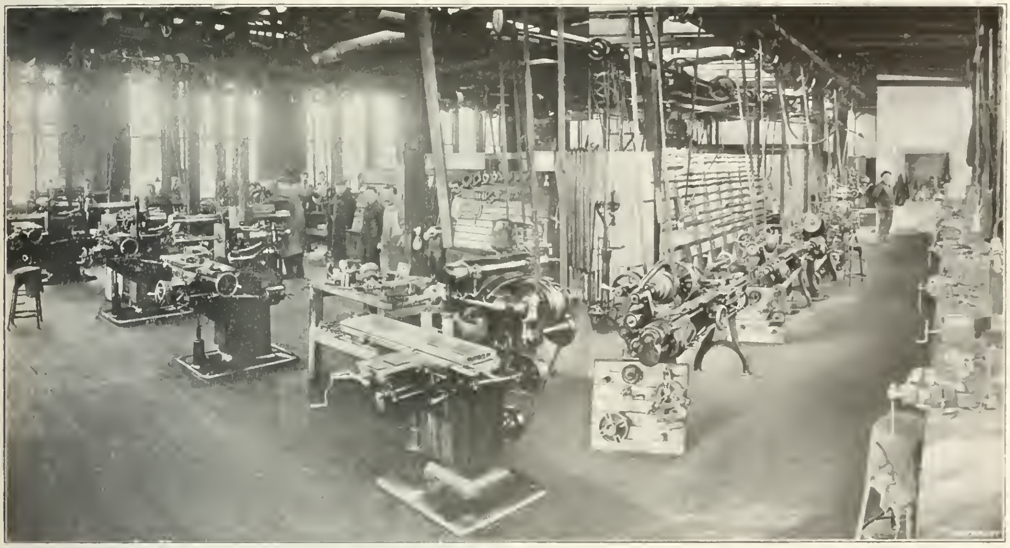
Fig. 16. General View of E. B. Van Wagner Co.'s Die-making Department

Fig. 17. First Step in making the Mold—Grinding Surfaces of Blocks

Before taking up the actual machining operations of the mold-making as conducted in this factory, it will be well to take a typical die-casting mold and note its general construction. Fig. 20 shows a typical die-casting mold closed, while Fig. 18 shows the same mold disassembled on the bench to show its construction. The piece for which the mold has been made is also shown. Fig. 19 shows a similar die in section. From the three illustrations a good idea of an average die-casting mold can be obtained. Referring to these illustrations, the principal parts of this die are the ejector box *A*, and the ejector plate *B* which is operated by the racks *C*. For operating the ejector plate, the pinion shaft *D* having a handle suitable for turning, is furnished. This, of course, fits into a bored hole in the ejector box, bringing the pinion into mesh with the racks for raising the ejector plate. In the ejector plate are three ejector pins *E* for removing the casting from the mold. The ejector pins operate through holes *F*. Beyond the pinion shaft may be seen the casting for which this mold has been made. It will be noticed that the top side of the casting has three projecting lugs through which are small holes. Provision for forming this side of the die-casting is made in the lower half of the mold *G*, while the upper half of the die-casting is taken care of by the top plate *H*. One of the toggles for operating the core pins through these three

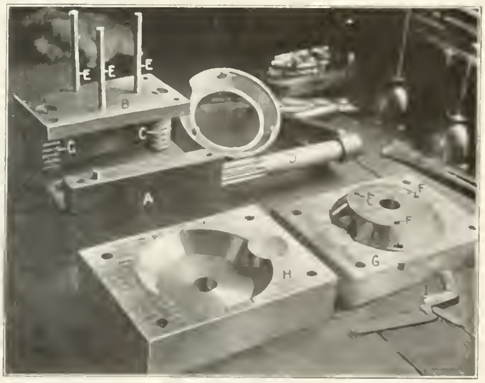

Fig. 18. Die-casting Mold shown in Fig 20, disassembled

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* Associate Editor of MACHINERY.

lugs is shown at *I*. These parts will be described more fully later. The sprue cutter is shown in position in the die at *J*.

Machining the Die Cavities

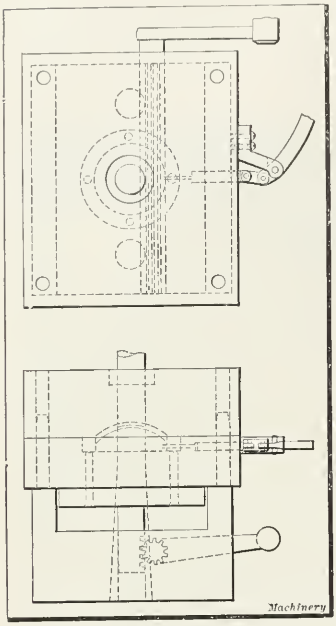


Fig. 19. Section through a Die-casting Mold

As will be noticed from Fig. 16, the machinery in the Van Wagner diemaking department is of modern design, for no other class of work demands as good tool equipment and as much skill in the making as die-casting molds. The die-blocks are made of machinery steel. Fig. 17 illustrates the first step in making a die-casting mold after the die-block has been shaped approximately to size. This operation consists in carefully facing off the die surfaces on a vertical-spindle grinding machine. This, of course, is a quick method of surfacing the die-block, and it insures that the top and bottom surfaces of these plates will be parallel, permitting the die-faces to come together properly.

The next step consists in laying out the die, as shown in Fig. 22. This is done in the usual manner, by working on a coppered surface, using dividers, scales and a center punch. When laying out the die, the necessary allowances are made for shrinkage and finish, these points having been planned before actual work on the die has been started. As in other phases of die-work, the machining operations are performed, as far as possible, before any hand-work is done. In Fig. 23 may be seen a diemaker turning the cavity in a part of the die-casting mold. The highest type of skilled workmanship is called for on this machine work, and, as may be surmised from Fig. 23, where the diemaker is shown measuring the die with a vernier caliper, the measurements must be exact, for no grinding operations follow the machine work.

Figs. 24 and 26 show typical milling operations being performed on die-casting molds. In Fig. 26 the diemaker is shown indicating a pin in one corner of the mold cavity, preparatory to doing additional milling. The block is held in the usual manner by being clamped on the bed of the milling machine, and after it has been properly located under the cutter head, tools are substituted for the indicator and the milling of the cavity is completed. Fig. 24 shows one of the sections of the die-casting mold which is to be used in producing the casting shown at the right of the work. In this case the diemaker is milling the recess for the steel arbor which may be seen directly in the foreground. This will be fitted in place to provide for the forming of the hole in the side of the piece.

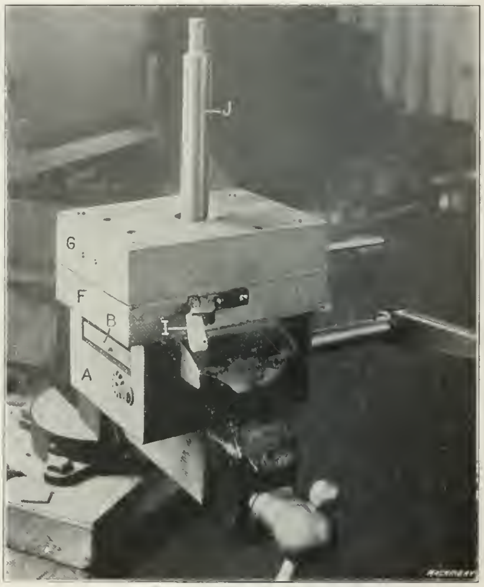


Fig. 20. A Typical Die-casting Mold

Fig. 21. Planning the Die-casting Mold

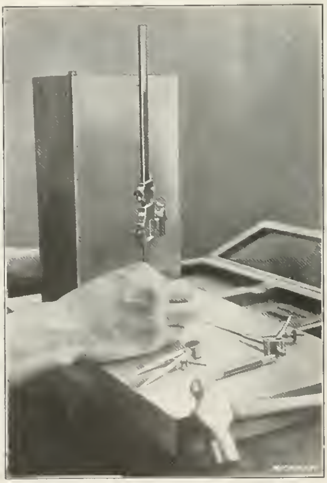


Fig. 22. Laying out One of the Mold Parts

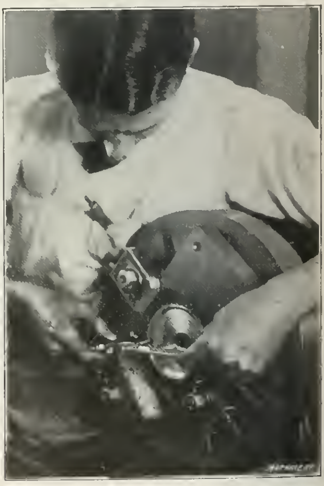


Fig. 23. Turning Out a Die-casting Mold

Fitting the Parts of the Mold

Fig. 27 illustrates several important points in the making of a die-casting mold. This illustration shows the ejector box with the lower half of the mold on it, the ejector plate being held against the under side of the die-plate by means of the pinion shaft. The operation being done is the drilling of the ejector pin holes. Referring back to Fig. 18, which by the way shows the same die disassembled, the holes being drilled are those shown at *F* for the reception of the pins *E*. The method employed is to drill the holes through the die and into the ejector plate, afterward reaming all holes to size and driving the pins into position in the ejector plate, while they are allowed to slide freely through the die-plate. We will now assume that the ejector box and plate have been completed and fitted, a pinion shaft for operating this plate also fitted, the lower and upper dies completed by the machining operations previously described and all are assembled. The final operation of the fitting of the pins is shown in Fig. 28 in which the diemaker may be seen filing off the ends of these pins so that when dropped to the lower position they will lie flush with the surface. If of uneven lengths, these pins will cause irregular spots in the casting. It now remains to describe the toggles used for operating the cores which form the holes through the three lugs in the casting. One of these toggles, of which there are three, is shown at *I*, in Fig. 20, and also in Fig. 18. These toggles consist of brackets which are attached to the die-plate and levers which are fulcrumed at the ends of the brackets so that their operation works the core pins. It is necessary to remove these core pins after each casting has been made and position them before another casting can be produced.

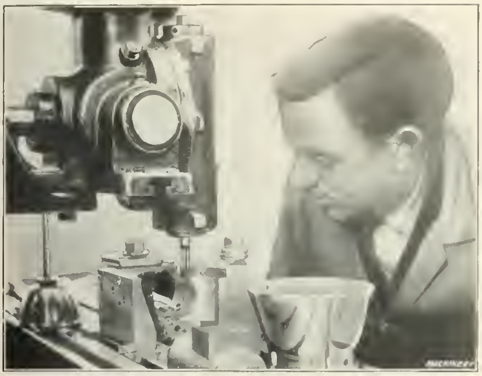


Fig. 24. A Milling Operation on a Die

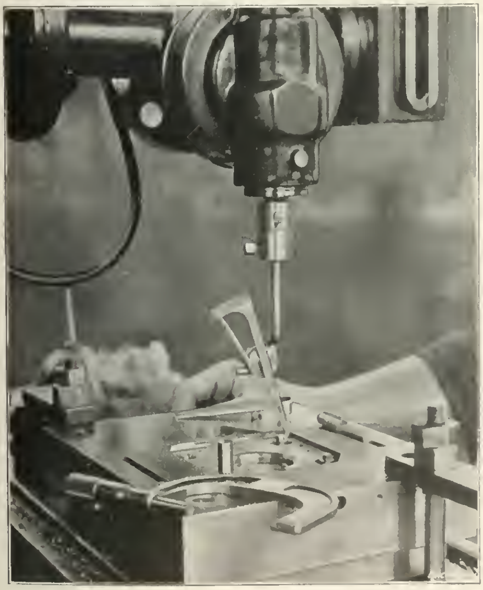


Fig. 26. Indicating a Mold on the Milling Machine

The fitting of the parts of a die-casting mold is one of the most important parts of the work. It demands the highest type of workmanship, for a poorly fitted die means a die which works hard in addition to producing poor castings. It is very important that all movable parts should work freely. Fig. 25 shows the assembling operation on a die-casting mold, the casting which is to be duplicated being shown in the immediate foreground. These parts must all be screwed into their respective places, making the joints as nearly air-tight as possible. One cause of poor die-castings arises from the trapping of air in the die, and different methods are employed for overcoming this trouble.

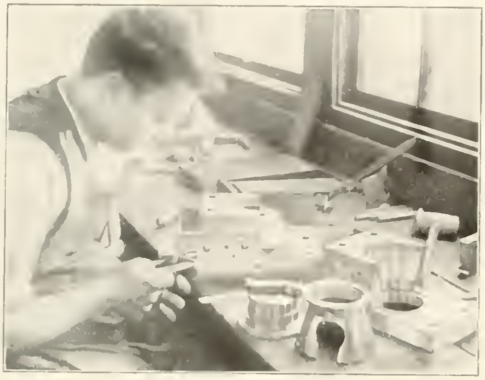


Fig. 25 Assembling a Die-casting Mold

Venting the Dies

There are two methods of preventing air from being trapped in die-casting molds: either by constructing the dies so that the air may be exhausted from the mold cavity before admitting the metal, or by venting the die so that the air may be forced out by the inrushing metal. In the first of these methods it is necessary that the joints in the mold be made as close as possible, otherwise it will be impossible to produce anything like a vacuum in the mold cavity. If, however, it has many parts which must be fitted, it is usually considered advisable to provide the die with vents consisting of milled recesses a

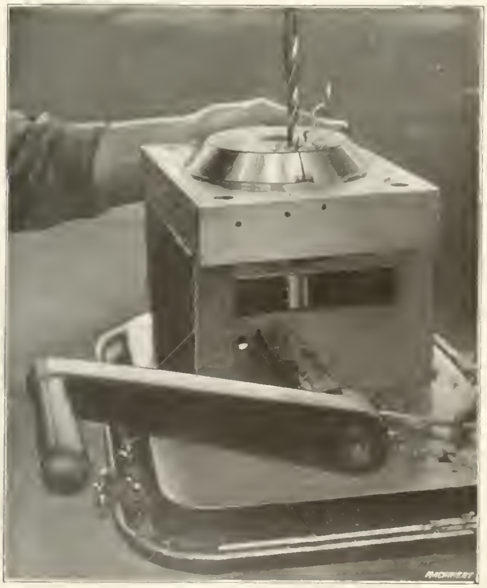


Fig. 27 Drilling the Ejector-pin Holes

few thousandths inch deep. Several vents are provided, from which the air can escape when the metal is admitted to the dies. The hot metal, of course, "shoots" through them in thin ribbons, but not enough escapes to affect the pressure on the metal which goes into the casting.

No matter how carefully a die may have been constructed, nor how carefully it has been assembled, there is always a certain amount of "babying" to be done before it will work satisfactorily. The casting may stick a little here, or there may be a rough spot there, and it is the successful elimination of these troubles which constitutes the production of a good die-casting.

Die-casting Metals

One of the purposes of writing this article is to correct several erroneous impressions which are prevalent in regard to die-casting possibilities. Many people seem to think that nearly all metals can be die-cast, but as a matter of fact, those metals which can be successfully die-cast can be numbered on the fingers of one hand, being alloys of lead, zinc, tin, copper and antimony. The tin base metals shrink very little, while the zinc base metals shrink considerably, although those with a large per cent of aluminum have a very high shrinkage. Without doubt, the most used die-casting metals are the zinc base metals. A typical metal of this class contains about 85 per cent zinc; 8 per cent tin; 4 per cent copper and 3 per cent aluminum. The melting point of this metal is between 800 and 850 F. While this alloy is one of the most common, it is not by any means the best, as there is too little tin employed, but it is a comparatively cheap metal, which probably accounts for its large use. This metal is easily affected by heat and cold, and rapidly deteriorates with age. The Van Wagner Co. has a metal similar in composition in which these defects have been reduced to a minimum. The melting point of this metal is from 650 to 675 F. It has a better color and also gives better castings. The lead base metals may be typified by an alloy containing 80 per cent lead; 15 per cent antimony; 4 per cent tin; and 1 per cent copper. This composition melts at approximately 550 F. and it is generally used for castings which receive little wear and where no great strength is required. The weight of this metal is its greatest objection, and it is also quite brittle because of the large percentage of antimony.

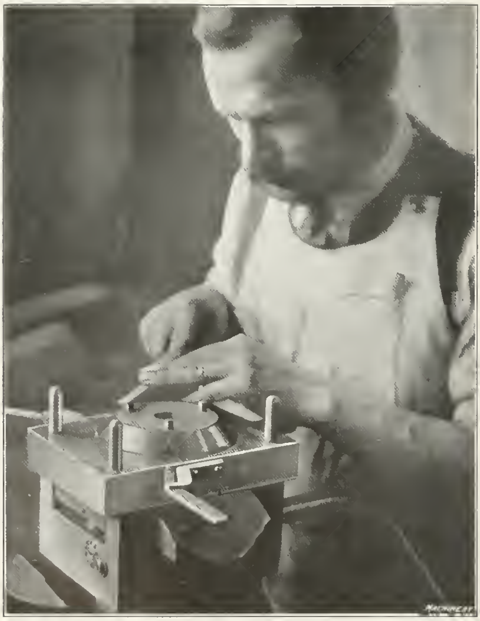


Fig. 28. Fitting Ejector-pins

For the best class of die-castings, the tin base metals are employed. These range from 60 to 90 per cent tin, and from 2 to 10 per cent copper, together with a little antimony. The melting point of a mixture of this composition is from 650 to 675 F. The castings have a good color and they are much better in quality than any of the other alloys. It is absolutely essential that tin base metals be used for carbureter parts or other parts coming in contact wih gasoline. Also, the tin base metals must be used for parts which come in contact with food products, as the lead or zinc alloys have a contaminating effect. A very successful tin base metal can be furnished by the Van Wagner Co. which contains over 30 per cent tin and still is comparatively low in price. This is a good general metal to use and its corrosive qualities are very low.

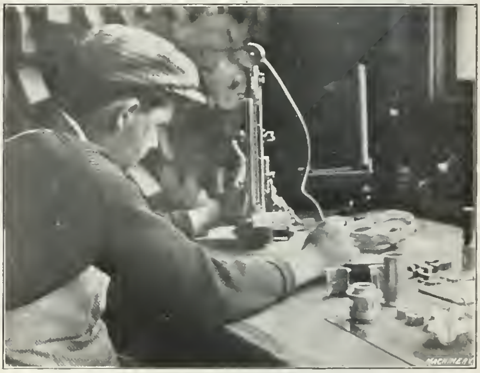


Fig. 29. Inspector using Scleroscope in the Metallurgical Laboratory

Aluminum alloys have been cast in France and Germany in limited quantities, but very seldom in this country on account of their high melting point, as well as their effect upon the dies. After aluminum alloys have been run in the dies for a short time, the surfaces of the molds become pitted. Through some unexplainable cause, the metal seems to flake out particles of the steel in the molds. When an aluminum alloy is to be used, a good mixture is 80 per cent aluminum, 3 per cent copper and 17 per cent zinc. This alloy has a high shrinkage and it has also the same deteriorating effect upon the dies, but to a much less degree than pure aluminum. Fig. 29 shows a corner of the experimental laboratory, in which the inspector is shown subjecting a casting to a scleroscope test. Dies are about to be made for this piece and it is essential to know the comparative hardness of the alloy which should be used in order that the specifications may be taken care of properly. By the use of the scleroscope he is able to get an approximate idea of the hardness of the composition without a chemical analysis, and by comparing this reading with that of a casting of known composition can come very close to the mixture to be used. With this knowledge in hand, he can confer with the diemaker, telling him just what shrinkage may be expected from the alloy.

On the subject of die-casting alloys, as well as many other points of the business, a modern die-casting company can render great service to its customers. Oftentimes, by consultation, an alloy can be selected which will serve all the purposes required at a low cost, and likewise a die-casting proposition can be made far more economical by following some of the recommendations given when designing the piece. It will thus be seen that it is for the mutual advantage of the die-casting user and manufacturer to work in harmony.

* * *

The fire department of Brunswick, Germany, has made exhaustive experiments with calcium carbide to ascertain the practicability of using this material for thawing out frozen pipes and water hydrants. The carbide is sprinkled upon the snow or ice-covered pipes and hydrants and the gas evolved is lighted. It is stated that one of the hydrants that was frozen exceptionally hard, and besides was covered with a very thick coat of ice, was thawed out in 15 minutes. The method, however, is combined with certain elements of danger and should not be employed by inexperienced persons.

TWO DRILL JIG ATTACHMENTS

BY CHRISTIAN F. MEYER

Fig. 1 shows a drill jig *A* with a cast-iron frame *B* set in it. The latter is only partially shown, since the missing part is foreign to the purpose of this article. The frame *B* has a number of finished surfaces *S*, and a large number of drilled holes which are not shown. The finishing of these surfaces and the drilling of all holes is performed in the same jig. It is necessary, however, to perform two other operations before the frame is ready to be placed in this jig. The first operation is to finish the two locating surfaces *Q* in such a way that both finished sides of each of them—shown by dotted lines in the side view—are at exactly the same distance from the center line *Y-Y*. The bottoms of flanges *V* and *W* are finished at the same time. These guiding surfaces serve to locate the frame accurately in the jig for the final operations. Two holes in each of the flanges *V* and *W* must also be drilled before the frame is ready for the last operations, the jig shown in Fig. 1 being designed for this purpose. The frame is lifted into the jig by means of an opening left in the right side for that purpose. It is then placed in position with flanges *V* and *W* under the drill guides *D* and *C*, respectively. As the accuracy of the entire frame depends upon the correct location of these guide holes, the center-line of the frame should be exactly on the center-line between the drill guides before the holes are drilled. When the operation was performed by the old method, the frame was set by means of a soft hammer, the distance from the finished sides *Q* to the center-line of the respective drill guide being measured at frequent intervals. The frame was then fastened by means of bracket *N* and hardened screw *O*, which would press it against stops *E*. Almost invariably, the tightening of these screws would throw the frame out of alignment again. Since the frames weigh 200 pounds, they are very difficult to handle and to set, and it can be readily understood that the work turned out by this jig was inaccurate and took a long time to produce.

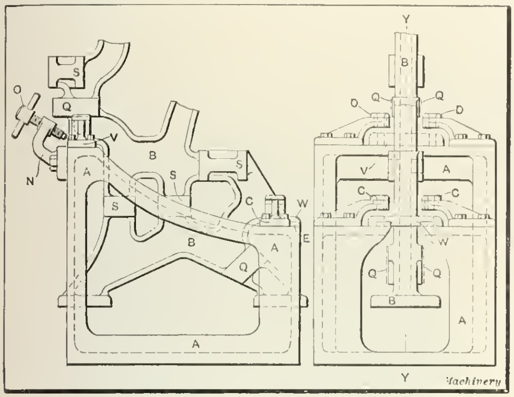


Fig. 1. Original Type of Drill Jig used to machine Frames A

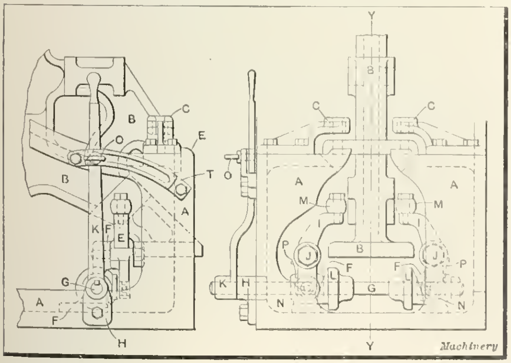


Fig. 2. Improvements made in Design of Drill Jig shown in Fig. 1

As large quantities of these frames were used, it was decided to change the entire process of manufacturing them, even though a considerable outlay was involved. Then the writer of this article constructed two little attachments by means of which the jig is enabled to give excellent results. The attachment for the right side of the jig is shown in Fig. 2. It consists of two brackets *F* fastened to the bottom of the jig at both sides of the center-line. Each of these brackets is provided with a lever *I* swinging around a suitable stud *J*. Each lever has an upper roller *M* and a lower roller *N*. Rollers *N* work against two cams *L* which are fastened upon a shaft *G*, the latter being supported by suitable bores in brackets *F*. The upper rollers of levers *I* work against the finished locating surfaces of the frame *A*. The outer end of shaft *G* is supported by the bearing *H* and is provided with a lever *K*. The latter works in a slotted guide *T* and may be held in any position by means of a screw and nut *O*. Flat springs *P* always press lower roller *N* of levers *I* against cams *L*. The latter may be adjusted on shaft *G* in such a way that their turning will always keep the rollers *M* at exactly the same distance from the center-line *Y-Y*.

The second attachment at the left side of the jig is shown in Fig. 3. It consists of a cast-iron bracket *Z* fastened in place of the old bracket *N* of Fig. 1. A cast-iron lever *P* swings within *Z* on the pin *R*. Lever *P* is provided with a small hardened steel plate *I*, which works against flange *V* of frame *A*. The upper part of lever *P* is provided with a slot in which the guide piece *S* is a sliding fit. The latter has a V-shaped cut-out in front and is fastened in the lever in such a way that the center-line *X-X* coincides exactly with the middle line between the centers of the drill-guides, or with the center-line *Y-Y* of frame *A*. The backward motion of guide piece *S* is limited by a strong spring *J*, the lower end of which is held by two flat head screws, while the upper part is free to swing out. The extension of bracket *Z* holds a steel cam piece *T* by means of stud *M*. The cam piece *T* is turned by handle *N* and engages with a hardened steel plate *G* fastened to lever *P*, thus pressing the steel plate *I* against the flange of the frame. The operator lifts the frame into the jig as before. He next throws over lever *K* (Fig. 2) and the rollers *M*, working against the finished locating surfaces, bring the right side of the frame into exact position. The locking of screw *O* will also hold lever *K*, and consequently frame *A*, in this position, while the rollers *M* permit an easy forward movement against stops *E*. The cam piece *T* is now turned and presses lever *P* forward. Guide piece *S* engages the locating surfaces of frame *A*, thus pushing the latter exactly into line. As soon as *A* has come up against stops *E*, the guide piece *S* will press back spring *J* and so allow lever *P* to tighten frame *A* to any

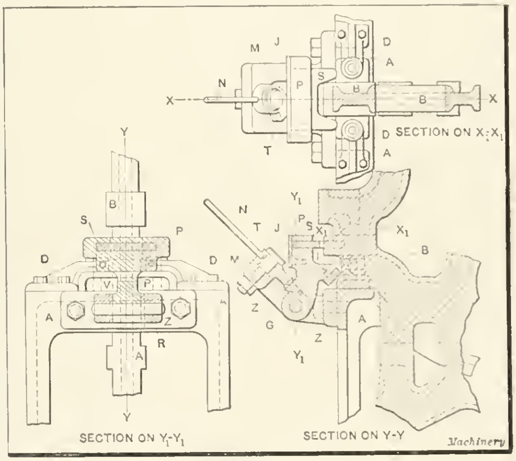


Fig. 3. Detail of Mechanism used to secure the Required Sidewise Adjustment

desired degree. Another feature of the improved jig is that a small strip of metal is cut away to an angle of 45 degrees right in front of stops *E*, as shown in Fig. 2. This allows the chips to fall away and makes the stops of the jig self-cleaning. It will be seen that by means of these attachments every frame is brought into exact position and held there very simply. The efficiency of the jig has increased 500 per cent and every frame is now a sample of accuracy.

---

*Address: Garfield Ave., Wyomissing, Pa.

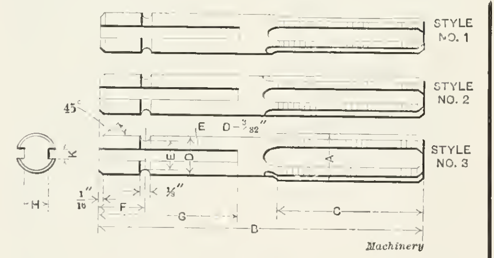
* * *

SPECIAL SHANKS FOR TAPS

When tools for special holders or chucks—such as the Beaman & Smith or the Graham—are to be made, it is often the custom to send a sample along with the order on account of the fact that tables giving dimensions for these shanks are not readily available. This not only causes delay and inconvenience, but sometimes is the cause of a gradual loss of the original sizes or standards. Hence, a table has been compiled applying to taps with shanks which fit the Beaman & Smith and Graham special chucks or holders, these two being the most used of the special chucks with which the writer has had experience. The tables as made up for the Beaman & Smith holders are applied to hand taps, but it is, of course, obvious that tools of any kind, which are suitable to be used in these holders, can be made with shanks of the same dimensions as here recorded. The three different styles of taps referred to in the tables are those with the shank smaller, equal, or larger in diameter than the threaded portion of the tap, as indicated in the engravings.

Besides hand taps, regular Briggs' standard pipe taps are frequently made with shanks to fit the Beaman & Smith holders. When this is the case, taps of 1/8 and 1/4 inch nominal size generally fit the No. 1 holder; taps from 3/8 to 3/4 inch nominal size are made to fit the No. 2 holder; taps from 1 to 1½ inch nominal size are made to fit the No. 2½ holder; and taps from 2 to 3 inches nominal size are made to fit the No. 3 holder. The length of the shank, of course, is made long enough to allow some clearance between the end of the slot cut in the shank and the threaded portion of the tap.

TABLE I. HAND TAPS FOR NOS. 1 AND 2 BEAMAN & SMITH HOLDERS

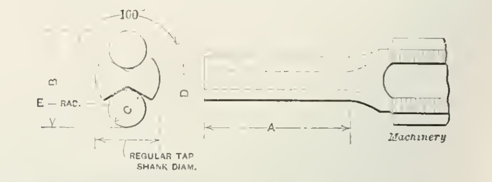


No. of Holder	Diameter of Tap A	Total Length B	Length of Thread C	Diameter of Shank D	Center of Groove from End F	Length of Slot G	H		K		Style of Tap, No.
							Max.	Min.	Max.	Min.	
No. 1 Holder	1/4	2 3/4	1	3/8	5/8	1 1/16	0.24	0.22	0.12	0.11	1
	5/16	3	1 1/8	3/8	5/8	1 1/16	0.24	0.22	0.12	0.11	1
	3/8	3 1/4	1 1/4	3/8	5/8	1 1/16	0.24	0.22	0.12	0.11	2
	7/16	3 1/2	1 3/8	1/2	13/16	1 5/16	0.36	0.34	0.13	0.12	1
	1/2	3 3/4	1 1/2	1/2	13/16	1 5/16	0.36	0.34	0.13	0.12	2
	9/16	4	1 5/8	1/2	13/16	1 5/16	0.36	0.34	0.13	0.12	3
	5/8	4	1 5/8	1/2	13/16	1 5/16	0.36	0.34	0.13	0.12	3
No. 2 Holder	11/16	4 1/8	1 7/8	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	1
	3/4	4 7/16	2	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	2
	13/16	4 3/4	2 1/8	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	7/8	5 1/16	2 1/4	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	15/16	5 3/8	2 3/8	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	1	5 11/16	2 1/2	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	1 1/16	5 11/16	2 1/2	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	1 1/8	6	2 5/8	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3
	1 3/16	6	2 5/8	3/4	13/16	1 3/4	0.54	0.52	0.21	0.20	3

The slot, the length of which is given as *G* in Tables I and II, should be flat or parallel in the bottom for a length equal to that dimension.

The Graham chuck shanks are used also to a considerable extent on drills. Table III gives the dimensions for the grooves in the shanks, and the size of taps for which the different sizes of shanks are to be used. The tap should, of course, be so proportioned that the total length of the shank is slightly greater than the dimension *A*.

TABLE III. DIMENSIONS OF TAP SHANKS TO FIT GRAHAM CHUCKS

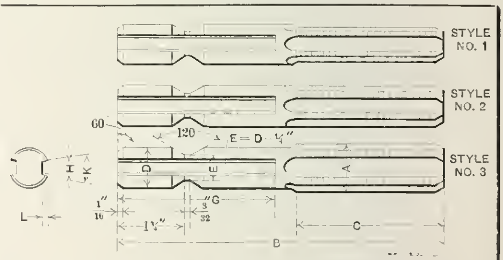


No. of Shank	Sizes of Hand Taps Used for	Sizes of Pipe Taps Used for	A	B	C	D	E
1	1/4″ to 15/16″	1/8″ to 1/2″	1 5/8	0.710	1/4	0.0206	1/64
2	1″ to 2 1/2″	3/4″ to 3″	2 1/2	1.713	3/8	0.0402	1/32

* * *

The cost of workmen's compensation, as arranged under the British compensation act, appears to be insignificant as compared with the great benefits resulting in that disabled working men are not thrown upon the community or charity for relief, but are, so to speak, maintained by the industry responsible for their injuries. According to the returns for 1911, for example, in the coal mining industries, where the compensation charges range higher than in any other industry in Great Britain, the cost due to the working of the act is only 2.2 cents per ton of coal mined. The average payment in case of death was $770 and for temporary injuries, $20.

TABLE II. HAND TAPS FOR NOS. 2 1-2 AND 3 BEAMAN & SMITH HOLDERS

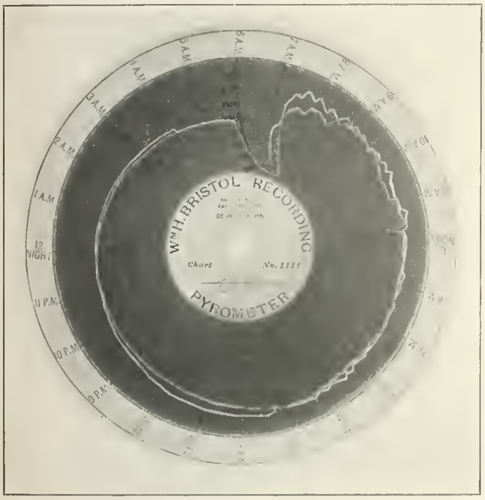


No. of Holder	Diameter of Tap A	Total Length B	Length of Thread C	Diameter of Shank D	Length of Slot G	Width in Bottom of Slot H	Angle of Sides of Slot, Degrees K	Depth of Slot L	Style of Tap, No.
No. 2½ Holder	1	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/16	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/8	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 3/16	6 3/4	2 1/2	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/4	7	2 5/8	1 1/2	2 1/4	1/4	20	3/16	1
	1 5/16	7	2 5/8	1 1/2	2 1/4	1/4	20	3/16	1
	1 3/8	7 1/4	2 3/4	1 1/2	2 1/4	1/4	20	3/16	1
	1 1/2	7 1/2	2 7/8	1 1/2	2 1/4	1/4	20	3/16	2
	1 5/8	7 3/4	3	1 1/2	2 1/4	1/4	20	3/16	3
	1 3/4	8	3 1/8	1 1/2	2 1/4	1/4	20	3/16	3
	1 7/8	8 1/4	3 1/4	1 1/2	2 1/4	1/4	20	3/16	3
	2	8 1/2	3 3/8	1 1/2	2 1/4	1/4	20	3/16	3
No. 3 Holder	2 1/8	9	3 1/2	2	3	5/16	16	7/32	3
	2 1/4	9 1/4	3 5/8	2	3	5/16	16	7/32	3
	2 3/8	9 1/2	3 3/4	2	3	5/16	16	7/32	3
	2 1/2	9 3/4	3 7/8	2	3	5/16	16	7/32	3

ANNEALING HIGH-SPEED STEEL

BY E. D. A.

The writer takes exception to the article by "A" in the December number under the title "Annealing High-Speed Steel." The method referred to as being the one most generally used for annealing high-speed steel is incorrect, in that the temperatures 1900 to 1950 degrees F. are very much too high. Also, the time in heating, of from nine to ten hours, is incorrect, and further, air-slacked lime is only used occasionally for a packing medium; the practice of using pulverized or powdered charcoal to pack the pieces of steel to be annealed is very much more common. The following method is recommended by one of the largest high-speed tool steel manufacturers in America. The writer has compared this method with the methods recommended by other manufacturers and finds that they are precisely the same in all the important points. Particular attention is called to the temperatures to which the steel to be annealed is to be heated, the time necessary, and also, that powdered charcoal is given first, it having the preference over fine air-dried lime or powdered mica.



Temperature Record obtained from an Annealing Furnace

> "In annealing high-speed steel, use an iron box or pipe of sufficient size to allow at least one-half inch of packing between the pieces of steel to be annealed and the sides of the box or pipe. (We call attention here to the fact that it is not necessary that each piece of steel to be annealed be kept separate from every other piece, but only that the steel be prevented from touching the sides of the annealing pipe or box.) Pack carefully with powdered charcoal, fine dry lime or mica. Cover with cap, which should be air tight, but if it is not, then lute on with fire-clay. Heat slowly to a full red heat, about 1475 or 1500 degrees F., and hold at this heat from two to eight hours, depending on the size of the pieces to be annealed. A piece of 2 by 1 by 8 inches requires about three hours time. Cool as slowly as possible, and do not expose to the air until cold. A good way is to allow the box or pipe to remain in the furnace until cold."

A series of experiments was recently made by the writer to determine the proper temperature to which to heat high-speed steel for annealing. It was found that when this steel was heated to below 1250 degrees F. and slowly cooled, as in annealing, it retained the original hardness and brittleness imparted to the steel in forging. When heated to between 1250 and 1450 degrees F., the Brinnell test indicated that the steel was soft, but impact tests proved that the steel still retained its original brittleness. However, when heated to between 1475 and 1525 degrees F. the steel became very soft, it had a beautiful fine-grained fracture, and all of the initial brittleness had entirely disappeared.

In carrying these tests further, to 1600, 1750, and 1850 degrees F., it was found that the steel became very soft, but there was a gradual increase in brittleness and in the size of the grain, until at 1850 degrees F. the steel became again as brittle as unannealed steel; the fracture at this temperature was dull, dry and lifeless, and showed marked decarbonization. Dried air-slacked lime was used as a packing medium in making these tests. The steel was packed in tubes sealed air-tight on both ends. The decarbonization that took place was probably due to the oxygen in the air that had filled the intervening spaces between each minute particle of lime, before it was packed in the tube, attacking the carbon of the steel; this decarbonization would not have taken place if powdered charcoal had been used. The latter would have supplied all the carbon necessary to combine with any oxygen present in the tubes.

The new method described by "A" would be very impractical in that the tools to be annealed are not packed in any medium. Persons acquainted with the heating of tool steel know that all grades of steel when heated to only 1250 degrees F. in the air, begin to scale, due to the oxygen of the air attacking the carbon of the steel. If a piece of steel were heated for even one hour to 1700 or 1750 degrees F., the scale formed would be from seven to ten per cent, in weight, of the total weight of the original piece. This amount of scale would ruin any steel. At the same time there would be a decarbonization extending below the zone of the scale to a depth of fully 1/32 inch. If it were required to subsequently harden such a piece of steel, all of this decarbonized surface would have to be removed before the steel could be hardened by any ordinary methods.

By permission, an annealing chart, taken by a Bristol recording pyrometer, showing the temperature of one of the annealing furnaces in which a well-known grade of high-speed steel is annealed by the manufacturer, is shown in the accompanying illustration. The method, which is carried on by this manufacturer day after day, is to first pack the bars to be annealed in ten-inch diameter wrought iron pipes, about fourteen feet long, the packing medium being pulverized charcoal. Then both ends of the pipes are sealed air-tight with fire-clay. The annealing furnaces are fired with coal and are brought up to 1500 degrees F. at 7 A. M. At this time the large furnace doors are opened and from four to six of the ten-inch pipes, previously packed with steel and sealed, are rolled into the furnace. The doors are then closed and the furnace is continuously fired until 5.30 P. M., the temperature being kept as near to 1500 degrees F. as possible. The chart, which shows two days work, will indicate how well this temperature has been maintained. At 5.30 P. M. firing is discontinued, all holes that might permit the influx of air are closed, and the pipes are permitted to cool down slowly with the furnace. It will be seen, by again referring to the chart, that there is a gradual drop in temperature from the time firing is discontinued until the pipes are taken from the furnace the following morning preparatory to beginning another day's work.

The chart also indicates that the temperature of the annealed steel, when taken from the furnace, is about 1000 degrees F. This temperature is several hundred degrees below the critical point, or recalescence point of high-speed steel, this point being at about 1350 degrees F., so that the annealed bars can be taken from the pipes and permitted to cool to normal temperature without further delay, because after cooling to 1000 degrees F. they would not again become hard without the application of more heat.

The above method is excellent for annealing high-speed steel on a large scale. If it is desired to anneal only a few small pieces of this grade of steel rapidly, they can be "water annealed," by a method similar to that used for carbon steels; the temperature to which the steel is raised, however, is not as high as for carbon steel. In water annealing, the piece to be annealed is gradually and uniformly heated to 760 degrees F. It is then taken from the furnace and plunged into a bath of pure water, previously heated to a temperature of 150 degrees F., where it is permitted to cool until reduced to the temperature of the bath. Afterwards the steel can be drilled, filed, or machined into any form with little difficulty. The more care devoted to the heating, the better the results will be. To heat rapidly will induce internal strains and greatly increase the risk of breakage when the pieces are plunged into the water bath.

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FEBRUARY, 1913

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TWIST DRILL GRINDING

The drilling machine is the most common machine tool in use. Hundreds of plants that have no machine shop have one or more drilling machines for use on repair jobs and other emergency work. In many cases they are operated by unskilled labor, and the drills are ground to all sorts of shapes and angles, few approximating the best form for efficiently cutting metal away to make smooth holes, true to drill size. It may be safely asserted that drills are the most common form of metal cutting tools and also the most abused.

But the neglect and abuse of drills, particularly twist drills, is by no means confined to those situations where unskilled labor is employed for operating drilling machines. Notwithstanding the attention that has been given to the development of cutting tools in the last decade, the drill has been badly neglected. Large plants are in operation using many drilling machines in which practically all the drills are ground by hand. The result is general inefficiency. Drills are broken needlessly, power is wasted and poor work is produced.

Twist drill grinders have greatly improved the conditions where used, but the idea still lingers in the minds of some workmen that they can grind a twist drill by hand better and quicker than on a machine. The notion is a mistaken one. While it is true that an expert can grind a twist drill so that it will cut efficiently, the average operator cannot or will not. Nothing is more common in plants in which the workmen are permitted to grind drills by hand than to find drills dragging on the heel, angles too pointed and other glaring defects that operate against efficient drilling.

More attention should be given to the problem of maintaining drills and drilling machines in first-class condition. Drills and power will be conserved, better work will be produced, and twist drill manufacturers would be spared many complaints as to the poor quality of their product.

* * *

ORDERLINESS IN SHOPS

A clean and orderly manufacturing plant, noted for the high grade of its output, does not produce first-class goods simply because good "housekeeping" is a characteristic of its management, but high-grade machines are generally made where orderly conditions prevail. In workrooms that are dark and dingy dirt is likely to collect on the floor, in corners and on the walls. Tools are left to encumber the floors and machines. Chips pile up and oil soaks the floor. The result is confusion, and the tendency is for the workmen to become slovenly.

Plenty of light shows the disorder, and well-lighted shops are generally clean shops. Light, cleanliness and order go hand in hand. Of course dark shops can be kept clean and orderly: the jigs and fixtures can be kept in the tool-room when not in use, chips can be kept off the floor, and old belts can be carried to the junk room; but more force of management is needed to accomplish these results. Let the light in, and every well-trained man will be ashamed to make unnecessary dirt and litter. A light shop and a clean shop are synonymous.

* * *

SPECIALISTS WHO DO NOT SPECIALIZE IN PRICES

One of the peculiarities of manufacturing in this era of specialization is the fact that specialization in some cases is more apparent than real. Specialized manufacture that does not produce goods for the market at lower prices than the cost of making them without special equipment is a pretense. Take the manufacture of ball and roller bearings as an example. Several concerns make these exclusively, and presumably are well equipped to produce everything in anti-friction bearings needed by machine manufacturers at prices lower than they can be produced in a plant doing a large variety of work. Nevertheless, ball and roller bearings are being made by machine tool builders and other machinery manufacturers for use in their products. Makers of motorcycles make their own roller bearings, using for the most part standard machine tools equipped with a few special jigs and fixtures. It seems very undesirable to complicate the manufacture of a complex machine by making the roller bearings. Why is it necessary? Simply because the bearings can be made exactly as wanted and at lower cost than that at which they can be bought from the specialists.

Is the cost of selling ball and roller bearings so high that the advantages incident to specialized manufacture are lost when the maker comes into competition with a manufacturer who uses the product in sufficient quantity to become a competitor? This question is one that needs the attention of those specialists who apparently don't specialize except for customers who cannot produce for themselves.

* * *

RED TAPE IN MANUFACTURING ORGANIZATIONS

The larger an organization is, the more likely are its activities to be hampered by circumlocution. The purchasing agent stands between the manufacturer and the heads of the departments which requisition his product. When the product is of standardized nature which can be treated like shelf hardware, shovels, sugar or cotton cloth, no particular harm results perhaps, when a specific make of goods is not ordered; but in the case of specialized machinery requiring skilled attendance and perhaps a certain degree of adaptation to the work on which it is to be employed, the situation is different.

The makers of certain classes of machine tools find their efforts greatly hampered in dealing with large corporations when they attempt to render special service. The head of a department may know exactly what he wants and may be a very desirable customer, but when his requisition must pass through the hands of a cold, unsympathetic purchasing agent having little appreciation of the conditions to be met and the need of personal conference of the interested persons, then dissatisfaction is likely to ensue.

Large corporations are at serious disadvantage when compared with small concerns in this respect, and perhaps this and other factors limiting expansion are fortunate for the well-being of the smaller firms; but in some businesses, especially that of transportation, which are necessarily large, improved methods of transacting business are badly needed. The improvement required is simplification of the method of buying and the injection of common sense. When buyer and seller should meet on common ground to discuss the special requirements of a given case the opportunity should be afforded.

METHODS OF OILING MACHINE TOOLS

The article by Mr. Horner on methods of oiling machine tools, begun in another part of this number, illustrates a large number of oiling devices, more or less conventional, many of which are in common use or have been employed on machine tools and other machinery. The review undoubtedly will be found of interest and value by mechanics and machine designers generally. Among the large number of oiling devices shown, some few must be better than all of the others for general purposes. The question of determining which are the best may not be easy to answer when the factors of first cost, ease of application, convenience of use and reliability of action are all considered. In view of the importance of lubrication generally, especially of high-speed machinery, every reader will find it well worth while to study these oiling devices, and weigh their respective advantages and disadvantages.

While considering the relative merits of the conventional designs, we should not lose sight of the fact that individual oil holes which are supplied by the operator from squirt-cans, are likely to become obsolete in the near future. High-grade machine tools and machinery generally will soon be self-oiling in the sense that the machines will automatically distribute oil from a central receiver to all their principal bearings. For this reason, perhaps the choice of the best device will necessarily be a flooded lubrication system, one example of which is shown.

* * *

PROCESSES FOR WORKING AND SEPARATING MATERIALS

The development of automatic machinery for working cloth, tissue, paper, fibrous materials, hair, bristles, etc., often requires ingenuity of a higher order than for working metals or other materials of firm constituency. Sheet metal, for instance, can be depended on to hold a definite shape irrespective of the influence of gravity or air currents. It can be grasped by jaws or fingers and can be pushed or pulled. Cloth in sheets can be fed readily, but when cut up into small pieces it becomes unmanageable with ordinary appliances. Paper, likewise, is capable of being easily handled in continuous rolls, but offers difficulties when cut into sheets or small pieces. Compressed air is used to separate sheets for feeding to printing presses, and fingers terminating in suckers or vacuum cups are successfully employed to handle small pieces of paper. Fibrous materials, tobacco, shredded wood, steel wool, cotton, waste, etc., offer peculiar difficulties when separating into small lots of definite weight. Feeding and cutting devices cannot be used in some cases because of damage to the fibers or because the sharp raw edges are not permissible. To divide steel wool into pound lots and pack it into cartons, for example, is a problem of no small difficulty. The material collects in irregular masses in the process of manufacture, and it cannot be cut apart to use for the purpose intended without damage. To wrap crackers in neat boxes is another problem which has been solved and for which there were few precedents.

In the separation of certain natural products, advantage is often taken of structural peculiarities. Bristles used for paint brushes must all be arranged with the "flag" ends the same way. To do this by picking them apart by hand and turning around "end to end" is out of the question, and it is hardly practicable to design a machine that would accomplish the proper arrangement by any of the common selective processes. But the fact that hair and bristles have surfaces covered with hooked scales all pointing toward the flag or outer end, enables the separation by a simple operation to be quickly and easily accomplished. A bunch of disarranged bristles will separate longitudinally when rolled back and forth between the hand and a table, the individual bristles moving butt end ahead. A few passes back and forth suffices to separate them into two groups, each group having the butts together. These can then be readily picked up and laid together with the butts and flags together.

Each material to be worked must be studied, and some individual peculiarity seized on to make it follow the course required. That method which will work well with one may be impracticable with another. Vacuum cups, of course, cannot be used on ordinary cloth as effectively as on paper. Gravity may be effective in one case and ineffective in another. Shaking or rocking motions which separate straight pins from crooked ones will not work on other shapes. Magnets which effectually pick out bits of steel and iron from grain are ineffective on stones. Hence a variety of means may be employed for cleaning a material. For example, in the cleaning of grain, advantage is taken of air currents, specific gravity, inertia, shape, size, elasticity, magnetic induction, etc.

* * *

THE VALUE OF A UNIFORM ACCOUNTING SYSTEM

The marked tendency of business in the last decade has been in the direction of eliminating competition by effecting combinations of competing concerns or making agreements which insure stability of trade. That these combinations have been made the cloaks for monopoly, restraint of trade and various nefarious practices distinctly illegal, has been only too apparent. The tendency to combine has been checked by the enforcement of the Sherman anti-trust law, but men having come to a realization of the wastefulness of unintelligent competition, are still seeking to eliminate such competition wherever possible, through cooperation.

Ruinous and foolish competition often results from manufacturers not knowing what their product actually costs to produce. Owing to this common ignorance, many products are under-priced or over-priced, especially when they are part of a large line of manufactured goods. If the manufacturer always knew exactly what it cost to produce each article, he would not be likely to place an article in competition with another, at a price below its actual cost of production.

Working on this assumption, some manufacturers are endeavoring to bring about the adoption of uniform systems of accounting in their respective trades, believing that the adoption of uniform cost systems will tend to eliminate destructive competition. Under the various systems of cost accounting now in use, there is often a lack of definite knowledge as to the cost of repair parts, or machines and other products built as part of a line. The cost systems are frequently defective, and the aim is to eliminate the faulty systems and bring about the adoption of certain principles of accounting which will provide manufacturers in competing lines with essentially the same system of costs. They will, it is argued, be more likely to place rational prices on their products.

The value of a uniform accounting system can hardly be overestimated. It would open the eyes of many manufacturers to losses hitherto unsuspected, and present the cold facts as to losses incurred in striving to outdo the other fellow by cutting prices. If prices are cut below actual manufacturing costs, the loss is plainly apparent, whereas some systems of cost accounting now in use are so irrational that the actual condition does not become apparent until heavy losses have been sustained.

* * *

As concrete floors have come into use, certain faults have developed. One of the most common objections is that of the men who complain that a concrete floor is "hard on the feet." A concrete floor is no "harder" to stand on all day than a wooden floor, but it is a much better conductor of heat, and it is now generally known that the tiring, chilling sensation of the concrete floor is due to its comparatively low temperature and high heat conductivity. When the floor is warmed, the "hardness" on the men's feet disappears. But another and real hardness remains which is of serious importance to manufacturers, especially those whose product includes many small cast-iron parts. It has been found that breakages are greatly increased. A casting dropping on a wooden floor from a lathe is seldom injured, but if it drops onto concrete it is very likely to fracture. Some machine builders have noted a very serious increase of casting breakages from this cause alone, and for this reason concrete is objectionable for machine shop floors, especially for light work.

FIXTURES FOR MACHINING EXHAUST PIPES

BY W. L. MYLES*

The following illustrations show a number of special fixtures which are used in one of the large gasoline engine manufacturing plants for machining a new style of exhaust pipe. These pipes are of the water jacketed flanged type and all of the turning and drilling has to be accurately performed in order that the work may fit properly when it reaches the assembling department. Fig. 1 shows one of these new style exhaust pipes assembled on the engine, and by referring to this illustration the arrangement of the different sections of the pipe will be clearly understood.

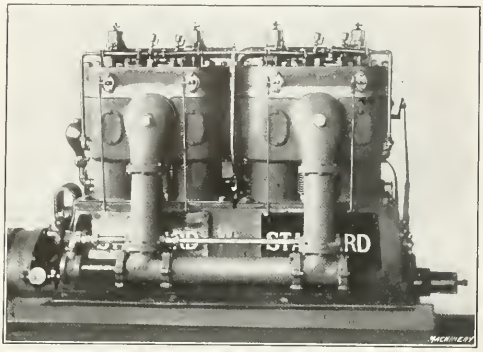

Fig. 1. View of Engine showing Assembled Exhaust Pipe

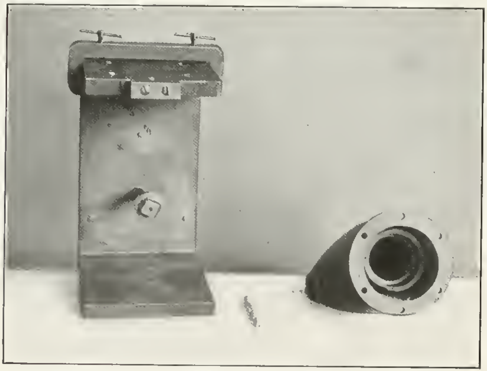

Fig. 2. Fixture for drilling Holes in Flanged End of Header

Fig. 2 shows the fixture which is used for drilling the holes in the flanged end of the header which bolts onto the engine cylinder. The casting is secured to the vertical plate of this fixture by the bolt shown in the illustration, the work being located in the desired position by means of the three pins which fit the outer flange of the header. The holes are drilled through the bushings in the horizontal plate at the top of the fixture, which locates them in the required positions.

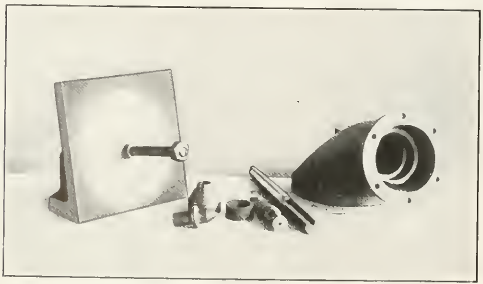

Fig. 3. Fixture for boring and turning Inside of Header

Fig. 3 illustrates a fixture for turning and boring the inside of the header to receive the water-jacketed pipe on the exhaust tee. In order to operate properly, this joint must be a tight fit, and consequently the work must be done with considerable accuracy. The header is secured by the bolt on the angle-plate fixture, which is bolted on the faceplate of the lathe. This brings the work into the required position for turning the flange and boring the inside of the header, the final form of which is shown in the illustration.

The fixture shown in Fig. 4 is used for drilling the holes in the flanged ends of the vertical pipe and also the hole for the water piping in the side of the vertical pipe. The work is located in this jig by means of the bosses on the plates which carry the bushings. These bosses fit into the inside of the pipe and center it, ready for the holes to be drilled through the bushings in the jig plates. The small drill shown in this illustration is then mounted in the drill press, and the six holes in the flanged ends of the pipe are drilled; the jig is then turned over on its side and the large holes for the water pipe are drilled.

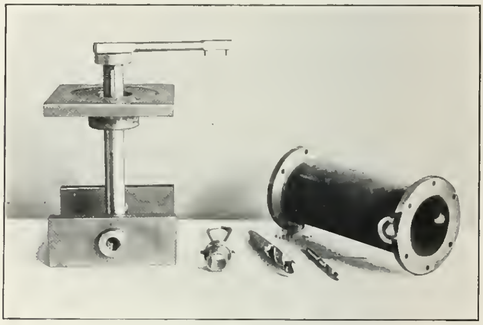

Fig. 4. Fixture for drilling Flanges and Holes for Water Pipe

The fixture shown in Fig. 5 is used for drilling holes in the flanged ends of the horizontal pipe connecting the two upright parts of the exhaust which are bolted to the engine. The pipe is centered in this jig by means of the pins *D*, which fit in either side of the extensions on the flange. When centered in this way, the holes can be drilled through the jig guides in the usual manner. When the holes in one end are drilled, the jig is reversed and the other end of the pipe is drilled.

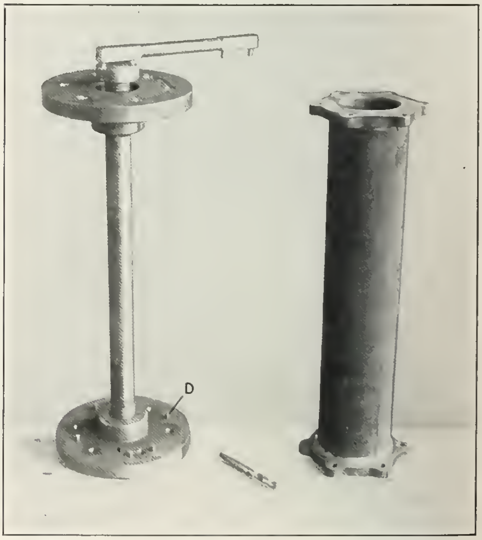

Fig. 5. Fixture for drilling Holes in Flanges of Horizontal Pipe

Fig. 6 shows a fixture for drilling and reaming the bolt hole in the exhaust header. The work is located in the angle iron in the exhaust header. The work is located in the angle-iron fixture by means of the small pins which fit into the holes in the flange and thus locate the work in the desired position. The hole is then drilled through the guide in the swinging arm. The construction of the jig will be readily understood by reference to the illustration. All of the fixtures are so made that they require no bolting or strapping to the drill press when drilling the holes, thus appreciably shortening the time which was formerly taken in securing the pipes to the drill press under the old method.

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The special advantages of this type of exhaust pipe are that it can easily be assembled and taken apart; also that the pipe is constructed in such a way that any one part can be taken out and renewed without requiring the entire pipe to be taken down, as in the case of the commonly used design of exhaust pipe for motor boat engines, which is of the screwed-together type. The present type of pipe is made entirely of cast iron, so it is not affected by the corrosive action of salt water as wrought iron pipe would be. As most of the machine work in this shop is done on the bonus plan, it can be readily seen that with these improved and adaptable fixtures, the cost of machining the work is greatly reduced.

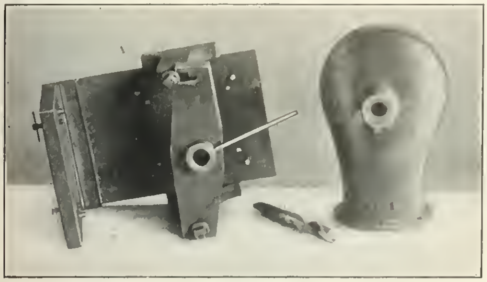

Fig. 6. Fixture for drilling and reaming Bolt Hole in Header

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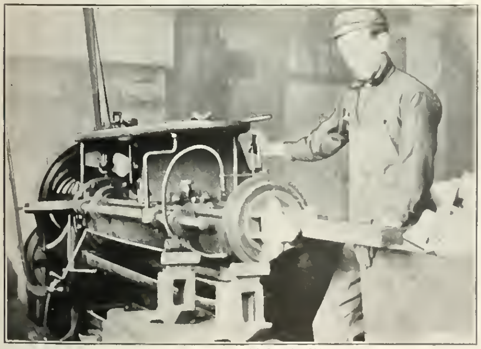
BROACHING THE SQUARE HOLES IN VISE BODIES

We are accustomed to thinking of broaching operations as confined to the cutting of keyways and irregular-shaped holes of comparatively small dimensions. At the Reed Mfg. Co.'s shops at Erie, Pa., the broaching process is being used for finishing the square holes through which the sliding jaws of their vises operate. The old method of finishing these holes was to chip away the bulk of the stock, finishing by filing. Of course in casting, the holes are cored as closely as possible to size.



Broaching the Square Holes in Vise Bodies

The illustration shows a broaching machine made by the Lapointe Machine Tool Co., Hudson, Mass., which is employed for broaching the holes in these vise bodies. Of necessity, the broaches used are heavy, and, of course, different sizes must be used for the various sizes of vises. The broach is cut with one side left blank or without teeth, except for the first quarter of its length. In operation, the broach cuts evenly on all four sides for one-quarter of the distance, just enough to clean out the cored hole. From this point on, the blank side of the broach slides over the work, allowing the other side of the broach to remove the excess metal. In this way the excess metal is always removed from the same side of the vise body, and it is possible to keep the work to a standard, thus insuring the alignment of the jaws in the finished vise. In order to keep the broached hole parallel with the base, the vise castings, while being broached, are held against a special supporting plate that is bolted to the head of the machine.

In addition to the better quality of work secured by this method, the rate of production is materially increased, it being possible to broach about twenty of these holes per hour, which is greatly in excess of the number which could be fitted by hand chipping and filing. C. L. L.

* * *

SELECTING THE CUTTER FOR MILLING SPIRAL GEARS[*][†]

BY GEORGE W. BURLEY[‡]

As is well known by all mechanics, a number of different shapes of cutters are provided for cutting spur gears of any given pitch, the shape depending upon the number of teeth in the gear to be cut. Thus, for example, there are eight different shapes used for spur gears of the same pitch, according to the Brown & Sharpe system for involute gear teeth. This series of cutters takes care of any number of teeth from a pinion of 12 teeth to a rack. The fact that a certain cutter is suited to cut a 12-tooth spur gear, however, is no sign that it is suitable for cutting a 12-tooth helical gear, since the fact that the teeth are cut at an angle considerably alters their shape. The cutter to be used when milling spiral gears, therefore, does not correspond directly to the number of teeth in the gear to be cut, but the number of teeth is found by the formula

$$N_1 = \frac{N}{\cos^3 a}$$

in which

N_1 = number of teeth for which the cutter is to be selected,

N = actual number of teeth in the spiral gear,

a = the angle of helix or spiral.

It involves a rather lengthy numerical calculation to obtain the value of $\cos^3 a$, and therefore the table in the accompanying Data Sheet Supplement has been prepared to facilitate calculations of this kind. This table gives the value of $\frac{1}{\cos^3 a}$ which has been termed K in the table. When having access to this table, all that is necessary, in order to find the cutter for any given spiral gear, is to multiply the actual number of teeth in the spiral gear to be cut by the factor K as given in the table opposite the angle of spiral. The product thus obtained gives the number of teeth for the cutter to be selected.

As an example, assume that the angle of spiral is 30 degrees and that the actual number of teeth in the spiral gear is 18; then in order to find the number of teeth for which the cutter is to be selected, multiply 18 by the factor K found in the table opposite 30 degrees. This factor is 1.540; hence, $18 \times 1.540 = 28$, approximately. Therefore, a spur gear cutter for 28 teeth should be used. According to the universal system for these cutters, a No. 4 cutter is to be selected.

The simplicity of this calculation, as compared with the process when the third power of the cosine of the spiral angle must first be obtained and then the actual number of teeth divided by this value, is apparent. The table, therefore, will probably be highly appreciated by many of the readers of MACHINERY who frequently have to deal with spiral gear calculations.

* * *

The fire losses in the United States and Canada, during 1911, amounted to about $235,000,000. The cost of fires each year is equal to one-half the cost of all the new buildings erected in a year.

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[*] See also, "To Find the Number of Cutter for Spiral Gears," MACHINERY, September, 1907.

[†] With Data Sheet Supplement.

[‡] Address: University of Sheffield, St. Georges Square, Sheffield, England.

METHODS OF LUBRICATING MACHINE TOOLS[*]—1

A REVIEW OF OILING DEVICES AND SYSTEMS OF DISTRIBUTION

BY JOSEPH HORNER[†]

Among the many and varied aspects of machine-tool design and operation, that of the lubrication of the moving parts forms one of the most interesting features. Far more attention is now paid to this detail than was the case formerly. The higher speeds and duties which prevail, the use of geared drives, and the practice of boxing-in portions of mechanism have all had their effect upon the methods of lubrication, and many new and improved devices have developed and come into general use. The tendency is always to render the lubrication as far as possible automatic in the most complete systems, so as to obviate frequent attention on the part of the attendant and to minimize the consequences of neglect. The details of construction of machine tools are so complex and varied that it is not surprising to find a multitude of ways of supplying oil to the different elements, and we propose to deal with the principal of these, with the help of typical illustrations.

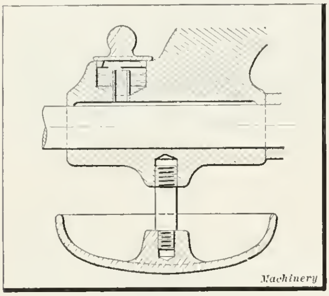

Fig. 1. Distribution of Oil supplied by Wick and Oil Groove

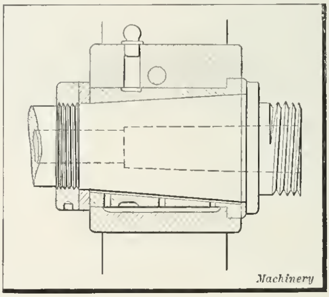

Fig. 2. Bearing with Reservoir and Drilled Bushing

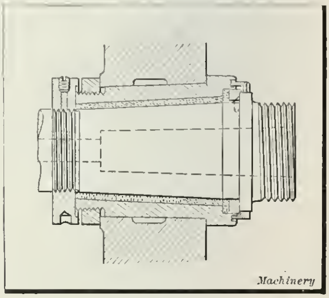

Fig. 3. Showing Felt Pads at Opposite Sides of Bearing

The question of lubrication divides itself naturally into two main heads, *viz.*, supply and distribution. Subsidiary to these are, the prevention of loss before the oil has done its work, the prevention of access of dirt to the surfaces, and the final catching after it has left the surfaces, with or without immediate return. In many instances it is necessary to prevent escape of oil onto belts and surfaces where its presence is undesirable.

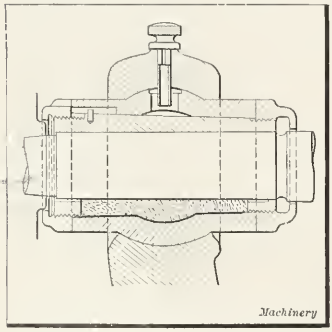

Fig. 4. Showing Felt Pad and Spring in B. & S. Grinder Head

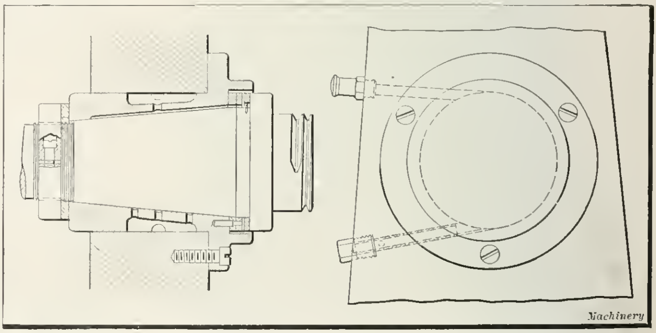

Fig. 5. Spindle Bearing with Reservoir and Distributing Holes (Garvin Machine Co.)

Oil supply is effected by gravity, by pressure, by capillary attraction, by a mechanical lifting action which raises oil from a well, or by contact, through the medium of wicks, pads, or rollers. Distribution is effected by rows of holes, or grooves, by wicks or pads laid suitably, by rollers, or by the splash method.

Such diverse conditions are met with that it is impossible to claim any particular mode of lubrication as being the best for shafts or slides. The speed of rotation may make a vital difference in the results, or a method of oiling that is quite satisfactory in one machine may be undesirable or impracticable in another, on account of inaccessibility of the parts or great increase of pressures. With the use of the boxed-in geared drives in so many types of machine tools the difficulties of reaching the parts have increased, and some rather elaborate devices have been evolved for supplying and catching the oil without having recourse to the removal of covers. Pipes naturally play an important part in the conduction, and there is often extensive drilling of shafts and bearings for the purpose of conveyance from the outside.

Similarly, in the means provided for distributing and catching the oil, widely varied methods are adopted, ranging from simple pots or troughs under open-ended bearings to the highly-elaborated systems in which a forced supply is fed to the bearings, and is completely collected from these and returned to the sump for use over again. The latter system, if properly embodied in the design of a machine, is the best solution of the lubricating problem, since the supply is constant and ample, and the trouble of attending to numerous lubricators is obviated. More thorough flushing of the bearings is also insured, and any dirt is carried away quickly, instead of being churned up for a considerable period, to the detriment of the surfaces, while cooling is more effectual also. With the same idea in view it is often the practice to obtain the oil for the journal bearings of a gear-box from the well in which the gears splash around, in place of providing each bearing with a separate well.

One of the greatest differences which affect the lubricating problem is the quantity of oil which has to be supplied, and this depends on the function of the moving part. It it runs at a good speed, under considerable duty, a copious supply is essential to prevent cutting and heating, but if the movement is slow or intermittent and the work light, a simpler system meets the case. In sliding ways which run at high speeds and carry much weight, ample lubrication is imperative, while on the other hand such parts as cross-slides, and tool-boxes, etc., which move slowly or intermittently will retain their film of oil for a long period without a fresh supply. The horizontal or vertical dispositions of sliding surfaces also make some difference in the amount of oil which can be fed. Certain horizontal ways admit of flooding without inconvenience, while this cannot be done with a vertical slide, nor would it usually be necessary.

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[*] For similar articles on machine tool details previously published see: "Machine Handles," June and July, 1912; "Forms of Lathe Beds," January and February, 1912; "Adjusting Strips or Gibs on Machine Tools," April, 1911; "Types of Milling Machine Braces," July, 1911; "Clamps and Locking Devices Applied to Machine Tools," December, 1910; "Machine Stops, Trips and Reversing Mechanisms," September, 1910.

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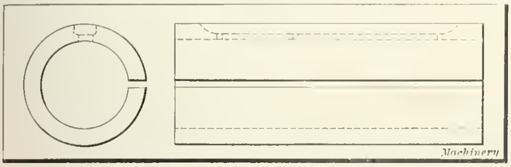

Fig. 6. Bushing with Long Slot and Oil Hole

Even though ample lubricant is fed to a bearing or slide, this is of little avail unless distributed correctly and evenly, so that no parts of the surfaces become dry. It is not sufficient to drill a hole and trust that the oil will get between two surfaces beyond the vicinity of the hole, although this is often done in cheap work. The oil must be distributed to right and left in a definite manner, with due allowance for possible clogging. The two chief methods of effecting the spreading are grooves or channels, and pads of felt. The first-named is satisfactory provided the quantity fed in is sufficient to carry it the required distance; the latter has the merit of absorbing a good deal of oil and keeping the surfaces moist for a period even after neglect, and it also prevents the access of grit if properly fitted, which grooves alone do not. Sometimes a compromise is made, using grooves and pads together. If the pads are let into a well of oil, a certainty of supply is guaranteed, though this will not distribute such an amount of oil as some other methods.

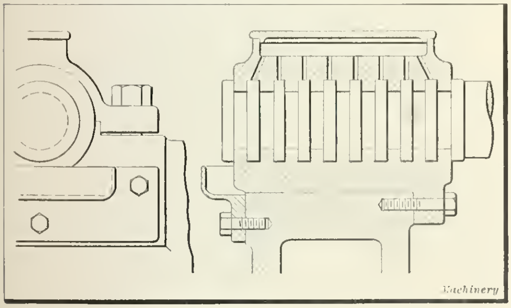

Fig. 7. Thrust Bearing with Oil Supply to Each Collar

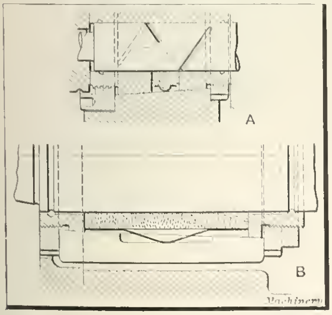

Fig. 8. (A) Narrow Pad in Bath Grinder Spindle. (B) Long Pad on Plain Spindle Landis Grinder

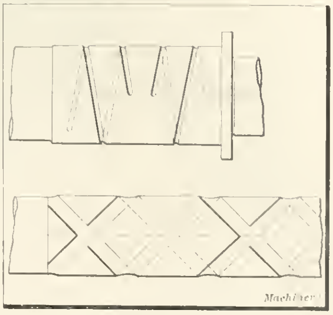

Fig. 9. Single and Double Grooves for Oil Distribution

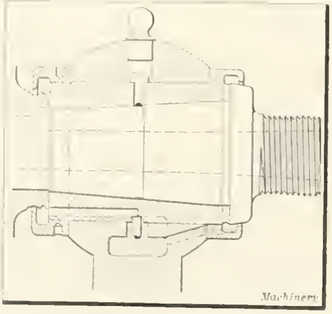

Fig. 10. Section through Hendey Ring-oiled Spindle

The arrangements for catching and draining oil from a surface or bearing influence the mode of feeding to a certain extent, and the two must be intimately related. A copious quantity of oil does not do much good if it is permitted to run out quickly and has to be collected in a primitive fashion, with inevitable waste and soiling of the machine. Under the pump and flooded bearing system this is practicable, but for ordinary use a moderate amount supplied at intervals is better. When, however, each bearing is self-contained, with a ring-oiling or similar system, the amount of oil passing constantly is not restricted, but depends on the method of lifting adopted. There is no waste here, because the oil from the surfaces returns to the reservoir and is carried again to the points at which it is needed.

The methods of feeding lubricant vary with circumstances and include: 1. The simple oil-hole, fed from a can, with no means of retaining a supply. 2. The Stauffer class of cup with forced feed, obtained by screwing down a cap or plunger. 3. The siphon cup with a wick feeding continually by capillary attraction. 4. The grease-cup device with constant feed by spring pressure. 5. The distributing box system with pipes and control taps to admit certain quantities of oil to the leading-out pipes. 6. The needle lubricator in which the feed is produced by the vibration caused by the rotation of the shaft. 7. The oil-well or reservoir which is filled to a definite depth, and serves to lubricate by wicks, etc., or by the splash method for a long period. 8. The force-pump which delivers a large amount of oil to one or several locations.

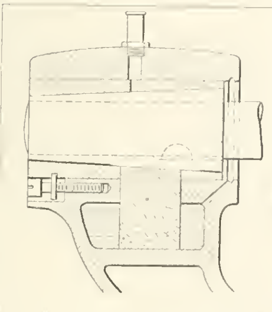
Fig. 11. Wilmarth & Morman Pad and Reservoir System

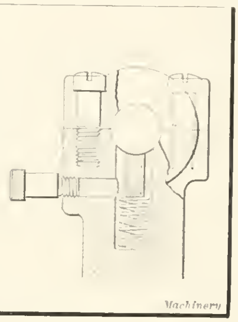

Fig. 12. Builders Iron Foundry Pad and Reservoir System

It is necessary to provide some way of observing the supply of oil. Many of the wells and lubricators may be inspected by opening a cover or door, or moving back a slide. Where, however, there is no means of readily accomplishing this inspection, sight or gage-glass tubes are fitted in which the height is visible, or a glass window is attached to the wall of a box or well. Glass-bodied lubricators often take the place of those with solid metal bodies in places where they are permissible. Occasionally a float gage is utilized to indicate the level of the oil. With a gear-box of ample capacity, no indicator may be necessary, since a certain amount is poured in, sufficient to last for so many weeks or months; and in the case of some ball-bearings a grease supply sufficient for a year or so is put in and the casing closed up.

The access of dirt and grit is guarded against by using strainers and filters. In a well system of lubrication the sediment naturally falls to the bottom, and care should be taken that it is not stirred up again; in fact many bearings embody provision for keeping the sediment quite out of the way where it cannot possibly be returned. Drain-plugs at the lowest position provide for the drawing-off at intervals. When using felt pads, there is opportunity to make these assist in keeping the surfaces clean by a wiper-like action which prevents access of foreign particles between rotating or sliding faces. The amount of protection which must be afforded to bearings and parts depends on the nature of the processes carried on, or what is done in the shop besides. Anything in the way of grinding demands rigorous guarding of all openings where access is possible, and felt pads and disks are used largely for such purposes.

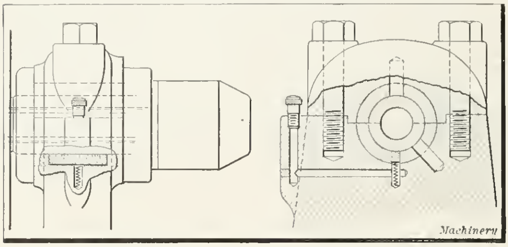

Fig. 13. Pad and Reservoir System with Supply from Side

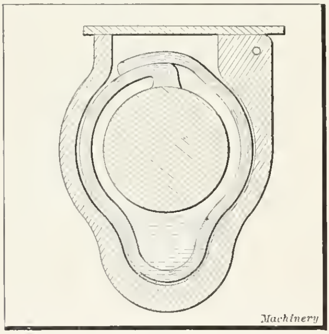

Fig. 14. Reed Wick Oiling System employed in Place of Pads

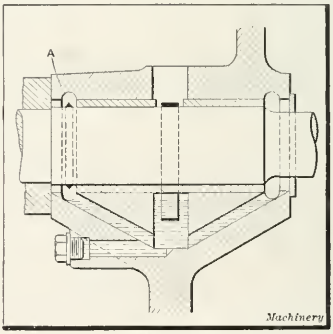

Fig. 15. Ring-oiled Bearing showing Throw-off Collar

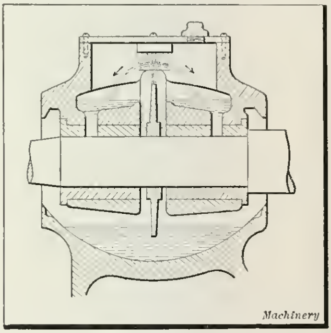

Fig. 16. Bearing lubricated by Disk and Distributing Box

As mentioned, the most primitive mode of oiling is that of drilling a hole and pouring oil in, leaving it to work its way along the bearing. An advance on this is to groove the bearing, as seen in Fig. 1, so that distribution takes place properly, and to fit a constant feed—in this case, a siphon pipe and wicking. The waste that drips from the bearing ends is collected in the drip-cup. Such a bearing is very suitable for light and moderate duties, and will run for a long period without attention, although it is not so suitable for high-speed shafts which require flushing and continual movement of the oil to let them run cool and smoothly. On many bushings and bearings the oil is distributed, not by a single hole and groove in the journal, but instead a long slot is cast, Fig. 6, and several holes are drilled through. This is convenient in some cases, especially where bearings are difficult of access, and where they have a longitudinal movement which would bring a single feeding opening out of the range of a pipe. Two holes are also often drilled through near to either end of a long bearing, so as to insure a distribution from both ends.

Fig. 2 illustrates a spindle-box construction (for a Hendey Lincoln miller) in which the outside of the bushing has a groove turned in it for the purpose of allowing the oil which is fed in through the plugged hole to pass round and down into the chamber in the box. Sufficient oil is introduced to rise up through the holes and spread by way of the groove all along the spindle body.

In the Garvin millers a drilled box is fitted (see Fig. 5) and is recessed to form a reservoir, the oil passing through the holes and along the grooves. The thrust washers are grooved also to distribute the lubricant. The oil-cup at the top and the drain-plug at the bottom are seen in the end view.

Thrust journals constructed with a number of collars may be lubricated on the separate passage system, Fig. 7, a hole for each collar leading from the common reservoir. This example is taken from a heavy planing machine table-driving screw; the illustration also shows the application of a trough below the end of the bearing to catch waste, a fitting that is very commonly used in various types of screws and other bearings that come at the ends of framings. Alternative practice is to cast a well below the collars of sufficient width to include them all, and fill this. The collars then are constantly smeared, avoiding the possibility of one or more running dry due to the hole being blocked with some foreign substance, as may happen with Fig. 7.

Examples of various methods of applying felt pads for distribution are seen in the following illustrations, either being used alone, or in combination with grooves in the bushing or on the shaft. The felt not only insures a supply of oil on every part of the journal that it touches, but it filters the oil as well, and prevents the passing of grit or particles of metal. The pads are fitted into slots cut in boxes or bushings, and either dip into a well, or are simply fed through holes by a cam, or from some type of lubricator. Fig. 3 shows a bearing with two felt strips laid in slots in the bushing, no oil distributing grooves being cut, because the strips are equal in length to the running surface. Fig. 4 from a Brown & Sharpe grinder wheel head, illustrates the fitting of a long felt strip, pressed up by a curved spring. The oil falls from the leading-in tube and passes around the annular chamber in the bearing. Fig. 8, *A* and *B*, from Bath and from Landis grinders, respectively, show the use of a narrow, and of a wide pad; in the first case the oil is carried to right and left by the grooves on the spindle; in the second there are no grooves. Both examples have collecting chambers in the bearings and channels to return to the pocket containing the pad. Fig. 9 represents two other arrangements of grooves on shafts. Many firms now favor this practice instead of cutting grooves in the bearings, the advantage being that the rotation of the shaft carries the oil along positively.

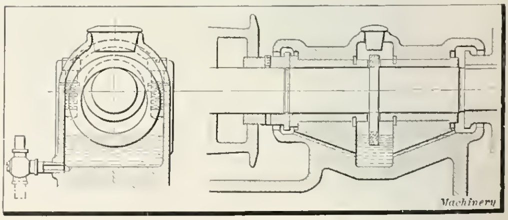

Fig. 17. Ring-oiled Bearing for Disk Grinder

The pad is often let into a capacious well holding sufficient oil to last for a long period (Fig. 11) with provision for the return of the waste oil by a channel from the end or ends of the bearing. Figs. 12 and 13 show two variations in practice, the first having a side fed well, and a pad contained in a brass holder pressed by a spring, and the second a modified arrangement, with the oiler set vertically. This disposition is sometimes more convenient for certain machines than placing it on top of the bearing cap, and there is the advantage that grit cannot reach the spindle, as it may when the supply is poured down from above. Alternatively to the fitting of a pad, wicking is sometimes adopted, Fig. 14, feeding to the top side of the shaft, the ends being joined to prevent displacement. One or two such wicks are provided, according to the length of bearing. The system most extensively employed for spindles and shafts is the ring-oiling method, which insures a larger flow than is caused by the pad device. It is used in conjunction with a reservoir for each bearing, or with a reservoir or box common to several bearings. If a gear-box, for example, has a body of oil into which the gears run, passages can be arranged to lead to the bearing wells, which simplifies arrangements. Or the bearings may be constructed in a self-contained manner if they lie out of the plane of the oil box. Fig. 10 shows a section through a typical ring-oiling bearing, with a well of moderate capacity, and channels for the return of oil into it. It will be noticed that the hub of the gear to the left has a vee-shaped projection turned on it to prevent the passage of oil, which is thrown off this high part into the recessed collar-nut; and when the spindle comes to rest, the oil on the surface drops off into the collar, as it does also at the front, from the highest portion of the shoulder. A drain hole extending laterally provides for cleansing.

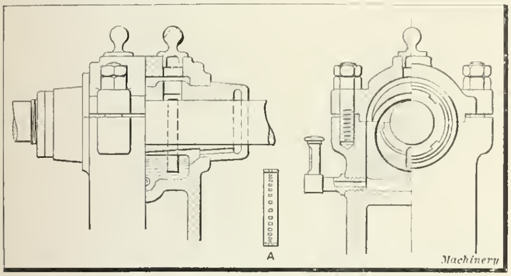

Fig. 18. Bearing with Two Oiling Rings and Height Gage. (A) Perforated Ring

The two sectional views, Fig. 17, give an example of a long bearing (for a disk grinder) with a ring, and grooved brasses. A capacious well is cored out, with a draining pipe, which is turned downwards to empty. When in the vertical position indicated, the well is filled until the pipe is filled nearly to the top, and the inlet is then plugged. The square shoulders on the pulley collar and the disk throw the oil off into the annular recesses whence it drains down into the well.

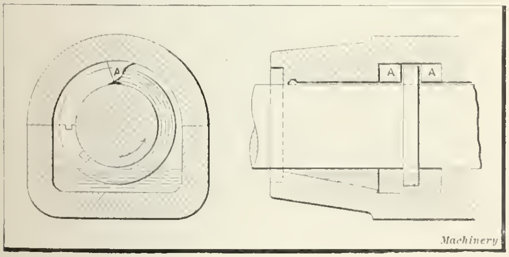

Fig. 19. Builders Iron Foundry Ring and Scraper Method of Lubrication

A common device to prevent creeping of oil along the shaft to the outside of the bearings is a vee-shaped ring, *A*, Fig. 15, which throws the creeping oil off into the recess. At the other end the bearing is sealed by a washer, and any oil coming against the face of this runs down to the drain channel. Another mode of arresting the creep which often takes place while a shaft is at rest, is to turn a shallow groove near each end; the oil will not pass this, but will travel so far, and then collecting at this point will drip from there into the reservoir, or into a channel communicating.

In long journals it is often the practice to employ two oiling rings to provide greater quantity and better distribution of the lubricant. An instance of this is seen in Fig. 18, whch also illustrates the gage-glass fitted to observe the height of oil. Sediment collects in the well at the bottom, out of the range of the rings. In a few cases the plain ring is not employed, because it will not lift enough oil for the requirements of the bearing, particularly if it should not happen to run freely in consequence of thickening of the oil. Some kind of auxiliary lifting is pressed into service, such as little scoops on the periphery, or projections, or recesses, or the ring is punched with holes, Fig. 18, *A*.

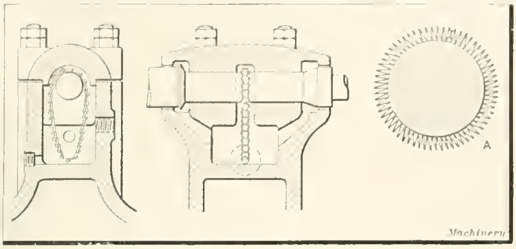

Fig. 20. Showing Lubrication by Chain and by Spring

In all the examples shown, the ring is hung loosely on the spindle, and revolves at a slow rate. If it is fixed to run at the same speed, the action is not sufficiently effective, because the centrifugal force throws the oil outwards and very little of it can reach the shaft. When some manner of catching or scraping the oil off the ring is included, this arrangement is not objectionable. For instance, in Fig. 16 (employed in the disk grinders of Roberts Bros. of Manchester, Eng.) the fixed ring or elevator disk throws the oil up into the distributor at the top, whence it flows onto and along sloping surfaces which communicate by vertical holes with the top of the bearing. Some high-speed spindles have a filtering arrangement incorporated; the oil is thrown by the disks into a trough at the top, and it runs along this into recesses filled with filtering material through which no foreign particles can pass into the bearings. Instead of providing a gage-glass for inspection, the simpler plan of screwing a brass window plate with a small piece of glass inserted is adopted.

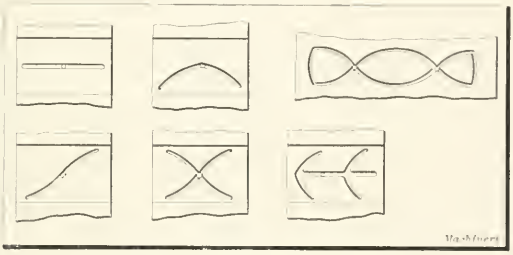

Fig. 21. Types of Oil-Grooves in Bearings

Scraping action is represented by Fig. 19 (Builders Iron Foundry), the ring being keyed to the shaft; at the top are two lugs or scrapers, *A*, with only sufficient space between them for the ring to revolve. The result is that the oil raised is scraped off the ring and thrown into the grooves in the bearing.

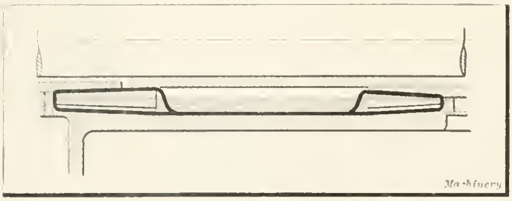

Fig. 22. Reservoir and Long Wick serving Two Bearings

Chains, of ordinary, or pitch type, supply an effective way of lifting a good quantity of oil, and they are employed largely.

Such a bearing, on a grinding machine, is shown in Fig. 20. The view shown at *A* represents a compromise between the chain and the solid ring—a spiral spring looped and hooked together to revolve with the shaft. A means of oiling shafts, used to a limited extent, is a roller of wood or cork floating up against the shaft and smearing it.

We have shown arrangements of shaft grooves for the distribution of lubricant. Much variation exists also in the grooving of bearings, a few examples being shown in Fig. 21, ranging from single to more elaborate forms. The grooves may extend around half of the brasses only, or completely around.

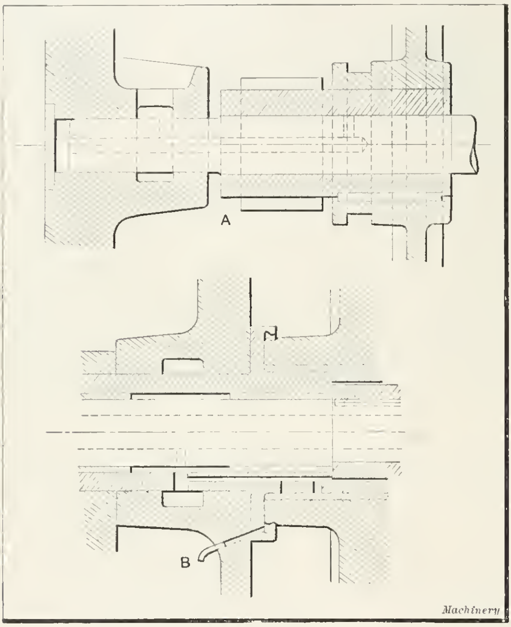

Fig. 23. Loose Running Wheels oiled from Reservoir

A method of lessening the tendency to heat, and of providing good lubrication is to employ graphite inserts, a brass netting being first prepared, and filled with a number of blocks of graphite, spaced rather closely, and the whole poured with babbitt, which is afterwards rolled and bored.

The example of wicking used to conduct oil to a bearing illustrated in Fig. 1 is an instance where various other means might have been adopted for feeding the oil. However, wicking is now largely utilized to supply bearings in a manner that could not be accomplished by pads, or at least not so well. The principle is to trail the piece of wick in the oil reservoir, and lead it from there to the bearing surface; this is a very elastic and accommodating principle, and possesses two main advantages. One is that the oil is filtered and consequently no dirt is transmitted by the wick; the other, that a feed can be procured from a well or gear-box not necessarily situated close to the bearing. If the wick is in proper condition, and the oil supply is maintained, there is no risk of the bearings running dry. No direct stream of oil ever reaches the bearings, since the wicking is arranged in such a fashion that the oil only climbs by capillary attraction. The bearings of the Hardinge bench-lathes, Fig. 25, afford an example of this; the wicks are laid in recesses at the bottom of the journals, and hang into vertical oil wells, these being filled from lateral holes at the rear of the head, with closed oilers. Fig. 22 represents the application of long wicking to feed two bearings.

A subsidiary advantage of wicking is that it can be employed to convey oil through a hole in the side of a reservoir or cup divided by a partition into two chambers. One of these is never opened to the air, and cannot receive flying grit or dust from the shop, but only forms a passage to lead the wick to the bearing surfaces. The other chamber contains the wicking coiled up in a mass to absorb oil, and the communication between the chambers is such that no direct flow can occur to wash undesirable substances along.

A good many ingenious devices exist for conveying oil to bearings and wheels which cannot be quickly reached in the ordinary manner, or which may be quite inaccessible when the machine is assembled. And cases also occur in which it is preferable to feed the parts from a central supply, or from a well adjacent, in place of fitting a separate lubricator. Such an example is shown in Fig. 23, taken from a milling machine, the view *A* showing conveyance from a fixed drilled shaft to the loose running wheel. The shaft receives its oil from the well cored out in the bearing, this being fed by the forced system which floods all the bearings. *B* represents the feeding of a wheel which runs on the bushing through holes communicating with the flooded reservoir. The edge of the wheel is lipped, and is enclosed by the turned-in rim of the bushing, so that superfluous oil is caught and drained down through the channel and pipe to the inside of the framing to the oil tank.

Pump systems embody many arrangements of a varied character for the thorough distribution of the lubricant. In the most complete gear-boxes, and in some machines—notably all-geared milling machines—the same supply is utilized to flood the gears and bearings, being pumped up from the well at the base and falling from a perforated pipe in cascades on to the gears, while suitably arranged pipes conduct it into the bearings. The top part of each bearing is cast as a trough, and the one below it catches the oil that runs out from the ends or center hole of the bearing. Grooves, holes, chutes, and pipes are employed to assist in the conduction. Fig. 24 is a sectional view through the frame of the Kearney & Trecker all-geared milling machine to show the various bearings and passages for the conveyance of the oil. The oil flows from the ends of the pipe at the top, and for the spur gears it drops from the holes on the under side so as to cover the entire area. Finally it runs on to the dividing web of the frame and passes through a hole into the reservoir, from which the pump raises it again to the top. The reservoir to the right is completely separated, and has its own pump and piping to convey the lubricant for the cutters. Many modifications of this arrangement might be illustrated, but this must suffice to show the general principle. When bearings of fixed or tumbler type happen to be situated between the sides of the framing, these can be supplied from the distributing pipe, either by a simple fall onto a lipped surface which collects the oil and lets it

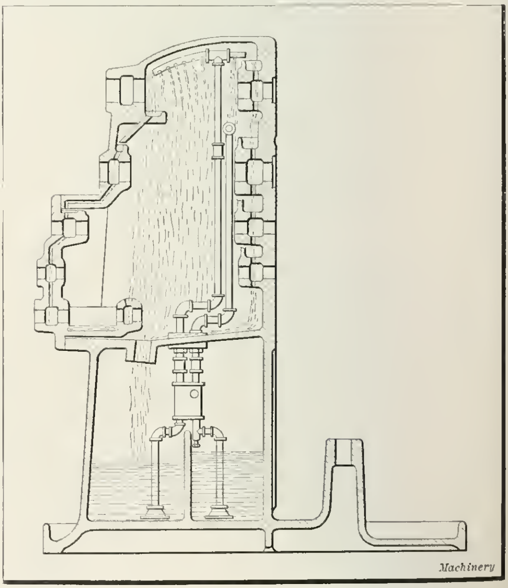

Fig. 24. Milling Machine Framing for Flooded Bearing System of Lubrication

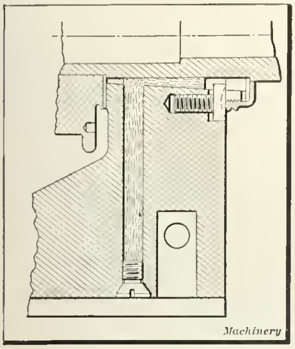

Fig. 25. Hardings Wick Lubrication

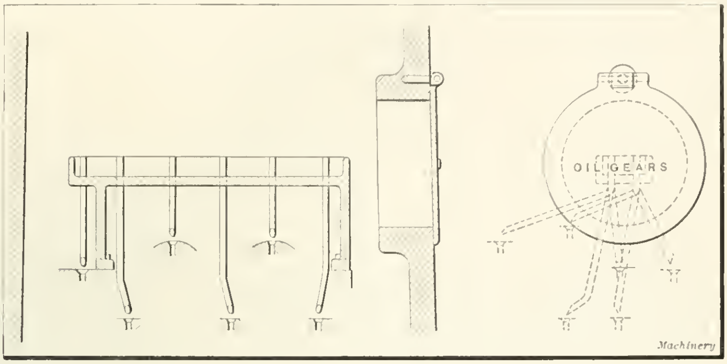

Fig. 26. Trough and Pipes supplying Several Bearings

run into the bearing apertures, or the employment of supplementary piping which reaches around obstructions that prevent a direct fall. If it is impossible to properly feed such bearings, or running wheels, or if they happen to come outside the framing, an internal feed must be arranged, as already shown by Fig. 24. In this way it is practicable to lubricate all the running shafts and spindles without recourse to independent lubricators. One little difference exists in regard to the oil-grooves in a flooded system, and that is they may always be cut in open style, to let the oil run through freely and carry anything foreign with it. On the contrary in a restricted supply from oilers, the grooves are frequently cut with closed ends, to retain the lubricant for a reasonable period. It is essential to close the ends of the bearings with caps, either bolted onto the face, or driven into the bore, and made tight with a coating of shellac, or with packing washers.

In very large machines, when a considerable quantity of oil has to be flooded through bearings and over surfaces, a head is obtained sometimes by the use of an elevated tank, from which pipes lead down to the various grooves or passages. The pump then replenishes the tank at the required rate, the oil being filtered before returning. Any blocking of the long pipes should be provided against by the inclusion of pet-cocks at suitable positions, close to the bearings, so that the position of an obstruction can be discovered.

Apart from this method of obtaining a large supply, the tank is also often embodied in portions of machines to feed certain details that are either inaccessible by an oil-can, or are too numerous for individual attention, and there is thus risk of neglect. The oil either runs direct to the places needed, or is fed slowly by siphon wicks. So long as the tank is filled, kept clean from grit or dirt, and the wicks are fitted properly, no trouble can ensue. Fig. 26 illustrates a typical case, where all the oiling orifices are located close together, and the pipes from the trough do not need to be carried far. As the trough is enclosed inside a column closed by the flap door no lid is needed to cover the oil, but such would be required if the trough were situated externally.

* * *

Happily for the common welfare, not all manufacturing concerns believe in the policy of "oslerizing" old employes. Some whose product is noted throughout the manufacturing world for excellence and durability pursue quite the contrary policy, and do it in a way that wins general appreciation. For example, the Skinner Chuck Co., of New Britain, Conn., presented a Christmas gift of a $20 gold piece to each of its employes who had been in the company's service more than twenty years. The three men, Joel Bloomquist, James Kindelan and Joseph Preissl, who were the recipients, found in their pay envelopes, an extra envelope containing the $20 gold piece and a note stating that it was a Christmas gift from the company in recognition of their long and faithful services. It is hardly needful to say that an action of this kind by a manufacturing company does more to endear it to its employes than many of the so-called welfare works which are heralded as great philanthropies for the benefit of workmen.

PITCH DIAMETERS FOR METRIC SYSTEM SCREW THREADS

In MACHINERY's Data Sheet Book No. 1, "Screw Threads," pages 32 to 35, tables are given of the pitch diameters of U. S. standard threads, for all diameters varying by thirty-seconds, and for number of threads per inch varying from 6 to 64. No table, however, has been published giving the pitch diameters of metric screw threads, including all standard and special millimeter sizes. The accompanying table has, therefore, been calculated. It gives the diameter in millimeters and the equivalent diameter in inches, the pitch in millimeters, and the pitch diameter in inches.

PITCH DIAMETERS FOR METRIC SYSTEM SCREW THREADS

Diameter, Millimeters	Diameter, Inches	Pitch, Millimeters	Pitch Diameter, Inches	Diameter, Millimeters	Diameter, Inches	Pitch, Millimeters	Pitch Diameter, Inches
3	0.1181	0.50	0.1053	41	1.6142	4.00	1.5119
4	0.1575	0.75	0.1383	42	1.6535	4.50	1.5385
5	0.1969	0.75	0.1777	43	1.6929	4.50	1.5778
6	0.2362	1.00	0.2107	44	1.7323	4.50	1.6172
7	0.2756	1.00	0.2500	45	1.7717	4.50	1.6566
8	0.3150	1.25	0.2830	46	1.8110	4.50	1.6960
8	0.3150	1.00	0.2894	47	1.8504	4.50	1.7353
9	0.3543	1.25	0.3224	48	1.8898	5.00	1.7619
9	0.3543	1.00	0.3288	49	1.9291	5.00	1.8013
10	0.3937	1.50	0.3553	50	1.9685	5.00	1.8406
11	0.4331	1.50	0.3947	51	2.0079	5.00	1.8800
12	0.4724	1.75	0.4277	52	2.0472	5.00	1.9194
12	0.4724	1.50	0.4341	53	2.0866	5.00	1.9588
13	0.5118	1.75	0.4671	54	2.1260	5.00	1.9981
14	0.5512	2.00	0.5000	55	2.1654	5.00	2.0375
15	0.5906	2.00	0.5394	56	2.2047	5.50	2.0641
16	0.6299	2.00	0.5788	57	2.2441	5.50	2.1035
17	0.6693	2.00	0.6182	58	2.2835	5.50	2.1428
18	0.7087	2.50	0.6447	59	2.3228	5.50	2.1822
19	0.7480	2.50	0.6841	60	2.3622	5.50	2.2216
20	0.7874	2.50	0.7235	61	2.4016	5.50	2.2609
21	0.8268	2.50	0.7628	62	2.4409	5.50	2.3003
22	0.8661	2.50	0.8022	63	2.4803	5.50	2.3397
23	0.9055	2.50	0.8416	64	2.5197	6.00	2.3663
24	0.9449	3.00	0.8682	65	2.5591	6.00	2.4056
25	0.9843	3.00	0.9075	66	2.5984	6.00	2.4450
26	1.0236	3.00	0.9469	67	2.6378	6.00	2.4844
27	1.0630	3.00	0.9863	68	2.6772	6.00	2.5237
28	1.1024	3.00	1.0257	69	2.7165	6.00	2.5631
29	1.1417	3.00	1.0650	70	2.7559	6.00	2.6025
30	1.1811	3.50	1.0916	71	2.7953	6.00	2.6418
31	1.2205	3.50	1.1310	72	2.8346	6.50	2.6684
32	1.2598	3.50	1.1703	73	2.8740	6.50	2.7078
33	1.2992	3.50	1.2097	74	2.9134	6.50	2.7472
34	1.3386	3.50	1.2491	75	2.9528	6.50	2.7865
35	1.3780	3.50	1.2885	76	2.9921	6.50	2.8259
36	1.4173	4.00	1.3150	77	3.0315	6.50	2.8653
37	1.4567	4.00	1.3544	78	3.0709	6.50	2.9046
38	1.4961	4.00	1.3938	79	3.1102	6.50	2.9440
39	1.5354	4.00	1.4331	80	3.1496	7.00	2.9706
40	1.5748	4.00	1.4725		....	....	.....

Machinery

* * *

Iron and steel ordinarily attain their maximum strength at temperatures of from 400 to 650 degrees F.

VARIABLE SPEED MECHANISM FOR MILLING MACHINE TABLE

A variable speed mechanism for rapidly feeding a milling machine table to the cutting point, then slowing it down for the cutting operation, and afterward quickly returning it to the loading position is in use at the Utica Drop Forge & Tool Co.'s plant, Utica, N. Y. This device is the patented idea of H. F. Kellemen, general manager of the concern, and one of the milling machines to which it has been successfully applied is shown in Fig. 1. The mechanism for producing the speed changes is located beneath the table, and in order to make its operation clear, it will be necessary to refer to Fig. 2, which shows a plan view of the milling machine table with a section broken out to illustrate the internal mechanism. The milling machine table, which is of the ordinary type, is represented by *C*, and the usual type of traversing screw is provided, being shown at *D*. The table is mounted upon the milling machine base and screw *D* runs through plain bearings *E*, *F*, and *G*, which are mounted upon the base of the milling machine beneath the table. Confined longitudinally between bearings *E* and *F* is the pinion *H*, which is a sliding fit over the outside of the screw *D*, but is prevented from turning independently by means of a feather key in the pinion and a spline in the screw *D*. Between bearings *F* and *G* is the rotatable nut *I*, internally threaded to fit screw *D*, the outside of which is in the form of a pinion. The sliding pinion *H* and the rotatable nut *I* should not be confused, as these are the essential factors in producing the speed changes. Mounted upon the base of the machine parallel with screw *D* is the jackshaft *J*. This jackshaft is supported in bearings *K* and upon it are loosely mounted pinions *L* and *M*. Driving shaft *V* continuously rotates the jackshaft in a constant direction through spiral gearing *W*. Within the housings *N* and *O* are clutch sleeves which encircle the jackshaft. The end of one of these clutch sleeves may be seen at *P*, and both these sleeves are keyed to, but capable of sliding along, the jackshaft. By means of teeth upon the ends of the clutch sleeves, which may be locked with teeth upon the sides of the pinions by the clutch mechanisms *Q* and *R*, either or both of these pinions may be coupled to the jackshaft, and thus operate the corresponding pinions on screw *D*. Within the housing *S* is a simple mechanism, which when either pinion *L* or *M* is keyed to the jackshaft, holds the other pinion against rotation. The clutches *Q* and *R* are thrown in or out of engagement by means of clutch rods which terminate in the dogs *T* and *U*. Thus, pinions *L* and *M* are thrown into or out of mesh with the corresponding pinions on screw *D*, when dogs *T* or *U* engage any of the three stops *X*, *Y* or *Z*, which are adjustably located upon the platen-side. These stops, as well as the dogs which operate the clutch shafts, are best shown in Fig. 3.

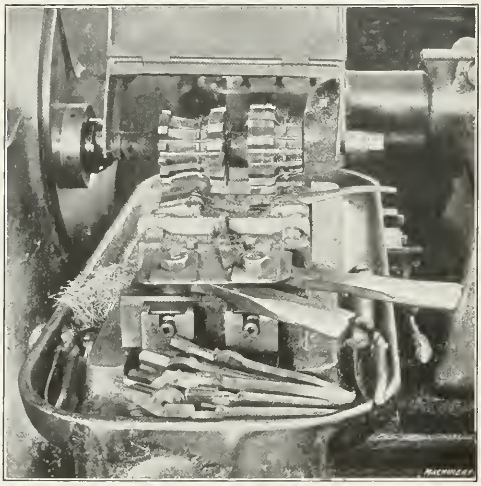

Fig. 1. Manufacturing Operation on which Variable Speed Mechanism is Advantageous

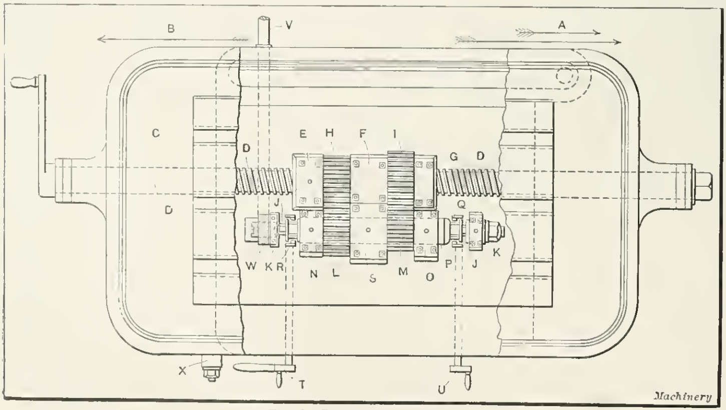

Fig. 2. Details of the Device

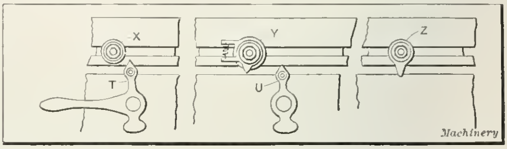

Fig. 3. Dogs and Trips used in Speed-changing

From the foregoing it will be seen that when the operator loads the work-holding vise on the table and throws in the lever dog *T* by hand, it causes clutch *R* to unite pinion *L* with the jackshaft and, consequently, to traverse the table in a rapid direction toward the cutters, as indicated by arrow *A*. This hand lever which the operator throws in may be seen at the right of the table in Fig. 1. The movement of the table is accomplished by the turning of pinion *H* driven by pinion *L*, which causes the screw *D* to turn through the pinion nut *I*, the latter being held from rotating at this time. Stop *Y* is located on the platen-side at such a point that when the table, and consequently the work, has reached the cutting point, the dog *U* is tripped, and this action, by means of the clutch rod and clutch *Q* throws pinion *M* also into rotation with the jackshaft. Pinion *M* then operates nut *I* in the same direction as pinion *H*, thereby greatly reducing the forward travel of screw *D*. This, of course, slows down the speed of the table as it feeds by the cutters, because the ratio between pinions *M* and *I* is much greater than between pinions *L* and *H*. Stop *X* is so located upon the platen-side that as soon as the cutters have finished their work it trips dog *T*, throwing pinion *L*, through the clutch mechanism, out of rotation with the jackshaft. As the pinion *M* on the jackshaft is still driving nut *I* on the screw, the direction of the travel of carriage *C* is consequently reversed as soon as pinion *L* is released from the jackshaft, and the carriage continues in the direction indicated by arrow *B* toward the loading point, until stop *Z* on the platen-side trips dog *U*, thereby throwing pinion *M* also out of rotation with the jackshaft. This brings the table to a stop, allowing the work to be removed from the vise so that it may be loaded for a second milling operation.

Summing up, it will be seen that there are three speeds given screw *D*; the fast forward speed when driven by pinion *L* in mesh with sliding pinion *H*; the medium return speed when the small pinion *M* drives through the threaded nut *I*; and the slow forward speed imparted when both pinions are driving screw *D*. The latter speed is the resultant obtained by subtracting the reverse speed from the forward speed.

C. L. L.

STEAM POWER PLANT PIPING DETAILS—1

DRAWINGS—GENERAL REQUIREMENTS OF PIPING SYSTEMS—ARRANGEMENT OF POWER PLANT PIPING

BY WILLIAM F. FISCHER*†

In steam power plant work, probably no detail of the layout requires more careful consideration than the steam piping, especially in medium and large size stations, where high pressures, superheated steam and high steam velocities are employed. A great many of the evils resulting from poorly or improperly designed piping systems are quite frequently attributed to other parts of the equipment. The successful and economical operation of the station as a whole depends to a large extent upon the general arrangement of the piping system; therefore, every engineer or designer connected in any way with the design, operation, or superintendence of steam power plant work should be familiar with the general requirements, at least, of a well designed piping system.

Drawings

Before any of the steam apparatus is finally located or installed in the station, the necessary steam and water piping systems should be worked out in detail. After the final blueprints of the engines, pumps, boilers, feed-water heaters, and other steam-driven machinery have been obtained from the manufacturer, the general arrangement of the plant should be decided upon and the apparatus located to scale on the general-arrangement drawing, after which the piping connecting the different units should be carefully worked out, taking care that proper clearance is allowed between the different apparatus and lines of piping, so that no serious difficulty may be experienced during the erection of the piping system as a whole or during its operation when installed.

All separators, valves, fittings, drip-legs, etc., should be drawn to scale in their respective positions, otherwise too much material may be crowded into a given space, making changes necessary during erection. Valves should be located in accessible positions and not crowded into a network of piping where it is impossible to reach them in a hurry. When indicating valves on a drawing, it is customary to show the flanges in their correct positions and to connect them by two crossed lines. If this is done care should be taken to see that proper clearance is allowed between mains to accommodate the valve, as the body of the valve, the handwheel and the rising stem, will project some distance beyond the flange limits. In crowded places it is much better to draw in the valve in full, or at least to show the correct position of the handwheel and stem, both in the open and closed positions, as this will tend to prevent errors and facilitate erection.

Valves should be arranged to be operated from the floor line or from operating platforms, where possible to do so. One frequently sees valves so placed in the line that the operator has to climb a ladder in order to operate them. When ladders are necessary for the operation of valves, they should, if possible, be built in, and a small platform or grating provided on which the operator may stand while operating or packing the valves. When important valves are placed overhead or in other inaccessible positions, they should preferably be equipped with a chain wheel and chain, or a system of gearing and extension stems, with the chain or handwheel in such a position that the valve may be operated from the floor line. Electrically operated "remote control" valves are frequently used in modern power stations for valves placed in inaccessible positions and which must be operated in a hurry. These valves are arranged with a system of gearing and an electric motor which is attached directly to the valve, and are operated by manipulating a controller located at any convenient point.

Some engineers merely work out their piping systems diagrammatically, allowing the piping contractor to work out all of the details, general location and arrangement of valves, etc. The contractor practically designs the systems to suit his own requirements and ideas, using the piping diagrams as a guide only. The excuse for this practice is that the piping contractor is better able to design the system to suit his own standards, and that he can then estimate closer on the work and save money for the client. The writer has been in the employ of piping contractors and has found just the opposite to be the case. When the contractor is given a diagrammatic layout on which to base his estimate, there is a large factor of uncertainty and ignorance regarding field conditions to be met, obstructions to be taken care of, etc., and for this reason, and also because he will be compelled to make his own shop and detail working drawings, and take care of all interferences in the field, he is bound to place a figure on the job high enough to cover engineering and drafting costs, incidentals, extras, etc. The practice of basing estimates and contracts on piping diagrams usually leads to misunderstandings between the designing engineer and the contractor, and quite frequently makes expensive changes and extra materials necessary during erection, all of which increases the cost of the equipment. It is, therefore, advisable that the piping system be well worked out on paper and carefully detailed before the piping contract is let. The drawing should show the location of all pipes, fittings, valves, steam separators, pipe hangers, etc., and should be dimensioned with center to center dimensions of all connections, so that the piping contractor can cut the pipe to the required length in the shop and ship it to the field ready for erection.

The drawings should be accompanied by complete specifications stating just what the contractor is expected to do, the type of valves, fittings, joints, gaskets, etc., and the quality of material required. The contractor should be allowed to use his own center to center and face to face dimensions of fittings and valves wherever possible, in order to avoid specials. In this way lower bids will be obtained on the work and the contractor will know just what conditions he is expected to meet. As a result there will be less chance of error and delay, due to misunderstanding between the engineer and the contractor. Piping diagrams should only be used for planning the piping system, and for operating purposes, in which case they will be found useful and convenient, as they show the complete system at a glance.

Shop and Field Cut Pipe

Pipe up to and including 5 inches in size can be cut, threaded and flanged in the field by hand, although this is much more expensive than to do the work in the pipe shop and send the pipe material to the field ready to bolt or screw together. One man and his helper, working in a pipe shop with power driven tools can cut, thread and flange more pipe in a day than a whole gang of pipe fitters could in the field when working with hand-power tools. In some cases it is advisable to leave certain dimensions to be obtained by the erecting crews, in which case the piping material up to a certain point will be cut and flanged in the shop, and the closing piece, or "filler," as it is known, will be cut to length and fitted in the field during erection. On a large job of pipe work the contractor sometimes finds it advisable to ship a portable, power-driven pipe machine to the field, in which pipe up to 8 or 10 inches in size may be cut and threaded. If the pipe work is to be furnished with "Van Stone," welded, or a similar type of attached flange, however, all of the pipe must be cut to proper lengths and flanged in the shop, as it is impossible to do such work in the field without the proper tools. With "Van Stone" and welded flanges, the joints must be faced off true and smooth after the flanges are attached, and this requires a long, power-driven lathe or pipe machine.

General Requirements of a Well Designed Piping System

To properly design a system of piping for a modern steam-power station, the designer should have some knowledge of operating conditions, and should be familiar with the manufacturers' standards, such as valves, fittings, separators, etc., and with the quality and strength of the materials employed in their construction. He should also have a general working knowledge of the methods employed in distributing and conveying steam and water, and for taking care of condensation, expansion, contraction, and vibration in steam mains.

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When the boiler valve is closed, the steam inside the boiler, owing to its pressure, may be said to possess "potential energy," as it is capable of performing certain work when liberated. When the valve is opened, permitting the steam to flow through the piping system, part of this "potential energy" is transformed into "kinetic energy." Among the several factors which tend to change the form of the original energy of the steam, are condensation, friction, and expansion.

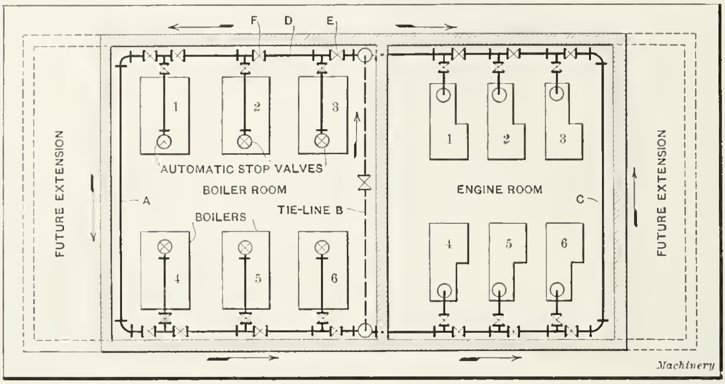

Fig. 1. Ring-main System of Steam Piping—Boiler and Engine Rooms End to End

Condensation in Steam Mains

When steam is turned into the piping system, part of it comes in contact with the inner surface of the pipe and fittings, thus transferring part of the heat to the metal of the pipe, from which it is transferred to the atmosphere surrounding the pipe. As the air near the outside surface of the pipe becomes heated to a higher temperature than that of the surrounding air, it quickly expands and rises, thus making room for cooler air which is in turn heated and rises, carrying the heat away with it. In this way a continuous stream of cool air passes over the surface of the steam pipes, robbing the steam of its heat and causing part of it to condense, or change back again into the form of water. The condensation which occurs when steam fills the pipe, but is not flowing through it, is known as "static condensation," and that which occurs while the steam is flowing, is known as "dynamic condensation." The amount of condensation has been found to be practically the same in both cases; therefore, no distinction is made between them when speaking of condensation losses.

In order to prevent excessive heat radiation and the resulting condensation losses, the steam piping system should be well covered or lagged with a good grade of non-conducting covering material. No matter how carefully the steam piping is covered, however, some water is still likely to accumulate in the system, due to condensation; therefore, the piping should contain no low spots or pockets in which water can collect. If water pockets are unavoidable, they should be dripped free of water at all times, and the water of condensation should be automatically returned to the feed-water heaters, or to the boilers direct, either through a system of steam traps, or a drip pump and receiver automatically controlled by a float-operated valve. Water pockets that are not properly drained are a constant source of danger, as the water of condensation will accumulate in them until picked up by a heavy flow of steam. It may then be projected with great force against a fitting, valve, blind flange, or sharp turn in the piping, in which case rupture is quite apt to occur; or the water might be swept into the engine cylinder by the flowing steam and thus cause serious damage to the engine. It is always advisable to install a steam separator in the steam line at a point near the engine throttle. Besides intercepting the "slugs of water" that may be carried over by the steam, and the moisture in the steam, the separator performs another function of great value in that it provides a reservoir of steam close to the engine, which cushions the reaction and absorbs the shock and jar caused by the quick cut-off in the steam chest.

Horizontal steam pipes should always be pitched in the direction of the flow, so that any water of condensation forming in the pipe or carried over from the boilers, will flow with and not against the current of the steam. When the water of condensation is made to flow against the current of the steam, "water hammer" is very apt to occur. For this reason it is not advisable to carry a steam line on an upward slope from a lower to a higher level. The pipe should rise vertically to the desired height and then be carried horizontally to the desired position, taking care that the horizontal pipes are pitched in the direction of steam flow. Drip-legs, or pockets, should always be provided at the base of a vertical riser, and should be automatically drained of water; otherwise the water would collect at this point, gradually decreasing the area of the pipe, until the first heavy draft of steam would carry a large "slug" of water with it through the riser and horizontal branch pipe above.

Friction

Friction of steam in the piping system is caused by the flowing steam rubbing against the inner surface of the pipe, valves and fittings, and by sudden changes of direction of the steam flow. Friction causes a loss of pressure in the piping, and this should always be taken into account when proportioning the pipe sizes for a given service. Loss of pressure in a steam pipe causes the steam to expand or increase in volume, and this, in turn, causes an increase in velocity at which the steam is traveling; that is, the velocity of the steam will vary slightly throughout the length of the pipe. Pipes and fittings should be carefully proportioned to permit of a free flow of steam from the boilers to the engines, without causing undue friction and loss of pressure in the system.

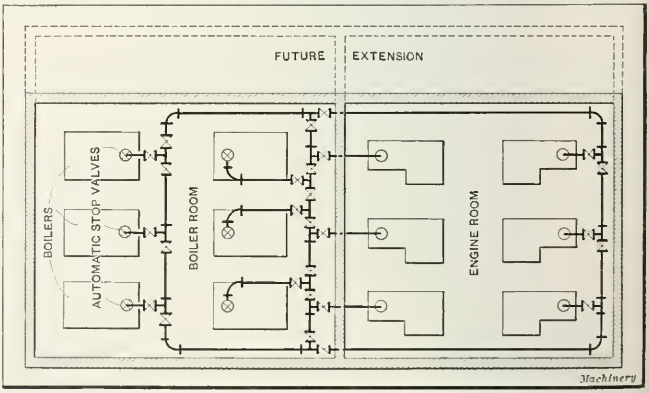

Fig. 2. Ring-main System of Steam Piping—Boiler and Engine Rooms Side by Side

Expansion and Contraction

Unless firmly anchored, the main steam header is subject to a change in position due to expansion and contraction strains in the main header and in the branches leading to and from it. In steam mains of any length, proper provision should, therefore, be made to take up or relieve the expansion and contraction strains as much as possible, thus preventing undue strains at the joints. Otherwise, leakage is liable to take place, and rupture may be caused at the weakest point in the main.

Where a pipe line is anchored or fixed at any two points, an expansion bend of long radius should be installed in the line somewhere between the anchors or fixed points, as no ordinary system of anchoring or fastening will resist the force of expansion and contraction, and even if it would, the strains would fall on the pipe joints and cause trouble. The old type of slip expansion joints are now seldom, if ever, used in good steam piping, as they have proved a constant source of trouble, require frequent repacking and adjustment, and are extremely dangerous when used in high pressure work. Steel pipe expansion bends, of long radius, are now used to take up or relieve the strains on the piping system, in preference to any of the old-time expansion joints. Steel bends curved to a radius of less than six diameters are undesirable as expansion bends, because they are too stiff to take up the expansion in the line, and the strains are thrown on the fittings and joints. Expansion bends should be curved to a radius of, at least, six times the diameter of the pipe, and wherever possible, the radius should be greater, say from eight to ten times the diameter, in order to give sufficient elasticity.

Vibration

Steam, when flowing at a high velocity in the supply pipe of a modern high-speed engine is alternately stopped and raised again to this high velocity several hundred times a minute, due to the rapid opening and closing of the steam valves. This intermittent motion of the steam has, in many cases, been found to cause vibration in the engine supply pipe, which, in turn, is transmitted to other branches of the system. Vibration is also caused by suddenly changing the direction of steam flow through tees and short turn elbows, and sometimes by the unequal velocity of steam flowing through different branches of the piping system. Vibration, combined with expansion and contraction strains, is a constant source of danger and annoyance and should be guarded against as much as possible in the original design of the piping system. The pipes should be so proportioned that the velocity will be as nearly uniform as possible in all branches of the system. The engines should be equipped with steam separators of large capacity to cushion the steam, at or near the engine throttle, and the piping should be firmly anchored at suitable points.

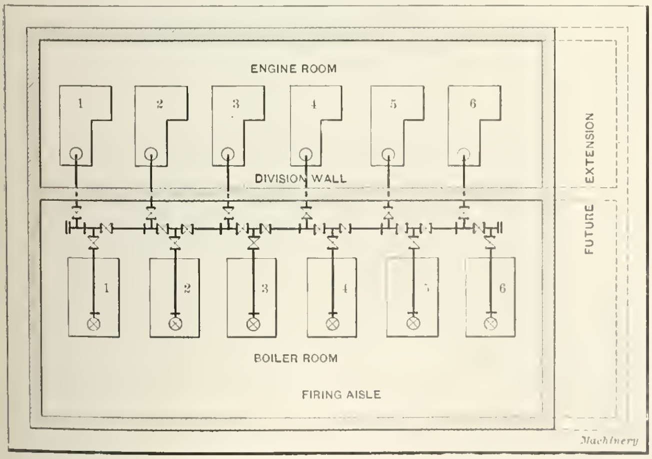

Fig. 3. Single-main System of Steam Piping—Boilers and Engines Back to Back

It frequently happens that vibration within the boilers or engines, due to some cause independent of the conditions of the piping system, is transmitted to the piping. In this case no amount of anchoring will cure the vibration. The cause must be found and remedied.

Steam boilers that do not contain sufficient steam space above the water line are subject to vibration, especially when steaming rapidly at overload periods. At such times the pressure is liable to fall off rapidly, causing a violent bubbling and boiling action within the boiler. This violent agitation of the water may cause the boiler to vibrate considerably. Steam engines in which the governor and valve mechanism are not properly adjusted, are also subject to vibration.

General Arrangement of Steam Piping

No general rule can be given for the general arrangement of steam lines in a steam power plant, as the conditions to be met vary greatly in different plants. The designer should aim to carry his mains as direct as possible and should avoid unnecessary pipes and fittings. The piping should contain as few joints as possible and should be so designed as to permit of repairs being made to any disabled branch without interfering with the regular operation of the plant. The system should be properly protected by valves, so arranged that any disabled branch of the system may be cut out of service. The general arrangement of the power plant as a whole, depends to a large extent upon the design and arrangement of the steam piping system, just as the arrangement of the piping system depends upon the arrangement of the plant. Therefore, it is not advisable to finally locate or install any of the steam driven machinery without first giving due thought and attention to the arrangement of the main steam piping. The accompanying diagrammatic views illustrate several methods of arranging the boilers and engines in a steam power station, and the arrangement of the main steam piping suited to the conditions.

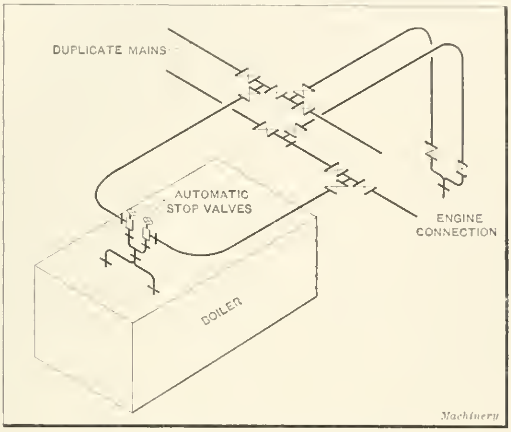

Fig. 4. Duplicate-main System of Steam Piping

In Fig. 1 is shown the "ring main" system of steam piping. This system is readily adapted to power plants in which the boiler and engine rooms are placed end to end, as shown. The steam from the boilers passes to the engines through two main headers, one on each side of the building. These headers are connected at each end of the building as shown at *A* and *C*, the whole forming a complete ring of piping. In some cases it has been found advisable to cross-connect the ring system through an additional tie line, placed as shown at *B* to provide a better distribution of the steam. Valves are placed in the mains between each unit, so that any section of the main may be cut out of service by closing two of the valves in case of an accident occurring to any branch of the system. If, for example, the ring main failed at point *D*, the valves *E* and *F* could be closed, boiler No. 3 cut out of service, and the steam from the other five boilers carried around through the ring main to the engines as shown by the arrows.

In order to be effective, the ring main should be made full size throughout its entire length, and should be of sufficient area to supply all the engines in the plant. All valves in the main header should be kept open during operation. Where the boiler and engine rooms are placed end to end as shown in Fig. 1, a large quantity of piping material is required, and owing to the large area of radiating surface, the condensation loss in the steam mains is quite considerable. If at any future date additional boiler and engine units are added to a plant of this type, the building must be extended at each end, as shown by the dotted lines, and the piping may be too small to accommodate the additional units.

The ring system of steam piping became quite popular some few years ago, especially in medium and large size plants where continuous operation and uninterrupted service are a necessity. In those days a poorer grade of piping material was in general use, and valves and fittings were not so well designed nor as reliable as they are to-day; as a result there was more danger of a "blow-out" in the piping system than there is at the present time. Owing to the large quantity of piping material necessary in a system of this kind, it is expensive in first cost, expensive to install, and expensive to keep in operation. There are a great many joints liable to leakage, a great many valves to be repacked and kept in repair, and the heat and condensation losses are excessive.

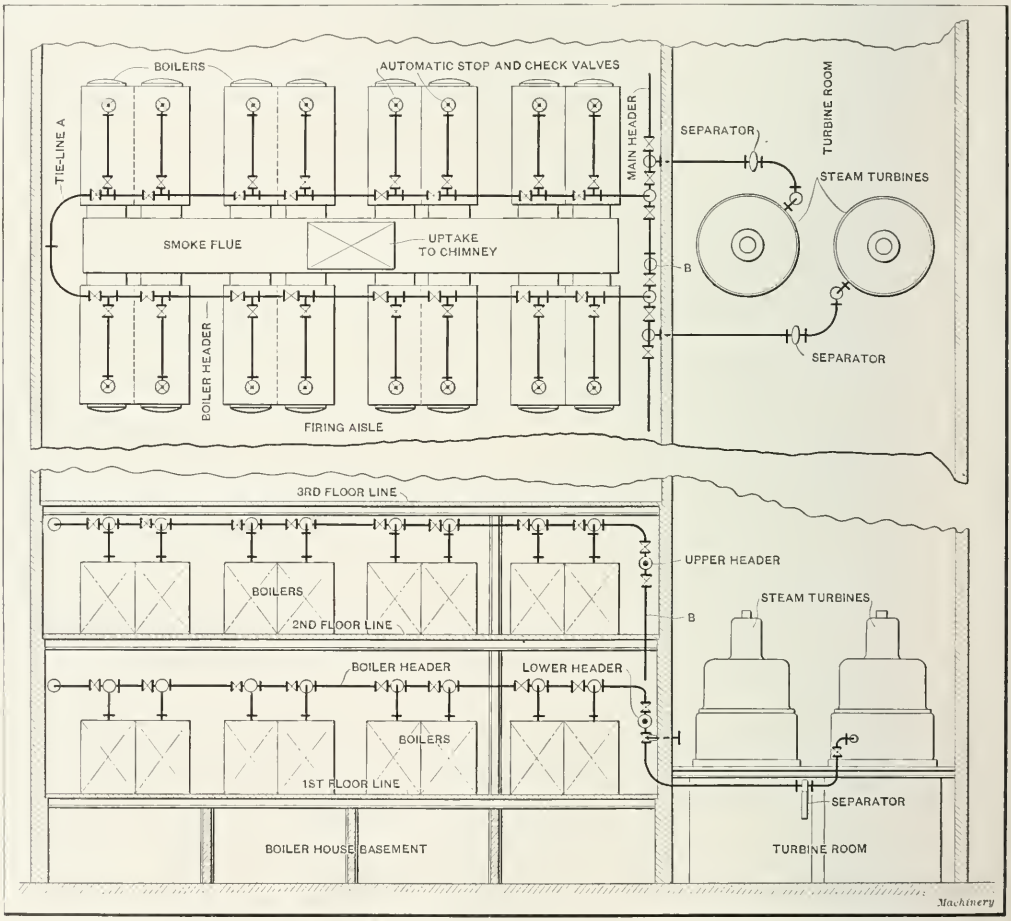

Fig. 5. Plan and Elevation of Double-deck Boiler House and Unit System of Steam Piping for Large Steam Turbine Power Plant

In Fig. 2 is shown another method of applying the loop or ring system of piping. In this case the boiler and engine rooms are placed side by side, with a division wall between them. Valves are located in the main header between each connection as in Fig. 1. As additional boiler and engine units are added to the plant, the building will be extended in the direction of the dotted lines.

In Fig. 3 is shown a more modern type of power station, in which the boilers and engines are placed back to back in separate buildings with a division wall between them. The main steam header consists of a single line of piping placed at the rear of the boilers. This header may be supported on brackets on the division wall, or suspended from the roof trusses overhead. With the boilers, engines, and piping arranged as shown, the flow of steam is direct from the boilers to the engines, and the main steam header may be made considerably smaller in size than in either of the previous cases, where the header must necessarily be large enough to pass the steam from all of the boilers in order to be effective. In fact, with the system shown in Fig. 3, the main header need be but little, if any, larger than the largest branch leading from it, as the piping is so arranged that the boilers feed the main steam header uniformly, or nearly so, throughout its length, and the engines are fed in a similar manner. The station is divided into complete and independent units, as it were, by placing gate valves in the main header between each connection. The valves are so placed that any section of the header may be cut out of service for repairs when necessary, or by closing the valves in the main header each unit may be made entirely independent of the others.

This system is generally used in present-day practice in preference to the ring system. It is cheaper to install as there are considerably less piping material, valves and fittings required, the piping is smaller in size, less pipe covering is required, and the steam flow is more direct than in any other system. Smaller pipe sizes and shorter mains expose considerably less radiating surface, and as a result the condensation losses are reduced. The dotted lines show how the building may be extended when additional boilers and engines are added to the station, in which case it is only necessary to extend the main header the desired length, keeping the size the same throughout.

In Fig. 4 is shown one unit of the duplicate-main system of steam piping. In this case the piping is arranged as in Fig. 3, except that the main header, and the branches from each boiler and to each engine, are in duplicate. Each main header is supplied by a separate boiler connection, and each engine supply pipe is connected to both headers. Two automatic stop valves are shown at each boiler, but, if so desired, only one need be used, with two branches leading from it, one to each main. This elaborate and costly system of piping is gradually losing favor and is seldom used in present-day practice. The duplicate-main system was introduced some years ago in order to insure greater reliability. Manufacturers are now, however, meeting the demand for a first-class single-main system by supplying a better grade of material and better workmanship. As a consequence, duplicate mains and ring mains are rapidly becoming relics of the past. Reliability is better assured by the careful design of valves, fittings, and flanged connections, by the judicious placing of cut-out and by-pass valves, and by properly providing for expansion and contraction, as well as by the use of steel pipe bends of long radius in preference to the short radius, cast elbows. The locating of the drip pockets and separators in the line where they will do the most good, and the trapping of all water of condensation back to the boiler as fast as it forms, will result in a single piping system far superior to the elaborate and expensive duplication of the past.

Double-deck Boiler Plants

In large central power plants it frequently happens that sufficient ground space is not available to accommodate all the boilers on one floor, in which case the boilers are placed on two floors as shown in Fig. 5. In this case the boilers and steam turbines are placed in separate buildings. For convenience only part of the station is shown; *i. e.*, two complete units. Each turbine unit requires 16 boilers for its operation, as shown in the plan view, and these boilers are placed on two floors. The boilers on each floor discharge to a common ring main at the rear of the boilers. This main is tied together at one end by tie-line *A*, and at the other end through the main header. This main header is carried on the division wall. There are two main headers, one on each floor; these are tied together at certain intervals through tie-lines *B*. Thus the steam from the upper boilers is discharged into the upper header, and from thence to the lower header, from where it is distributed to the steam turbines, as shown in plan and elevation. Valves are placed in the headers between each connection so that any damaged section may be cut out of service without crippling the station.

This station is arranged on what is known as the "unit system," under which each prime mover has its own complement of boilers, separately connected, and cross-connected from one to the other through the main headers. By dividing the station into units, the operating force may be divided into crews, each crew taking care of one or more units, depending upon the size of the station. With the unit system, boiler and engine tests may be run on any one unit without interfering with the operation of the other units, and any one unit may be put in or taken out of service as desired. The piping for the different units being cross-connected through the main headers, makes it possible to switch the load over from one prime mover to another in case of an accident, without changing from one set of boilers to another.

In order to guard against any possible damage to the electrical apparatus due to a ruptured or exploding steam main, the main header and as much of the steam piping as can be so arranged, should be placed in the boiler room. In this case, should a blow-out occur, doors may be closed between the boiler room and engine room, thus protecting the electrical apparatus from damage. After the steam pressure falls sufficiently in the boiler room, the damaged section may be cut out of service, and the balance of the plant may be operated while repairs are being made. Should the blow-out occur in the engine room, however, it might be necessary to shut down the plant for several days on account of the damage to the electrical apparatus.

All the boilers in a steam power plant should be protected by automatic stop and check valves, placed in the steam line at the outlet of each boiler. Then, should a tube burst in any of the boilers, the automatic stop valve will close when the pressure falls, preventing the steam from the other boilers from flowing into the damaged one and out through the ruptured tube. If these valves are arranged to work in both directions they will shut down the boilers automatically in case the header explodes, preventing the steam from all of the boilers emptying through the damaged main.

In the piping systems just described, valves are shown in the main header between each connection to and from the header. This provides a well protected system of piping. Valves are quite expensive, however, and for this reason they are frequently omitted in the main header. In some cases the designer compromises by placing valves only between every second or third unit; this, of course, is a question to be decided in each individual case.

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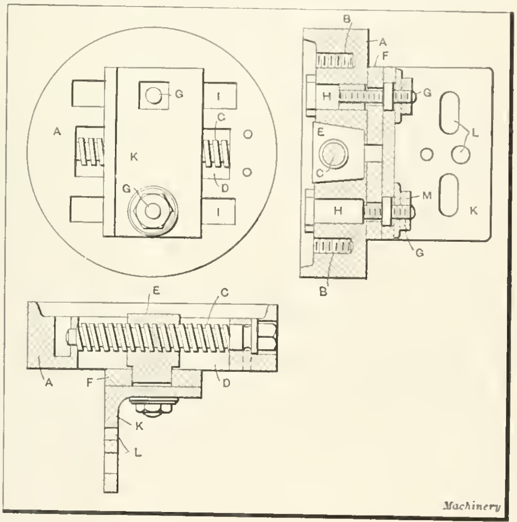
ADJUSTABLE ANGLE-PLATE FOR LATHE FACEPLATE

The accompanying engraving, reproduced from *Engineering* (London), shows an appliance that has been devised for mounting work on the lathe faceplate. It consists of an angle-plate which is adjustable by means of a screw across the faceplate. The screw does not carry the weight of the angle-plate and the work attached to it, but is merely used for adjustment. When the work has been adjusted to the position required, the angle-plate is clamped firmly to the main portion of the attachment. The engraving shows a plan view and sections. The device consists of a plate *A* which has two or more screw holes *B*, by means of which it is attached to the faceplate of the lathe. The adjusting screw is shown at *C* and is carried in bearings at opposite ends of the slot *D*. The sliding block *E* is provided with a projection which fits into an opening in the sliding intermediate plate *F*. This latter is attached to plate *A* by screws *G*. The ends of these screws are threaded into rectangular sleeves *H*, with flanges on their outer ends. These sleeves work in slots *I*, as shown. The angle-plate *K* has holes in it which receive the square collars on bolts *G*, thus preventing the latter from turning. Holes *L* are provided for attaching the piece to be machined to the angle-plate.



Adjustable Angle-plate for Lathe Faceplate

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A chrome-vanadium crankshaft, weighing only 61 pounds but of 125 horsepower capacity, was recently turned out by the Bourne-Fuller Co. of Cleveland, for the Roberts Motor Co., of Sandusky, Ohio. The crankshaft is 76 3/16 inches long, 3½ inches outside diameter, and is bored to 3⅛ inches inside diameter throughout its length except at the tapered ends. The rough shaft weighed about 250 pounds.

DIMENSIONS OF TAPER KEYS AND KEYWAYS*†

BY G. G. DANA‡

The establishment of a practical and accurate method of dimensioning keyways on drawings is a problem with which many draftsmen have undoubtedly been confronted. The writer, having used the customary method of dimensioning and noted its shortcomings in shop work for a number of years, has originated a method of dimensioning on the drawings which meets the requirements of the shop and reduces to a minimum the cost of fitting keys, at the same time insuring a better grade of work.

The method formerly used was to give the depth of the keyway at the side, that is, from the corner to the bottom, as shown in Fig. 1, the dimension *B*, in the hub, being given at the thick end of the key. The principal objections to this method were that the machinist could not measure the depth *A* accurately on account of burrs that would be raised at the corner in cutting the keyway; nor could he measure at *B* if the hub was made of cast iron, on account of the corners being ragged and broken. The hub in some instances was not machined on the end, where the dimension *B* was to be measured; hence there was no definite point from which to measure. No two machinists would read a scale alike in taking measurements under these conditions. A micrometer could not be used, so the result was that an unnecessary amount of stock had to be left on the thickness of the key, to be taken off when the key was fitted, on account of the variations due to the impossibility of accurate measurements being taken by the machinist.

The new method of dimensioning keyways overcomes all of these objections and makes it possible for the machinist to use calipers, micrometers or gages for all measurements. The depth of the keyway in the hub is given at the thin end of the key, and the measurement is taken from the opposite side of the hole as shown at *H*, in Fig. 3, while the depth of the seat in the shaft is measured from the opposite side of the shaft to the bottom of the keyway, as shown at *S*. The width of the keyway in the shaft and hub is given in the usual way. It will readily be seen that by taking the dimensions from the opposite side of the shaft or hole, there is no excuse for inaccurate work. These surfaces must come together when the key is driven in. In the event that the turning or boring is not accurately done, it will not affect the fit of the key. The allowance of stock to be left on the key for fitting can be reduced to a minimum; not over 0.003 inch is allowed when the machining is done by fairly accurate workmen.

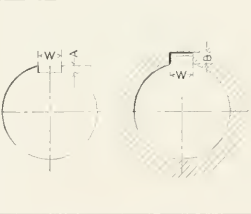

Fig. 1. Usual Method of dimensioning Keyways

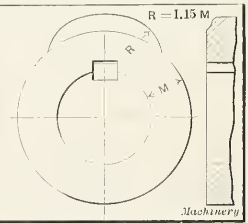

Fig. 2. Reinforcements for Hubs over Keyways

Since, in the majority of cases, the hubs of the keyed parts are faced on the side running against a bearing or other machine part, and as this end of the hub usually carries the thin end of the key, it was decided to establish the system on this basis. By using the thin end of the key as a basis, there is no necessity of varying the standard when a very long hub is used; the depth simply increases in the hub as the length of hub is increased. With the old method of measuring from the thick end of the key, the depth in the hub would decrease, so that with long keys a variation from the standard had to be made to avoid too shallow a keyway in the hub at the thin end of the key.

The following rules for the proportions of keys were used: Width of key equals the adopted fractional size nearest to one-fourth of the diameter of the shaft; thickness of key at thin end equals three-fourths of width; the taper of the key is ⅛ inch in 12 inches. Keys 1 inch wide and wider are made thinner than the above rule calls for. The width of key is made to vary by 1/16 inch until 3/4 inch is reached, then by ⅛ inch increments until 1¼ inch is reached, after which the advance is made by ¼ inch. The depth in the hub and shaft are made approximately equal at the thin end of the key, this depth being taken at the side of key. This allows the increase of thickness due to the taper to come in the hub, which is usually of a weaker material than the shaft; thus the greater bearing surface at the side of the key will, in a measure, compensate for the difference in strength of the materials. On specially heavy work, or where the hubs are proportionately short, it is advisable to use two keys set 90 degrees apart.

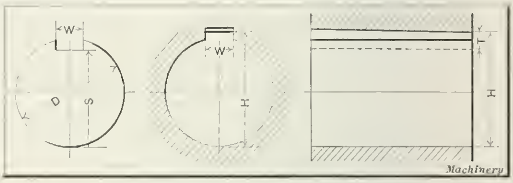

Fig. 3. Improved Method of dimensioning Keyways

The correct dimensions for *H* and *S*, as shown in Fig. 3, may be arrived at by mathematical calculation, or, perhaps more quickly and with sufficient accuracy, by graphical layouts to an enlarged scale. The latter method was the one pursued in obtaining the figures in the accompanying Data Sheets. In order to give the dimensions in even sixty-fourths of an inch, the depth in the hub was increased.

In deciding upon the reinforcement over the keyway many draftsmen and designers do not follow any systematic rule. It is evident that the strength of the hub at the keyway should be at least equal to that of any other part of the hub. In addition to the equal strength, there should be extra strength on account of the localized strains due to the force exerted by the key against the side of the keyway in transmitting the power, and also due to the wedging action of driving the key, which has a tendency to crack the hub at the corners of the keyway. The metal surrounding the key, then, should be thicker than that in the body of the hub by an amount equal to from 10 to 20 per cent, or, for average practice, 1.15 times the thickness of the body of the hub. The reinforcement should not extend to the extreme end of a hub which is faced, as this would add to the machining work, but would add nothing to the strength. Referring to Fig. 2, if *M* is the thickness of the metal in the body of the hub, then the reinforcement for the key should be laid out as shown, with the radius *R* taken from the corner of the keyway, the length of *R* being 1.15 *M*.

The thickness of the metal in the hub may vary to conform to the nature of the work done by the pulley, gear or sprocket, but for average practice a good proportion for the metal in the hub is 0.45 of the diameter of the shaft for small shafts, say up to 1½ inch diameter, and about 0.35 for shafts of larger sizes, say 5 inches diameter and up. The designer must, of course, exercise his judgment to a great extent, and vary the proportions to suit the nature of the work, the length of the hub, and other factors which tend to modify the design.

* * *

During the year 1912, 2997 miles of new railway tracks were built, and 226,195 freight cars, 3623 passenger cars and 4424 locomotives were ordered. The number of freight cars ordered in 1912 was nearly double the number ordered in 1911, which was only 133,117. The number of passenger cars ordered in 1911 was 2623 and of locomotives, 2850.

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*With Data Sheet Supplement.

†The following articles dealing with this and kindred subjects have previously been published in MACHINERY: "The Effect of Keyways on the Strength of Shafts," January, 1911, engineering edition; "Keyway Gaging in Shafts and Hubs," December, 1908; "Device for Laying Out and Testing Keyways," March, 1908; "Keys and Keyways," March, 1907, engineering edition; "Measuring Keyways," October, 1906; "Notes on Keys and Keyways," September, 1901. See also MACHINERY'S Reference Series Book No. 22, "Calculations of Elements of Machine Design," Chapter VI. "Keys and Keyways;" and MACHINERY'S Data Sheet Book No. 7, "Shafting, Keys and Keyways." pages 32 to 40 inclusive.

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KEYSEATING AND PLANING FIXTURES

A keyseating fixture of simple design and which can be applied to a shaper, is shown in Fig. 1. This device was made by the R. A. Kelly Co., Xenia, Ohio, for keyseating gears and pulleys, and is shown in the illustration attached to a 20-inch Kelly back-geared crank shaper. The fixture consists mainly of a cast-iron bracket *A* provided with two legs which are bolted to the base of the shaper column, and having a boss at its upper end bored to suit the tool bar *B*. This bar is threaded on its rear end and is screwed into the hole ordinarily occupied by the screw holding the clapper-box holder, which is removed. A keyseating cutter is held in the bar *B*, which is moved back and forth by the shaper ram.

The work to be keyseated is held in the shaper vise in the usual manner. The feed for the keyseating is obtained either by hand or by the power elevating feed, the table being raised a slight amount for each stroke of the ram. To resist the thrust of the cut and prevent any binding action of the bar in the hole in the bracket, the latter is supported by straps *C* which are fastened by cap-screws to the top of the bracket and to the ways of the machine.

Fig. 2 shows a planer fixture in use in the shops of the R. A. Kelly Co., for planing five shaper vise jaws at one setting in a 30 by 30-inch Gray planer. The fixture used consists of a cast-iron strip *A* which is provided with projections planed to suit the shape of the bases of the vise jaws *B*. The dovetailed portions of the jaws are held against corresponding faces on the fixture by set-screws held in blocks which are provided with shanks fitting in holes in the planer fixture. The jaws *B* are held down on the fixture by five straps *C* and bolts, as shown. In this fixture, only those faces on the top of the cast-iron base against which the steel jaws are held, are machined.

Particular care was taken in planing this fixture to have the projections against which the vise jaws are held at right angles to the tongues formed on the base of the fixture and fitting in the grooves in the planer table, so that the faces of the jaws would be square with the vees. It is evident that the use of this fixture simplifies the planing of these jaws to a marked degree, and makes possible the interchangeability of the parts.
D. T. H.

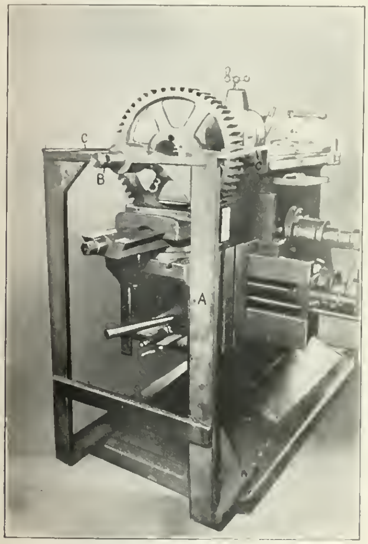

Fig. 1. Simple Keyseating Fixture for Shaper

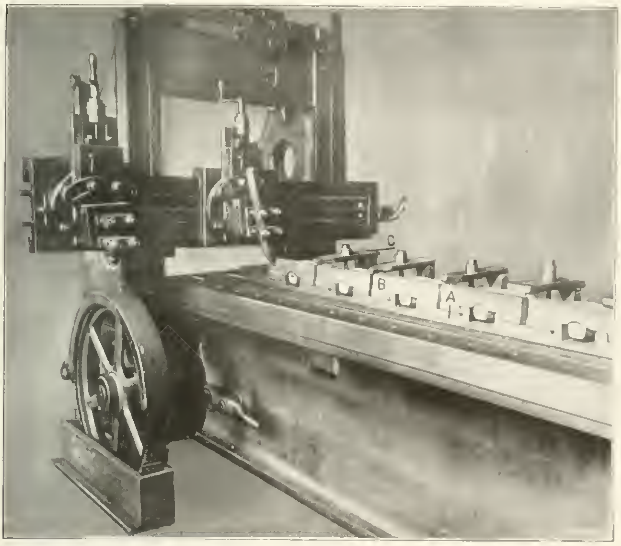

Fig. 2. Planing Fixture used in machining Vise Jaws for Kelly Shapers

* * *

The International Aluminum Syndicate has fixed the price for the metal for 1913 at 160 marks per 100 kilograms, equivalent to about 17.5 cents a pound. It is generally believed, however, that the production during the next ten months will not be able to keep pace with the consumption, and that a higher price will prevail towards the end of the year.

TOOLS FOR MULTIPLE PLUNGER PRESSES[*]

BY CHARLES DOESCHER[†]

The multiple plunger press has become a most important factor in the economical manufacture of articles from sheet metal. In the following, the writer will describe the construction and use of the punches and dies as applied to this type of press. It should be stated in the beginning that multiple plunger presses are used for both large and small work; the presses for the large sizes of work are necessarily of a stronger and more massive type of construction than those that are used for smaller work. The tools illustrated and described in this article are used for the smaller classes of work. The method of transferring the work from one plunger to another was described by the writer in the August, 1911, issue of MACHINERY, so that it will not be necessary to again go into details regarding this part of the work. A brief description of the punches and dies and the manner in which the work is made complete from the sheet metal will, however, be given.

Preparation for Making the Tools

Before going into details concerning the construction of the punches and dies used in multiple plunger presses, it may be well to lay stress upon the fact that, preparatory to constructing the tools, one of the first things to do is to make sure that the construction of the press is such that the tools will not only be interchangeable in a given press, but also with the tools in other presses. In trying out a new set of tools, it is often found that better results are obtained by changing the sequence of some of the operations; for instance, we will say plunger No. 2 does the cupping, No. 3 the forming, No. 4 the piercing, etc. It often happens that some of these operations must be reversed, and if the tools are interchangeable, this can be done without any extra time being spent in altering the length of the punches, or in making new ejecting pins to fit the press. Then, again, if the tools for different presses are not interchangeable, they can only be set up and run in the press for which they were originally made; this means that there are often times when some of these presses will be out of use, simply because there are no orders for work which calls for the use of the tools that were made for the "dead" machine in question. On the other hand, there may be orders for work which must necessarily wait until another job has been run through on a given press that is in use, because the tools to be used were made for the press that is already in use, and are not interchangeable. This deplorable condition actually exists in some shops. The fact must be taken into consideration that the taper wedges used for adjusting the stroke of the plungers afford only 3/16 inch adjustment, and unless the presses are made so that the tools are interchangeable, the loss of time due to having "dead" machines is bound to occur again and again.

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[*] For additional information on this subject, see "The Multiple Plunger Press," by Charles Doescher, in the August, 1911, issue of MACHINERY.

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In adjusting a multiple plunger press to insure interchangeability, the first thing to do is to regulate the taper wedges used for adjusting the stroke of the plungers, so that they will all be in the same relation to each other. The press is then given a half turn, so that all the plungers except plunger No. 1 are down as far as they will go, so that the distance from the top of the die bed to the face of the respective plungers can readily be measured. It seems hardly necessary to say that this distance must measure the same in each case. The same can also be said of the face of the knock-up plungers which, when raised up as far as they will go, must all measure the same distance to the top of the die bed. The depth of the ejecting pin holes in these plungers must also be the same, as, on small work, the ejecting pins rest on the bottom of these holes; and it is therefore essential that the depth of the respective holes be the same if the ejecting pins are to be interchangeable. It is also important to have the holes for the dies in the dovetail die-holders perfectly central with the threaded holes in the plungers, and also bored out to fit plug standards, so that there will be interchangeability so far as the various dies and die-holders are concerned.

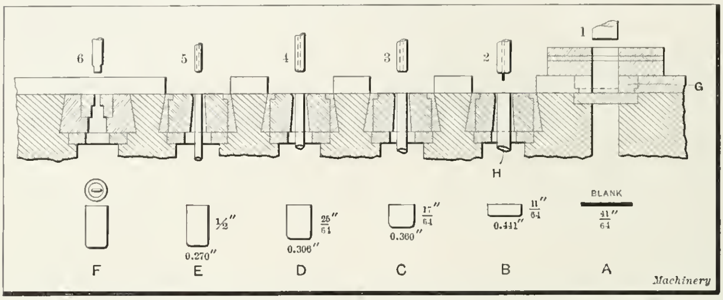


Fig. 1. Construction of Punches and Dies and Successive Operations in drawing and piercing Shell F

An Example of Shell Work done on Multiple Plunger Press

Fig. 1 shows a set of tools for a six-plunger press used in making the shell which is shown completed at *F*. The diameter of this shell is 0.270 inch, the length is ½ inch, and it has a small elongated slot pierced out of the bottom. The metal is first fed between the guide plates, where the round blank *A* is punched out and forced into the nest *G* in the transfer slide by the blanking punch in plunger No. 1, the nest being made to fit the blank tight enough to retain it. The blank is then carried under the drawing punch held in plunger No. 2 and drawn up into the shell shown at *B*. The punch is made small enough so that it will just draw up the shell and keep it from wrinkling, thereby preventing the metal from becoming too hard to be successfully worked in the following operations. After the shell is drawn up, it is ejected from the die by the ejecting pin *H* and then forced between the fingers in the transfer slide. These fingers hold the shell in place while it is being carried under plunger No. 3. As the shell *B* does not hug the punch tightly, no stripper is necessary; the push-pin prevents the shell from clinging to the punch. When the shell *B* comes under plunger No. 3, it is redrawn to the shape and size shown at *C*, care being taken to have the redrawing punch small enough so that it will not pinch the metal any harder than is absolutely necessary. The same can also be said with reference to the following drawing operations, except the one done under plunger No. 5, which draws the shell *E* hard. The last operation is piercing out the narrow slot in the bottom of the shell, which is done by the piercing punch held in plunger No. 6 and the piercing die shown directly underneath it. The finished shell is then pushed from the press into a pan or box by a push-finger held in the transfer slide. It will be seen that no ejecting pin is used in this operation, as the shell rests on the top of the piercing die while being pierced, and therefore the knock-up plunger can be removed in order to allow the scrap punchings to escape. In stripping the shell from the punches in the third, fourth, fifth and sixth operations, stationary strippers similar to the one shown in Fig. 2 are used.

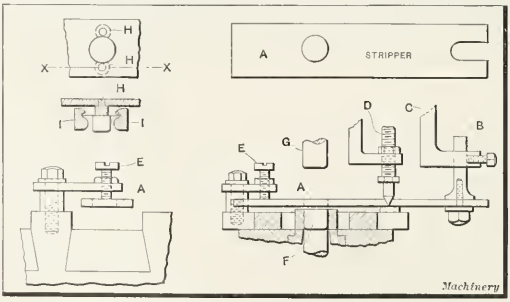


Fig. 2. Stationary Stripper and Method of securing it to the Press

Stripping the Work from the Punches

For the punches and dies used in a multiple plunger press, two forms of strippers are generally used. One of these strippers is known as the stationary stripper, while the other is called a traveling stripper and is used in connection with a thimble for stripping the work from the punches. Fig. 2 shows the stationary stripper *A* held in position by the stud *B*, which, in turn, is held by a bracket *C* fastened to the rear of the press. The stripper has an elongated slot in one end to provide for adjustment. In addition to the stud *B*, the stripper is supported by the pointed screw *D* and the screw *E*, which are placed on each side of the hole used for stripping the shell *F* from the punch *G*. These screws, as well as the stud *B*, can be adjusted to different heights to accommodate different lengths of shells. The pointed end of the screw *D* rests in a small countersunk hole in the stripper; this not only helps to stiffen the stripper but also tends to prevent it from shifting endways. Fig. 2 illustrates the manner in which the stripper strips the shell shown directly underneath it. The device used for stripping flanged shells from the punch with a stationary stripper is shown in the

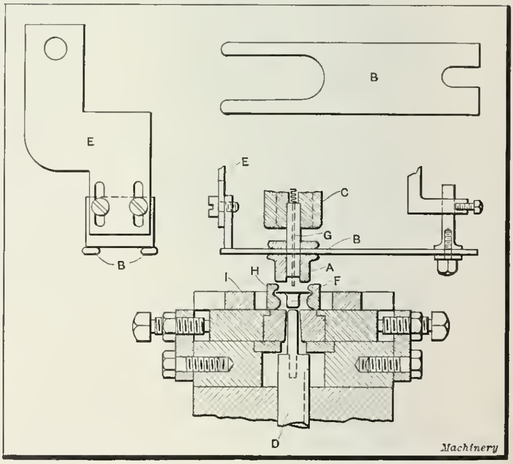


Fig. 3. The Use of a Traveling Stripper on a Multiple Plunger Press

upper left-hand view. Two short shouldered pins *H* strip the work from the punch, so that the flanged part of the shell can be readily grasped and retained in the circular grooves in the fingers *I*, as shown. These pins are made small and placed in the center of the open space between the fingers so that the projecting pins will clear the fingers and not interfere with their free action. The sectional view of this stripper is on the line *X–X*.

Fig. 3 shows the manner in which a traveling stripper is used in the multiple plunger press for stripping the work from the punches. The punch is made a sliding fit in the stripping thimble *A*, which has a circular groove that engages in the forked part of the traveling stripper *B;* this thimble is also used in forming up flanged shells, as the face of the punch-holder *C* forces the thimble down on the flange and keeps it flat, thus preventing the work from getting out of shape. Making use of the stripper thimble in this manner, does away with the necessity of using a solid shouldered punch; and as these thimbles can be used over and over again, they effect quite a saving. When in operation, the thimble is forced downward by the punch-holder; on the upward stroke of the press the traveling stripper, which acts in the capacity of a flat spring, forces the thimble upward with the assistance of the knock-up plunger *D*. When the fork of the stripper comes in contact with the adjustable stop *E*, as shown, it affords a substantial stripping arrangement for stripping the shell *F* from the punch. The stop *E* is fastened to the front of the press, and is made adjustable to allow for different lengths of shells, in order that the shells can be stripped from the punches at the right time on the upward stroke of the press. The punch is made slightly tapering so that the shells can be readily pushed off by the push-pin *G* and grasped by the fingers *H* in the transfer slide *I*.

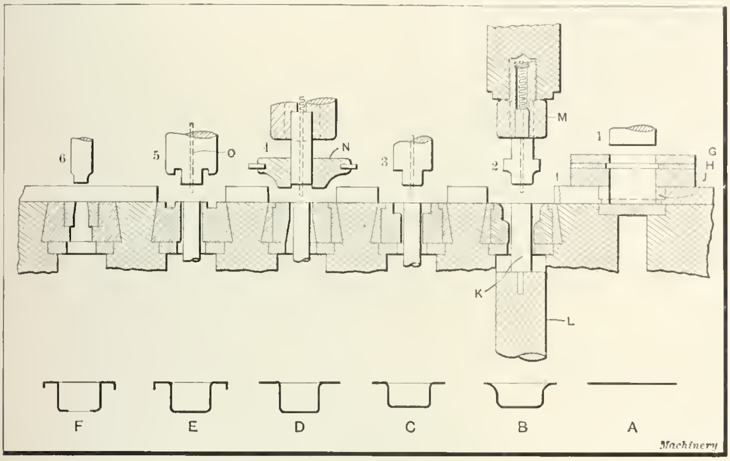


Fig. 4. An Example of Flanged Work formed on Six-plunger Press

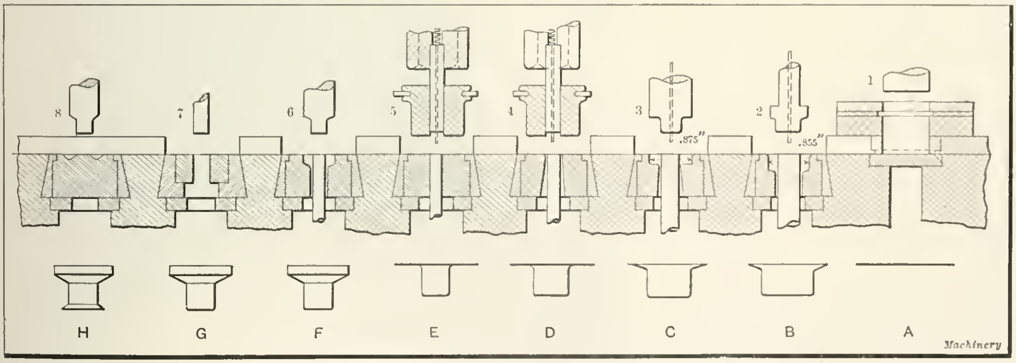


Fig. 5. Construction of Tools used to form Shell H on Eight-plunger Press

Another Interesting Example of Shell Work

Another interesting example of shell work, as performed on the multiple plunger press, is shown in Fig. 4. These tools complete the shell shown at *F* in six operations, their construction and operation being somewhat similar to the tools described in connection with Fig. 1. The metal is fed under stripper *G* in the usual way, and guided by the plates *H*. *I* is the blanking die and *J* the nest in the transfer slide for carrying the blank under plunger No. 2, where it is forced into the die and cupped up as shown at *B*. In this operation no blank-holder is used to prevent the blank from puckering while it is being drawn up. On the downward stroke of the press, the cupping punch forces the blank and the ejecting pin *K* downward. As the knock-up plunger *L* which holds the ejecting pin in place is held up by spring tension, the blank is prevented from shifting and is held central while being cupped up. The blank is first partly cupped by the round corners shown on the top of the die, after which it is drawn up into the desired shape by the lower shoulders on the die. On the upward stroke of the press, the ejecting pin forces the cupped shell out of the die into the fingers of the transfer slide. No stripper is required, as the metal is not pinched hard by the punch, and the shell therefore does not hug the punch. The push-pin *M* merely prevents the shell from clinging to the punch on account of any settlement of oil in the bottom of the shell. In cupping up the shell in the manner previously described, it should be stated that a clean cut blank must be used which is free from all burrs—otherwise the shell will pucker and wrinkle while being drawn into shape, inasmuch as no blank-holder is used, as previously stated.

After the shell is cupped, it is transferred under punch No. 3, where it is drawn up and flanged as shown at *C*. Punch No. 4, with the aid of the thimble *N*, draws the barrel part of the shell smaller and longer, as shown at *D*, while punch No 5 acts upon the flanged part of the shell only, and forms it into the shape shown at *E*. The teat of this punch is made a sliding fit in the barrel part of the shell and guides it into the die. As the shell does not hug the punch, no stripper is necessary; the push-pin *O* prevents the shell from remaining on the punch. The last operation is to pierce out the ¼-hole in the bottom of the shell, shown at *F;* this is done by punch No. 6, after which the finished shell is stripped from the piercing punch by a stationary stripper. The work is then either blown out of the way by compressed air, or pushed off the press by a push-finger, and drops into a box under the press.

Example of Shell Work performed on Eight-plunger Press

Fig. 5 shows a most interesting set of tools for making the shell shown at *H* complete from sheet metal on an eight-plunger press. The tools shown in Fig. 5 are made and operated in the same manner as those already described and therefore require very little explanation. The illustrations show the progress of each operation very clearly, as the shell is carried from one punch to the other. To be brief, the blank *A* is cut from the metal, carried under punch No. 2 and cupped up in the usual way. The cupped shell *B* is then transferred and gradually drawn up into a flanged shell as shown at *C*, *D* and *E*. In drawing up the shell to the form shown at *D* and *E*, the usual stripping thimbles are used in connection with traveling strippers. On the next operation, punch No. 6 cups the flanged part of the shell into the shape shown at *F*. The teat of punch No. 6 next engages the inside of the shell and forces it into the die. As the shell is drawn into the die, the flanged part is cupped up while being drawn over the corner of the die which is slightly rounded, after which it is formed into the desired shape by the beveled shoulder of the die. Punch No. 7 pierces the bottom of the shell; the shell is then stripped from the punch by the stationary stripper. On the last operation, the bottom end of the shell is flared outward, as shown at *H*, by being forced over the short tapered teat shown in the center of the die. The shell is then stripped from the punch and drops into a box under the press.

* * *

STEEL BELTING FOR POWER TRANSMISSION

The use of steel belts in some of the large manufacturing establishments of Huddersfield during the past year has been most satisfactory, states U. S. Consul Franklin D. Hale of Huddersfield, England. At a local mill a steel belt 7⅞ inches wide, weighing 119 pounds, performs the work formerly done by a leather belt 22 inches wide, weighing 814 pounds, driving 300 horsepower. In another mill a steel belt 3½ inches wide, weighing 12 pounds, does work in driving 40 horsepower that formerly required a leather belt 12 inches wide, weighing 64 pounds. This is especially appreciated here in the woolen industry, where steadiness and uniform speed are essential to the best results. The steel belt is also an economizer of space, does not slip or stretch, and gives the greatest efficiency of power delivery. A government test has shown a saving of 61 horsepower on a drive of 640 horsepower in using the steel belt. Wooden pulleys grooved for rope drive need not be discarded in changing to the metal belts, for the former can be easily, and at small cost, converted into serviceable ones for steel belts by stretching a steel band over the top of the grooves, thus obtaining a flat pulley.

* * *

An interesting method for heating a building has been adopted by the Moline Automobile Co., Moline, Ill., in its chassis assembling department. This building is heated by means of steam pipes embedded in the concrete floor. The structure is 120 feet long by 60 feet wide and has door openings extending completely across the ends of the building. As the workmen are obliged to frequently lie on the floor in making necessary repairs and adjustments, it was decided to keep the floor surface comfortably warm; hence 1¼-inch steam pipes spaced 42 inches apart are installed 2 inches below the surface of the 6-inch floor. The concrete is reinforced locally against cracking due to the expansion of the steam pipes by corrugated iron pipes enclosing the former. It is stated that by using only five small ordinary radiators in addition to this heating system, it is possible to maintain a uniform temperature of from 65 to 70 degrees F. throughout the building.

* * *

It is stated that the barbers in the Calumet region have an experience of their own with Portland cement. The barbers claim that the dust in the cement plants in these districts settles in the men's beards, and that after having been moistened with perspiration it sets hard, forming, in combination with the beard, a good reinforced concrete that takes the edge off the razors. Here is an opportunity for a prolific inventor to produce a tonsorial sand blast.

PROPORTIONS FOR ROLLING MILL FILLINGS OR DETAILS

BY R. H. CREVOISIE[*]

The accompanying illustration and the formulas give proportions for mill fillings. Assume that *U* equals the unit pitch diameter of the rolls; then referring to the illustration:

$A = U \times 0.3$

$B = U \times 0.075$ to $U \times 0.1$

$C = U \times 0.1$ to $U \times 0.125$

$D = U \times 0.075$

$E = U \times 0.25$

$F = (V \div 2) + D - E$

$G = U \times 0.16$

$H = (U \times 0.55) + 2S + \frac{1}{2}$ in.

$J = U \times 0.4$ to $U \times 0.5$

$K = U \times 0.55$ to $U \times 0.65$

$L = U \times 0.3$

$M = L + 2$ inches

$N = U \times 0.6$

$P = \frac{1}{2}V + \frac{3}{4}$ to $1\frac{1}{2}$ inch

$Q = \frac{1}{4}$ inch minimum

$R =$ from ¼ to ½ inch

$S = U \times 0.05$

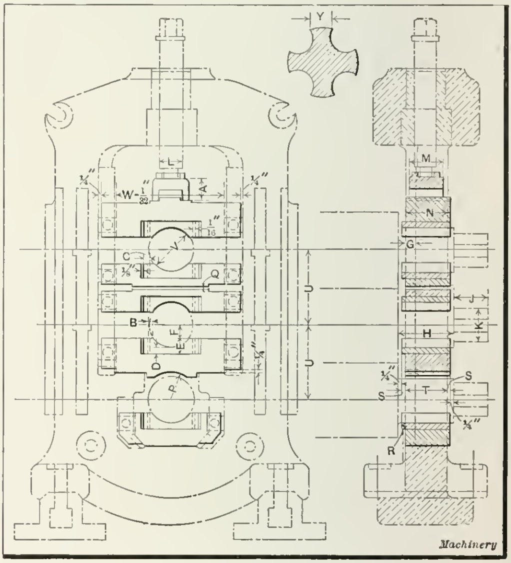
$T = U \times 0.55$

$V = U \times 0.6$

$W = U \times 1.3$

Make pitch of Acme thread on screws equal to $U \times 0.05$.

When capped housings are used, two bolts should be employed, square in housing for key, and round in cap.



Notation used in Formulas for Proportions of Rolling Mill Details

The wabbler on the rolls and spindles is usually made with four jaws, as shown in the detail view at the top of the illustration. Dimension $Y = V \div 4$.

The diameter of the bolts $= U \times 0.19$ to $U \times 0.20$.

Outside diameter of spindles $= U \times 0.55$ to $U \times 0.65$.

Length of wabbler on roll $= U \times 0.4$ to $U \times 0.5$.

Outside diameter of coupling box $= U \times 0.9$.

The length of coupling box $= 2J$.

Allow ½ inch clearance between end of roll and end of spindle. Allow 3/16 inch clearance on radius between spindle and coupling box.

The boxes should be made of brass with babbitt set in pockets. The boxes are not finished. The carrier should be made of steel casting.

Face of pinions $= U \times 0.35$ to $U \times 0.5$ for each stand in the train. Use machine molded herringbone teeth and solid pinion boxes of steel casting with brass shell and babbitt strips. Allow ⅛ inch from the body of the pinion to the box in the pinion stand.

It is common practice to make the maximum peripheral speed of the finishing rolls 900 feet per minute.

In using the above formulas on fractional sizes less than 1 inch use the nearest larger sixteenth of an inch, and on sizes over 1 inch, use the nearest one-eighth.

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[*] Address: Wickes Boiler Co., Canton, Ohio.

DESIGNING STEEL TOWERS FOR WOOD TANKS*—2

A COMPLETE ANALYSIS OF THE STRESSES IN THE TOWER STRUCTURE

BY EDMUND B. LA SALLE†

In the first article on this subject, the computations necessary for the determination of the stresses in the members of the tower frame were discussed. The present article applies the principles discussed to an example. We will consider a structure consisting of a medium sized tank and a tower of medium height. An outline of the methods used for finding the stresses in the structure and proportioning its members to sustain these stresses will be given; and this outline will be followed in illustrating the procedure in designing a tower. The principles applied in the present discussion were fully explained in the article published in the January issue of MACHINERY, and that article should be read as a preparation for what is to follow, especially by those not familiar with the subject. The following is an outline of computations necessary for determining the stresses in a four-post tower.

A. Dead Load in Post

The sum of the following gives the load on the posts: Weight of water, roof, tank, railing, balcony, floor system, and tower. The total weight of these items divided by 4 and multiplied by the secant of the batter of the posts (if any) gives the load in one post due to gravity. The secant for a batter of 1 inch per foot of column length is 1.00692. Multiplying the sum of the foregoing weights by 0.25173 gives the same result for a 1 inch batter.

B. Tank Wind Overturning Moment

1. Vertical projected area of the roof multiplied by the wind force per square foot determined according to either of the formulas previously given. 2. Vertical projected area of tank multiplied by 15. 3. Depth of cap beam multiplied by tank diameter, multiplied by 30. 4. The sum of these three results is the "tank wind." The tank wind multiplied by tank wind leverage gives the tank wind overturning moment.

C. Tower Wind Overturning Moment

1. Height of tower (length of posts) multiplied by the wind pressure per vertical foot gives the "tower wind." 2. Tower wind multiplied by half the tower height gives the tower wind overturning moment.

D. Stress in Post due to Tank Wind, and E, Stress in Post due to Tower Wind

$$\frac{B}{\text{Diagonal column centers}} = \text{stress in post due to tank wind overturning moment.}$$

$$\frac{C}{\text{Diagonal column centers}} = \text{stress in post due to tower wind overturning moment.}$$

D and E can be combined to obtain the stress due to the total wind load as follows:

$$\frac{B + C}{\text{Diagonal column centers}} = \text{stress in post due to total wind load.}$$

Diagonal column centers refers to the diagonal at the base of the tower or at the bottom of any panel under consideration.

F. Total Column Load, and G, Load in Anchor Rods

$A + D + E =$ total column load.

$$D + E - \frac{\text{Weight of structure—weight of water}}{4} = \text{load in}$$

anchor rods.

H. Initial Load in Stress Diagram

This stress is obtained from the following formula:

$$\frac{\text{Tank wind}}{2} + \frac{\text{top panel wind}}{4} = \text{initial load in stress diagram.}$$

I. Load in Top Girt

The sum of the following gives the load in the top girt: weight of water, roof, tank, railing, balcony, and floor system. The sum of the preceding divided by 4, multiplied by the tangent of batter and added to H gives the load in the top girt. For towers with posts which batter 1 inch per foot of length, the load is given by the formula:

$$\frac{\text{Total weight in } A\text{—weight of tower}}{48} + H = \text{load in top girt.}$$

J. Wind Load Concentrated at Panel Points

The wind load concentrated at the panel points is found by multiplying the two panels adjacent to strut (or girt) by the wind force per foot of tower, and dividing the result by 4.

With this outline as a guide, we will take a 75-foot, four-post tower, supporting a wooden tank 20 feet in diameter by 20 feet high, and carry through all of the operations involved in its design. A 75-foot tower means a tower of sufficient height to raise the inside of the tank bottom 75 feet or, in other words, to give the lowest water line in the tank a 75-foot elevation.

Weight of Parts

By referring to the table of tank capacities, we find that a 20 by 20 foot tank contains 41,540 gallons. At 8.33 pounds per gallon, we have a water weight of 346,167 pounds. The table also gives the maximum weight of a cypress tank of this size as 19,200 pounds. No attempt will be made to tabulate the various weights of each item mentioned under A; therefore, the writer has made careful comparison of the data at his disposal and compiled a set of formulas which will give a close approximation of the various weights. We will take them in the order in which they were named in A.

TANKS WITH ROUND HOOPS MADE FROM THREE-INCH MATERIAL

Length Stave, Feet	Diameter		Hoops				Gross Capacity in Gallons	Pine, Weight	Cypress, Weight
	Feet	In.	$\frac{3}{4}$-in.	$\frac{7}{8}$-in.	1-in.	$1\frac{1}{8}$-in.			
10	10	0	8	..	..	..	4750	3200	4200
12	10	0	10	..	..	..	5700	3700	4900
14	10	0	11	..	..	..	6680	4200	5600
10	12	0	9	..	..	..	7053	4000	5300
12	12	0	10	..	..	..	8488	4600	6000
14	12	0	12	..	..	..	9902	5200	6800
14	12	6	13	..	..	..	10798	5600	7200
14	14	0	14	..	..	..	13750	6500	8400
16	14	0	17	..	..	..	15701	7400	9600
14	15	0	14	..	..	..	15906	7000	9100
14	16	0	15	..	..	..	18229	7700	10000
16	16	0	5	11	..		20833	8900	11400
18	16	0	4	14	..		23406	9800	12600
14	17	0	16	..	..		20701	8400	10900
14	18	0	3	10	..		23340	8900	11600
16	18	0	4	12	..		26689	10200	13100
18	18	0	4	16	..		30004	11500	14700
18	18	6	4	16	..		31772	12100	15500
20	18	6	4	20	..		35285	13200	16800
16	19	2	4	13	..		30433	11200	14400
16	20	0	4	13	..		33270	11600	14900
16	20	8	4	13	..		35620	12100	15400
18	20	0	..	4	13		37423	13400	17100
20	20	0	..	4	18	..	41540	15200	19200
18	21	0	4	23	..		41428	14500	18500
14	22	0	4	11	..		35451	11800	15200
16	22	0	4	15	..		40576	13300	17000
16	22	3	..	15		..	40702	13600	17400
20	22	0		4	19	..	50687	17000	21500
24	22	0	..	4	28		61129	20900	26100
16	24	0		4	14	..	48606	15700	19900
16	24	6		4	14	..	50723	16200	20200
20	24	6		4	24		63884	20300	24800
18	26	0	..	4	17		64587	19200	24300
16	27	0		3	16		62006	18700	23700
18	28	3		4	19	..	76667	22000	27800
16	30	2			20	..	77926	22200	28000
20	30				4	22	96480	27800	34200
20	30	6	..		4	22	102669	28400	35000

Machinery

—From Catalogue of the U. S. Wind Engine & Pump Co., Batavia, Ill.

$(\text{Tank diameter})^2 \times 11 =$ weight of roof for tanks 25 feet in diameter and larger.

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* For further information on the design of steel towers for wood tanks, see the first installment of this article published in the January issue of MACHINERY; also "Double Angle Columns," published in the January, 1912, issue of MACHINERY.

† Address: 159 Harrison St., Batavia, Ill.

$(\text{Tank diameter})^2 \times 12 =$ weight of roof for tanks 24 feet in diameter and smaller.

Diameter of tank × 22 = weight of gas pipe hand railing.

Diameter of tank × 100 = weight of balcony or walkway.

Capacity of tank × 0.20 = weight of floor system.

Four-post Steel Towers

The weight of a tower depends a good deal on the designer. For the same capacity of tank, towers of different heights increase or decrease in weight in about direct proportion with the heights. For different capacities we strike another condition, and the only way to arrive at the approximate weight is by comparison with some previous design for the same capacity. The writer has fairly complete data on four-post steel towers for wooden tanks ranging from 10,000 to 50,000 gallons capacity, and from this data he has developed the following formulas:

For 50-foot towers to support tanks within the capacities named, the approximate weights are:

$$\text{Weight} = 15{,}800 - 9600\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

For 75 foot towers,

$$\text{Weight} = 23{,}500 - 14{,}200\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

For 100-foot towers,

$$\text{Weight} = 35{,}600 - 23{,}200\left(\frac{50{,}000 - C}{40{,}000}\right) \text{ pounds.}$$

C in each case is the capacity required in gallons.

For intermediate heights, the weights can be obtained by interpolation. It is a good plan to round off the weight by raising it to the next higher 1000 pounds. For tanks of 60,000 to 100,000 gallons capacity, a different style of construction must be used for the tower. For tank capacities up to 50,000 gallons, the cheapest tower construction is one of angle steel, but for tanks of over 50,000 gallons this construction is not economical and laced channel columns are used instead of the double angle columns. For the laced channel towers, the following formulas will apply for tank capacities ranging from 60,000 to 100,000 gallons:

50 foot towers,

$$\text{Weight of tower} = 26{,}000 - 4000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

75-foot towers,

$$\text{Weight of tower} = 39{,}000 - 12{,}000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

100 foot towers,

$$\text{Weight of tower} = 50{,}000 - 14{,}000\left(\frac{100{,}000 - C}{40{,}000}\right)$$

We have now provided a method of finding the approximate weight of any part of the structure and can, therefore, proceed with the calculations. We will give the weights of parts calculated by the foregoing formulas and also arrange computations in accordance with the outline previously given.

A. Dead Load in Post

Weight of water = 346,167 pounds.
Weight of roof = 4800 pounds.
Weight of tank = 19,200 pounds.
Weight of railing = 440 pounds.
Weight of balcony = 2000 pounds.
Weight of floor system = 8308 pounds.
Weight of tower = 20,500 pounds.
Total weight, 401,415 pounds.
Weight on each column = 100,354 pounds.

Multiplying 100,354 by 1.00692 we have 101,048 pounds for the dead load in one column. Multiplying 401,415 by 0.25173 we have 101,048, which is a good check on the other method and really simpler.

B. Tank Wind Overturning Moment

Assuming the tank roof as 2 feet larger than the tank and quarter pitch, we have a roof 22 feet in diameter and 5 feet 6 inches high. The vertical projected area is equal to 11 × 5.5 = 60.5 square feet. At 3 pounds per square foot, the wind on the roof becomes 182 pounds. The wind on the tank is 20 × 20 × 15 = 6000 pounds. The cap-beams used for a 20 by 20 foot tank are 20-inch I-beams. This gives the wind on the floor system as 1.67 × 20 × 30 = 1002 pounds. The total tank wind then is 7184 pounds. In case the floor system has not been designed and the size of the cap-beams is not known, the following formula will give the approximate bending moment in inch-pounds:

$$M = \text{diameter} \times \text{capacity} \times 2.$$

Then dividing by the fiber stress to be used, we have the section modulus of the cap-beam; 12,500 pounds per square inch is a safe value for fiber stress. Tests have shown that steel beams fail at from 30,000 to 35,000 pounds per square inch, and a fiber stress of 12,500 pounds gives a safety factor of from 2½ to 2¾. Some engineers use 16,000 pounds for the fiber stress, but that is too high, especially if the beams have a number of holes punched in the flanges, as this reduces the section in the most vital place. The tank wind leverage is 85 feet and 7184 × 85 = 610,640 foot-pounds = tank wind overturning moment.

C. Tower Wind Overturning Moment

The wind force per foot of tower for a 20 by 20 by 75 foot tank and tower is about 210 pounds. The posts are 73 feet long in order to give 75 feet elevation to the tank, and also to make it possible to use stock lengths of material.

73 × 210 = 15,330 pounds = tower wind.
15,330 × 36.5 = 559,545 foot-pounds = tower wind overturning moment.

D + E. Stress in Post due to Total Wind Load

In order to arrive at the diagonal column centers at the base of the tower we must first know the column centers at the top. The most economical center at the top is 0.59 times the inside diameter of the tank. For a 20-foot tank, according to this rule, it becomes 11 feet 6 inches. With a column batter 1 inch per foot of post length, the bottom centers become 23 feet 8 inches. The diagonal of 23 feet 8 inches is 33 feet 5⅝ inches = 33.46 feet. The total overturning moment is 1,170,485 foot pounds. This divided by 33.46 gives a stress in the post, due to the wind, of 34,982 pounds.

F. Total Column Load

Total column load = $A + D + E$.

$$\begin{aligned} A &= 101{,}048 \text{ pounds.} \\ D + E &= \underline{34{,}982 \text{ pounds}} \\ & 136{,}030 \text{ pounds, total column load.} \end{aligned}$$

G. Load in Anchor Rods

Weight of complete, loaded, structure 401,415 pounds.

$$D + E - \frac{\text{Weight of loaded structure} - \text{weight of water}}{4} =$$

$$34{,}982 - \frac{401{,}415 - 346{,}167}{4} = 34{,}982 - 13{,}812 = 21{,}170$$

pounds = load in anchor rods.

Strength of Columns

The necessary loads have now been determined to enable us to proceed with the sizes of tower members. The first thing to decide on is the size of the columns or posts. There have been unlimited discussions among engineers as to the proper formula for determining the strength of columns, but as yet nothing definite has been accomplished along that line. The lack of tests on large sized specimens has been the chief drawback. Consequently the designer must use the formula that he believes is best suited for the work upon which he is engaged. In the January, 1912, issue of MACHINERY, two tables were published giving safe strength per square inch of section for various lengths of columns, calculated according to two formulas in common use in tank tower design. The formula in most general use is:

$$\text{Strength per square inch} = 17{,}100 - 57\,\frac{L}{R} \text{ pounds.}$$

This formula is specified by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies of Boston, Mass., for tank towers to be used in connection with sprinkler systems under its jurisdiction. The values given by this formula are, however, rather high. The other formula referred to is:

$$\text{Strength per square inch} = 16{,}000 - 70\,\frac{L}{R}\ \text{pounds.}$$

The values given by this formula are lower, but like all straight line formulas it is about right for medium heights, the results being too high at one end and too low at the other. In the preceding formulas, L is the distance between struts in inches, and R the least radius of gyration.

The *Engineering News*, of August 26, 1909, gives a record of government tests, made at the Watertown Arsenal, on columns of various shapes and lengths. The following gives the average stresses at which failure occurred: On 5-inch tubular columns the flat, round, pin and fixed end specimens show practically the same results. With a value of 50 for the factor $\frac{L}{R}$, failure occurred at 30,000 pounds fiber stress, while with a value of 150 for $\frac{L}{R}$ failure took place at 25,000 pounds. Here a straight line formula would do nicely as the intermediate lengths show failures almost in a line between the two extremes just mentioned. The rolled H-columns having values of 50 to 125 for $\frac{L}{R}$ failed at from 30,000 to 25,000 pounds with flat ends and at 30,000 to 22,000 pounds with pin ends. With 150 for the value of $\frac{L}{R}$ the flat ended columns failed at 20,000 and the pin ended columns at 15,000 pounds. Built-up angle and plate columns having flat and pin ends with values of 50 to 125 for $\frac{L}{R}$ failed at 33,000 to 30,000 pounds. With 175 for value of $\frac{L}{R}$, flat ended columns failed at 25,000 pounds and pin ended columns at 20,000 pounds.

All of the tests are not given, as we are not interested in anything under 50 or over 175 for the value of $\frac{L}{R}$. From the foregoing results the writer has developed the following formulas:

For tubular columns with flat or pin ends, having values of 50 to 150 for $\frac{L}{R}$, the ultimate strength per square inch is:

$$S = 30{,}000 - 50\left(\frac{L}{R} - 50\right)\ \text{pounds.}$$

For rolled H-sections with flat ends and 50 to 125 for $\frac{L}{R}$:

$$S = 30{,}000 - 67\left(\frac{L}{R} - 50\right)\ \text{pounds.}$$

For H-sections with pin ends and 50 to 125 for $\frac{L}{R}$:

$$S = 30{,}000 - 107\left(\frac{L}{R} - 50\right)\ \text{pounds.}$$

For H-sections with flat ends and 125 to 150 for $\frac{L}{R}$:

$$S = 25{,}000 - 200\left(\frac{L}{R} - 125\right)\ \text{pounds.}$$

For H-sections with pin ends and 125 to 150 for $\frac{L}{R}$:

$$S = 22{,}000 - 280\left(\frac{L}{R} - 125\right)\ \text{pounds.}$$

For built-up sections with flat or pin ends and 50 to 125 for $\frac{L}{R}$:

$$S = 33{,}000 - 40\left(\frac{L}{R} - 50\right)\ \text{pounds.}$$

For built-up sections with flat ends and 125 to 175 for $\frac{L}{R}$:

$$S = 30{,}000 - 100\left(\frac{L}{R} - 125\right)\ \text{pounds.}$$

For built-up sections with pin ends and 125 to 175 for $\frac{L}{R}$:

$$S = 30{,}000 - 200\left(\frac{L}{R} - 125\right)\ \text{pounds.}$$

In the work we are considering, tubular columns would not be adaptable as it would be hard to make good connections and splices with this section. They are occasionally used for light building work. The H-columns are rarely used for towers but are very well adapted for building work. The built-up angle column is used more than any other type except the single angle column which is the cheapest and best construction in the case of small tanks. The strength of single angle columns is limited, however, so that they cannot be used to advantage for tanks larger than 16 feet by 16 feet. In the January, 1912, issue of MACHINERY, on page 371, a type of column is shown that is used almost exclusively for tank towers, and from the sizes given in the Data Sheet Supplement for the same month, entitled "Properties of Double Angle Columns," we will select a column for the case in hand. We will also work out the value of the column by the three formulas just given, in order to show how they coincide, or rather how close they come to doing so.

We will first try a column made of two 6 by 6 by ½ inch angles fastened together by short tie plates, as shown in the article just referred to, and having a bottom panel length of 17 feet 6 inches = 210 inches. The radius of gyration of this section is 2.33 and the cross-sectional area 11.50 square inches.

$$\frac{L}{R} = \frac{210}{2.33} = 91$$

Using the formula: Strength per square inch = 17,100 — 57 $\frac{L}{R}$, a value of 91 for the slenderness factor $\frac{L}{R}$ gives the column a strength of 11,913 pounds per square inch or a total strength of 137,000 pounds.

Using the formula: Strength per square inch = 16,000 — 70 $\frac{L}{R}$, a value of 91 for $\frac{L}{R}$ gives a strength of 9630 pounds per square inch or a total column strength of 110,745 pounds. Both formulas are supposed to give a safety factor of 4, so it is interesting to note the comparative results.

Now we will try the formula derived from actual tests. With 50 to 125 for the value of $\frac{L}{R}$ we use the formula:

$$S = 33{,}000 - 40\left(\frac{L}{R} - 50\right)$$

and substituting a value of 91 for $\frac{L}{R}$ gives

$$33{,}000 - 40\ (91 - 50) = 31{,}360\ \text{pounds per square inch}$$

as the ultimate strength.

31,360 × 11.50 = 360,640 pounds as the ultimate strength of the column. The load on the column is 136,030 pounds and $\frac{360{,}640}{136{,}030} = 2.65$ actual factor of safety according to the government tests.

Then for the formula: Strength per square inch = 17,100 — 57 $\frac{L}{R}$ pounds we have an actual factor of safety of $\frac{136{,}030}{137{,}000} \times 2.65 = 2.63$ instead of 4 as it is supposed to be.

In the formula: Strength per square inch = 16,000 — 70 $\frac{L}{R}$ pounds we have $\frac{136{,}030}{110{,}745} \times 2.65 = 3.25$ for the actual safety factor. Of course, these particular safety factors only apply at the point where the value of $\frac{L}{P}$ is 91. At either extreme of the formulas, the difference will be greater.

We will try them with a value of 50 for $\frac{L}{R}$. For the first formula, the strength is 12,000 pounds per square inch, as that is the value specified for values of 90 and under for $\frac{L}{R}$. For the second formula, the strength is 12,500 pounds per square inch. According to the tests, failures for this length occurred at 33,000 pounds per square inch. Then the first formula gives a safety factor of $\frac{33,000}{12,000} = 2.75$. The second formula gives a factor of $\frac{33,000}{12,500} = 2.64$.

The first formula changes its safety factor between the points of 90 and 50 for the value of $\frac{L}{R}$ from 2.63 to 2.75. Owing to the fact that 12,000 pounds per square inch is called for with 90 and under as the value of $\frac{L}{R}$, there is a varying safety factor which becomes greater as the column grows shorter. If it worked the other way, so that the safety factor increased as the column grew longer, it would be preferable. The second formula changes at the same points from a factor of 3.25 to 2.64. With a value of 50 for $\frac{L}{R}$, the formula gives a safety factor of 2.64 instead of 4 as it is supposed to do.

We will now try the formulas with a value of 150 for $\frac{L}{R}$. The first formula gives 8550 pounds per square inch as the safe strength. The second formula gives 5500 pounds per square inch. The tests showed a value of the ultimate strength

$$S = 30,000 - 100\left(\frac{L}{R} - 125\right) = 27,500 \text{ pounds per square inch.}$$

This gives the first formula a safety factor of $\frac{27,500}{8550} = 3.21$. The second formula has a factor of $\frac{27,500}{5500} = 5$. From this we can see that the two formulas do not have a uniform safety factor throughout their length, although they are both supposed to have a factor of 4. The first one varies between the 100 points considered in two ways. From 91 to 150 as the value of $\frac{L}{R}$, the safety factor changes from 2.63 to 3.21, and for values of $\frac{L}{R}$ from 90 down to 50, the safety factor changes from 2.63 to 2.75. At that rate, the formula shows the column to be weakest for the middle points. The second formula has a gradual increase in its safety factor ranging from 2.64 with a value of 50 for $\frac{L}{R}$ to 5 with 150 for $\frac{L}{R}$.

We ought not to have an actual factor of safety of less than 3 and as two 6 by 6 by ½ inch angles do not meet this requirement we will try two 6 by 6 by 9/16 inch angles, which have a radius of gyration of 2.32 and a section area of 12.86. $\frac{L}{R} = \frac{210}{2.32} = 91$. With this length of column, the section is good for 31,360 pounds per square inch ultimate strength, as previously determined according to the writer's formula. This gives a total column strength of 403,290 pounds. We then have a safety factor of $\frac{403,290}{136,030} = 2.98$.

When we know that we have an actual safety factor of practically 3 under the maximum conditions of loading, we need feel no apprehension as to the design of our structure, providing, of course, that all joints and splices are made of the same strength as the main members. When we merely use formulas that give a varying safety factor we cannot feel sure that we have obtained safe results. As previously mentioned, the total length of posts for this tower will be 73 feet, and the structure will be divided into four panels. Starting with the bottom panel and going up, the panel lengths will be 17 feet 6 inches, 18 feet, 18 feet 6 inches, and 19 feet. The bottom panel should always be shorter where the same size post is used throughout, as the heaviest load occurs at the bottom, the loads becoming lighter toward the top so that the panels can be gradually lengthened. Of course, where a lighter post is introduced, this may not be possible. It will be necessary to calculate the loads in all panels when great economy in the use of material is practiced.

It appears that in the case under consideration we can reduce the post in the third panel from the bottom to two 6 by 6 by ½ inch angles. The tank wind leverage is decreased by 35 feet 6 inches and becomes 49 feet 6 inches. This gives: 7184 × 49.5 = 355,658 foot-pounds = tank wind overturning moment in upper panels. The height of the tower is likewise decreased by 35 feet 6 inches and becomes 37 feet 6 inches.

37.5 × 210 = 7875 pounds = tower wind in upper panels.
7875 × 18.75 = 147,656 foot-pounds = tower wind overturning moment in third panel.

The total overturning moment in the third panel is then 503,314 foot-pounds. The diagonal column centers at the bottom of the panel considered are 25.10 feet.

$$\frac{503,314}{25.10} = 20,052 \text{ pounds} = \text{column wind load.}$$

The dead and water load will be the same as before, with the exception of the tower weight which will be reduced nearly half. We can obtain the approximate weight by direct proportion, thus:

$$\frac{37.5}{73} \times 20,000 = 10,274 \text{ pounds} = \text{weight of lower panels.}$$

20,000 — 10,274 = 9726, and 9726 ÷ 4 = 2431 pounds = reduction in tower weight on each post.

$$\begin{array}{rl} 101,048 & = \text{dead load for bottom panel,} \\ 2431 & = \text{reduction in tower weight,} \\ \hline 98,617 & = \text{new dead load per post.} \end{array}$$

Then 98,617 + 20,052 = 118,669 pounds = column load in panel under consideration.

The panel length L is 18 feet 6 inches or 222 inches and the least radius of gyration $R = 2.33$.

$$\frac{L}{R} = \frac{222}{2.33} = 96.$$

According to Formula (3) this gives a unit strength of 31,160 pounds per square inch or a column strength of 358,340 pounds ultimate.

$$\frac{358,340}{117,850} = 3.04 \text{ safety factor.}$$

This shows that it is safe to use two 6 by 6 by ½ inch angles in the two top panels.

* * *

The desire to rate everything mechanical by horsepower has led to some peculiar expressions. We have 1000 H. P. boilers, 1000 H. P. feed water heaters, 1000 H. P. condensers, 1000 H. P. exhaust heads, etc. Rolling mill reversing engines frequently are rated by horsepower. We hear about 10,000 H. P. engines, 20,000 H. P. engines, and even 30,000 H. P. engines. The well-known engine size which for years was standard in American mills, namely 55 inches by 60 inches, when run with full steam admission, will develop over 25,000 H. P. at a speed of 250 R. P. M. And yet any such rating is arbitrary and misleading. The engine works with full steam admission only at low and medium speeds. When running at high speed, it works with greatly reduced steam admission, so that the horsepower developed by the 25,000 H. P. engine never exceeds 6000. In a test made on a blooming mill of the Pittsburg district the horsepower in the early passes was about 4000; it rose to less than 5500, and in the last pass it dropped again below 4000 in spite of the greatly increased speed. It is obvious that the steam engine cannot develop more power than the mill will take. On account of the fact that the engine cannot develop more power than the mill will take it is probably best to rate the rolling mill reversing engines solely by their cylinder sizes.

AUTOMATIC SCREW MACHINE EQUIPMENT*—1

TOOL EQUIPMENT USED ON NATIONAL-ACME MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON†

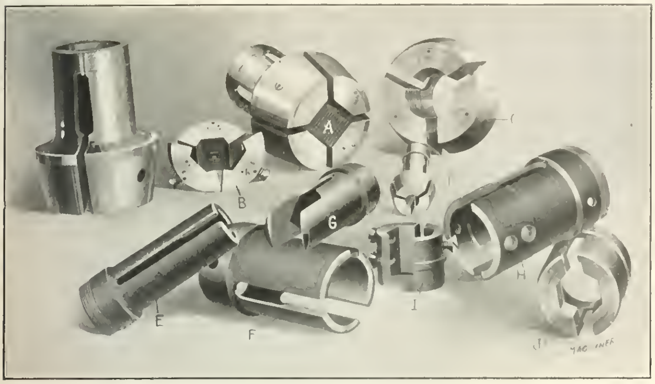

Fig. 1. Type of Spring Chucks and Feed Chucks used in the "Acme" Multiple-spindle Automatic Screw Machine

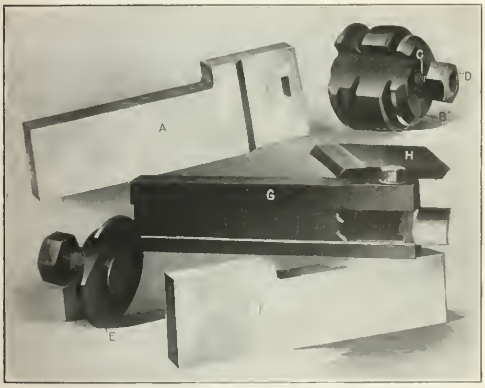

Fig. 2. Circular Form and Cut-off Tools and Holders, and Blade Type of Cut-off Tools and Holders

The standard tool equipment used on the "Acme" multiple-spindle automatic screw machine is somewhat similar in design to that used on any other screw machine, but, of course, a number of the tools are especially designed for this type of automatic screw machine. The standard tools used comprise spring chucks, feed chucks, circular form and cut-off tools, straight and blade type forming and cutting-off tools, drill-, tap- and die-holders, box-tools, etc. Under the heading of special tools are included shaving tools, thread rolling tools, reaming attachments, etc. In the following article these various tools will be illustrated and described.

Spring Chucks and Feed Chucks

The spring chucks for holding the bars when they are being operated upon are of the push-in type, a group of which appears in Fig. 1. In the larger machines—sizes 52, 53, 54, 55 and 56 these spring chucks are provided with jaws *B*, which are held in place in the chuck by screws. The spring chuck at *A* is provided with jaws for holding square stock, whereas that at *C* is for holding round bars. *D* shows the type of "solid" chucks which are used in the smaller machines. When conditions will permit the front of the chucks to be counterbored so as to hold jaws, they are then known as master chucks. This greatly increases their capacity, as it is evident that the same chucks can be used for holding various diameters of stock simply by substituting jaws of the proper size.

The dimensions of the solid and master spring chucks used in the various sizes of machines are given in Table I. Here it will be noticed in numerous instances throughout the table that no dimensions are given; the reason for this is that the shape of the chuck is changed from that shown in the illustration. For instance, in Column F size 52 has no flat, the tapered nose in these chucks extending up to the shoulder. In Column J, sizes 51 and 515 are not provided with jaws, so in this case the chucks would not be counterbored in the front end, but are bored straight to suit the bars which they are made to hold. The same remarks apply to Column N, except that for sizes 54 and 56, the holes in the chucks are made straight, but are meant to hold jaws. The counterbored seat *P* is omitted, of course, in the solid type of spring chucks; also pin holes *Q* and dimensions *L*. The same remarks made in connection with Column N apply to T. The depth of the counterbore in the master spring chucks for the screws holding the jaws should not extend beyond the line *X* in the engraving. Chucks intended to hold square stock should have four slots, at ninety degrees. A 5/16-inch

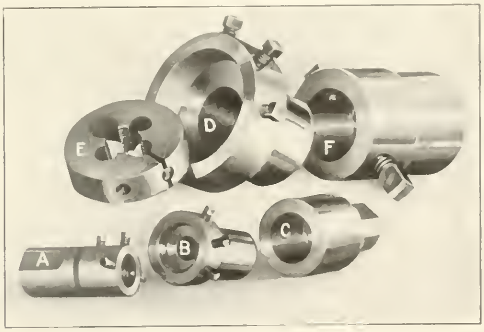

Fig. 3. Tap and Die Holders and Extension Shanks

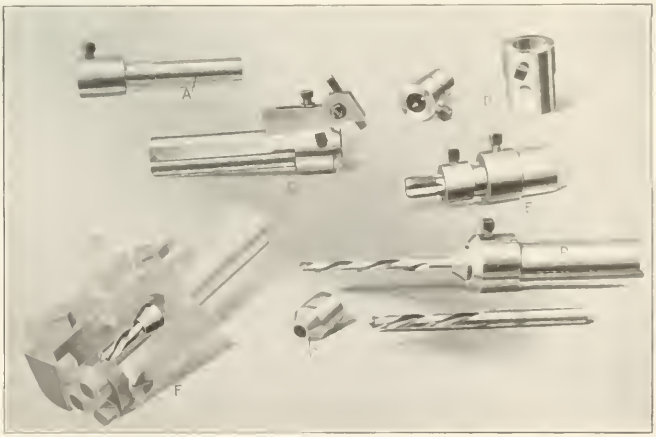

Fig. 4. Standard Drill Holders and Bushings

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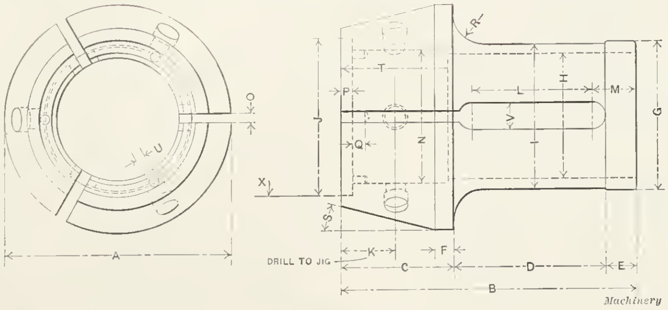
[*] For further information on National-Acme screw machine equipment, see "The Acme Multiple Spindle Automatic Screw Machine," December, 1912, and January, 1913.

[†] Associate Editor of MACHINERY.

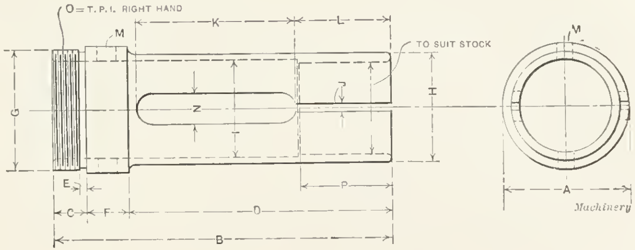
TABLE I. PRINCIPAL DIMENSIONS OF SPRING CHUCKS USED IN "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINES



Machine, No. or Size	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
	Dimensions in inches																					
51	7/8	1 25/32	19/32	31/32	7/32	1/16	41/64	7/16	19/32	...	...	11/16	5/16	...	5/64	..	..	1/8	16 1/2	...	..	3/16
515	1 3/8	2 13/16	3/4	1 11/16	3/8	1/32	1 1/16	13/16	1	...	...	1 3/8	1/2	...	0.081	..	..	1/5	13	...	..	1/4
52	1 7/8	3	11/16	1 7/8	7/16	..	1 1/4	15/16	1 3/16	1 5/16	25/64	1 1/2	9/16	1 1/16	7/64	1/8	1/8	1/4	13	23/32	#42	1/4
53	2 1/4	3 9/16	1 1/8	1 15/16	1/2	3/32	1 33/64	1 7/32	1 29/64	...	9/16	1 5/8	19/32	1 3/8	7/64	..	..	1/4	13	1	..	5/16
54	2 11/16	3 7/16	1 1/8	1 13/16	7/16	1/4	2 1/64	1 5/8	1 15/16	2	23/32	1 1/2	5/8	...	7/64	3/16	3/16	1/4	13	...	1/8	3/8
55	3 9/16	4 3/4	1 13/16	2 5/16	5/8	5/16	2 21/64	2	2 5/16	2 1/2	61/64	1 7/8	25/32	2 1/8	1/8	3/16	3/16	1/2	13	1 3/4	1/8	7/16
56	4 1/16	5 1/8	2 1/8	2 1/4	3/4	5/16	3 1/16	2 5/8	3	3	15/16	1 7/8	13/16	...	1/8	3/16	1/4	1/2	12 1/2	...	1/8	1/2

Machinery

TABLE II. PRINCIPAL DIMENSIONS OF FEED CHUCKS USED IN THE "ACME" MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE



Machine, No. or Size	Chuck Capacity in Ins.			Dimensions in Inches															
	Round	Square	Hex.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
51	1/4	0.176	0.216	0.465	1 7/8	3/8	1 1/8	1/16	3/16	7/16	13/32	9/32	5/64	3/8	1/2	3/16	1/8	32	1/2
515	9/16	0.398	0.487	27/32	3 1/16	7/16	2 1/4	3/32	3/8	3/4	3/4	19/32	5/64	1 3/8	3/4	3/16	3/16	30	13/16
52	3/4	0.530	0.649	31/32	3 7/16	7/16	2 1/2	3/32	1/2	7/8	29/32	23/32	5/64	1 1/2	7/8	1/4	3/16	30	3/4
53	1	0.707	0.866	1 9/32	4 5/16	7/16	3 3/8	3/32	1/2	1 3/16	1 3/16	1	5/64	2 7/16	7/8	1/4	5/16	24	7/8
54	1 3/8	0.972	1.190	1 23/32	4 9/16	7/16	3 5/8	3/32	9/16	1 5/8	1 1/2	1 5/16	..	..	..	5/16	3/8	24	1 1/4
55	1 5/8	1.24	1.51	2	4 5/8	7/16	3 1/2	1/16	11/16	1 7/8	1 13/16	1 11/16	..	..	..	5/16	7/16	24	1 1/4
56	2 1/4	1.766	2.19	2 39/64	4 3/4	1/2	3 1/2	1/16	3/4	2 1/2	2 3/8	2 3/16	..	..	..	3/8	1/2	24	1 1/2

Machinery

drill and a 3/8-inch counterbore are used for all screws, except in the 56 size where a 3/8-inch drill and a 1/2-inch counterbore are used.

A group of feed chucks, illustrating the types used in the "Acme" multiple-spindle automatic screw machine for feeding various shapes of stock, also appear in Fig. 1. *E* shows the regular feed chuck, *F*, the type used in the 56 machine for feeding heavy stock, and *G* the feed chuck for handling square stock. *H* shows a master feed chuck with the jaws removed, while *I* shows the jaws used. *J* is the same feed chuck showing the jaws in place. The dimensions and capacities of the feed chucks used in the various sizes of machines are given in Table II, to which the following remarks apply. Referring to Columns J, K and L, it will be seen that the dimensions for the 54, 55 and 56 sizes are not given; the reason for this is that slot *J* is continued up nearly to the shoulder, and is of the same width for its entire length. When jaws are used, the chuck is bored out larger than the diameter of the stock.

Forming and Cutting-off Tools

The forming and cutting-off tools, which are generally held on the side-working tool slides, and are sometimes held on the top-working tool slides when necessary for light forming, are shown in Fig. 2. Here *A* is the holder for the circular forming tool *B*, which is held on a stud *C*, the latter fitting in a square hole in the holder. The nut *D*, when tightened, draws the headed stud in, clamping the tool tightly against the face of the holder. The side of the tool which goes next to the holder is provided with concentric grooves to prevent it from turning when heavy forming is to be done. A circular cut-off tool which is held in the same manner is shown at *E*. *F* shows a blank holder for carrying circular forming or cutting-off tools.

The holder used for retaining the blade type of cut-off tool is shown at *G* with a cut-off blade in position. This holder is split and is clamped together by the bolt shown. A wider cut-off blade is shown at *H*. Table III gives the various dimensions of the blade type of cut-off tool-holders shown in connection with this table and also at *G* in Fig. 2, for the different sizes of machines. This holder is made from cold-rolled steel and is left soft. Upon referring to Table III, it will be noticed that the width of the tool *B* is in all cases expressed in decimals. The reason for this is that the tool-holders, in order to be easily inserted, are made from 0.005 to 0.010 inch less in width than the slots in the slides, which are made to even fractions.

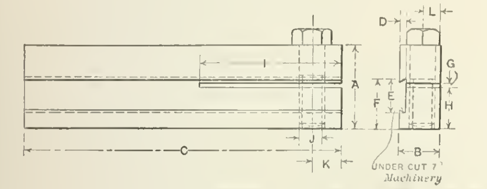
The principal dimensions of the circular form and cut-off tools, and also the holder and stud used for retaining them are given in Table IV, the notation used appearing in the illustration accompanying the table. In this illustration is also shown the gage used in setting the cutting edge of the tool in the proper relation to the bottom of the holder, which always bears the same relation to the center of the work. To provide for sufficient periphery clearance, the cutting edge of the circular form and cut-off tools is located a distance *B* below the center of the tool. For cutting brass, the top face of the cutting portion of the tool is usually parallel with the center line drawn through the axis of the tool, but in some cases, especially on soft brass, a negative rake is given as shown by the angle *a*. The cutting angles for the various materials specified are as follows:

Material	Cutting Angle in Degrees
Soft brass	$\alpha = 5$
Drill rod and tool steel	$\beta = 8-10$
Gun screw iron	$\beta = 12$
Machine steel	$\beta = 15$
Norway iron	$\beta = 18$
Copper and aluminum	$\beta = 25-30$
German tubing	$\beta = 25-35$

In regard to the location of the cutting edge of the tool in relation to the center of the work, the following points should be observed: For cutting steel and iron, the cutting edge of the tool should be set directly on the center of the work, while for cutting brass, bronze, copper and aluminum, better results are sometimes obtained by setting the cutting edge of the tool slightly above the center. This does not apply to some classes of bronze, especially that grade known as "Tobin" bronze. For this material, the cutting edge should be set the same as for steel.

Locating the cutting edge of the tool below the center, as shown in the illustration accompanying Table IV, changes the relative differences between the diameters of the tool (where it is used for forming more than one diameter), so that it is necessary to calculate the dimensions required on the forming tool. The formulas to use and the method to follow in making the required calculations will be found in MACHINERY'S Reference Book No. 101 on "Automatic Screw Machine Practice." Additional information on the subject of circular form and cut-off tools will also be found in the book just referred to.

TABLE III. PROPORTIONS FOR HOLDERS USED IN RETAINING BLADE TYPE OF CUT-OFF TOOLS



Machine Numbers	A	B	C	D	E	F	G	H	I	J	K	L
	Dimensions in Inches											
51	1 1/4	0.588	4 3/4	7/64	1/2	3/4	1/16	5/8	2 1/4	3/8-16.P.	7/16	1/4
515	1 1/4	0.588	4 3/4	7/64	1/2	3/4	1/16	5/8	2 1/4	3/8-16.P.	7/16	1/4
52	1 1/4	0.588	4 3/4	7/64	1/2	3/4	1/16	5/8	2 1/4	3/8-16.P.	7/16	1/4
53	1 11/16	0.838	7	17/64	53/64	1 1/8	3/32	15/16	2 1/2	3/8-16.P.	9/16	5/16
54	1 11/16	0.838	7	17/64	53/64	1 1/8	3/32	15/16	2 1/2	3/8-16.P.	9/16	5/16
55	1 11/16	0.838	7	17/64	53/64	1 1/4	3/32	15/16	2 1/2	3/8-16.P.	9/16	5/16
56	2 1/8	1.083	8	13/32	31/32	1 9/16	1/8	1 5/16	2 3/4	1/2-13.P.	5/8	3/8

Machinery

Drill-, Tap- and Die-holders

The drill-holders used in the "Acme" multiple-spindle automatic screw machine are of the ordinary type, as shown at *A* and *B* in Fig. 4, and are supplied with split bushings *C* which are turned cone-shaped on the end to assist in removing the chips from the flutes of the drill. With this type of bushing, of course, it is necessary to make a bushing for each size of drill. The shank of the holder is usually made to a standard length and adjusted by the screws in the tool spindle in which it is used. The type of drill-holder used in the threading spindle is shown in Fig. 5, and also at *D* in Fig. 4. The holder *A*, see Fig. 5, is retained in the threading spindle and carries the additional holder *B* in which the drill is held in a bushing by the set-screw shown. These drill-holders are also used for holding taps in the threading spindle as shown at *E* in Fig. 4. An over-cut box-tool holding a drill is shown at *F*.

In Fig. 3, *A* is a friction die-holder which is used when threading up to a shoulder on small work, when a button die is used for this purpose. *B* is a die-holder of small size, and *C* is an extension holder in blank form. *D* shows a larger die-holder and *E* the type of button die used in it, while *F* shows the extension shank retained in the threading spindle.

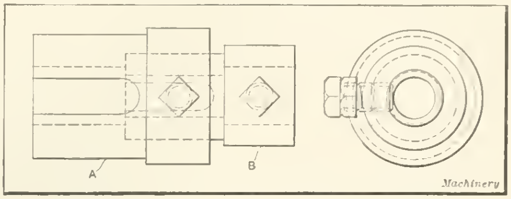
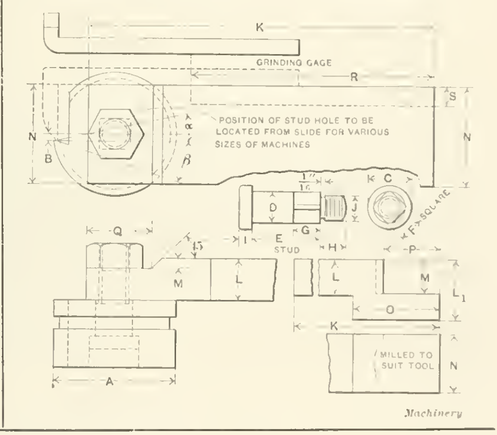


Fig. 5. Type of Drill-holder held in Threading Spindle

Telescopic Die- or Tap-holder

A telescopic or combination die- or tap-holder is shown in Fig. 6, which, as can be seen, enables two threading operations to be completed at the same time; that is, two dies of different diameters can be used, or a die and tap as required, the tap, of course, being held in the rear part of the holder. This special tool consists of a shank *A* in which a button die *B* is held by the cone-pointed screw shown. When a tap is to be used, the button die is replaced by a bushing for holding it. The front part *C* of the holder which carries the leading button die, is a sliding fit on a key in member *A*.

TABLE IV. PRINCIPAL DIMENSIONS OF CIRCULAR FORM AND CUT-OFF TOOLS, HOLDERS AND STUDS FOR RETAINING THEM



Dimensions in Inches	51	515	52	53	54	55	56
	Machine Numbers						
A	1 1/2	1 1/2	2	2 3/8	2 1/2	2 1/2	3
B	3/32	3/32	3/32	1/8	5/32	5/32	3/16
C	55/64	55/64	55/64	63/64	63/64	63/64	63/64
D	0.622	0.622	0.747	0.747	0.747	0.747	0.747
E	1 13/32, 1 1/32, 25/32	1 13/32, 1 1/32, 25/32	1 13/32, 1 1/32, 25/32	2 3/32, 1 11/32, 27/32	2 3/32, 1 11/32, 27/32	2 3/32, 1 11/32, 27/32	2 7/32, 1 15/32, 31/32
F	1/2	1/2	1/2	3/4	3/4	3/4	3/4
G	9/16	9/16	9/16	3/4	3/4	3/8	3/4
H	1/2	1/2	1/2	11/16	11/16	11/16	11/16
I	1/4	1/4	1/4	5/16	5/16	5/16	5/16
J	1/2-16.P.	1/2-16.P.	1/2-16.P.	5/8-16.P.	5/8-16.P.	5/8-16 P.	3/4-16.P.
K	5 1/4	5 1/4	5 1/4	7	7	7	8
L	23/32	23/32	23/32	27/32	27/32	27/32	1 3/32
L1	1 1/4	1 1/4	1 1/4	...	...	...	...
M	11/16	11/16	11/16	7/32	7/32	7/32	11/32
N	1 3/16	1 3/16	1 3/16	2	2	2	2 7/16
O	1 3/4	1 3/4	1 3/4	...	...	...	...
P	1 1/4	1 1/4	1 1/4	...	...	...	...
Q	...	...	...	1 1/4	1 1/4	1 1/4	1 9/16
R	...	...	...	4 1/4	4 1/4	4 1/4	5/8
S	...	...	...	5 1/2	5 1/2	5 1/2	9/16

Machinery

Offset type of holder shown to right in illustration is used only on 51, 515 and 52 machines.

To enable the cutting of two threads of different pitches at the same time, the front member *C* is restrained by two coil springs *D*, which allow it to lead out in advance of the other part of the holder, and as the shank *A* is held in the die spindle, which also is spring-controlled as regards the leading out of the spindle, it is evident that the lead of the two members is controlled by the pitch of the thread in the dies. A stop-screw *E* is provided for locating the holder *C* in its backward position, so that the two dies will always be in the same relation to each other when starting to cut. Clearance cuts are provided in both members to facilitate the removal of chips.

Opening Die-holder and Operating Attachment

Figs. 7, 8 and 9 show an opening die-holder which is recommended for cutting long threads of accurate pitch; this is designed especially for use on the "Acme" multiple-spindle automatic screw machine where it is necessary for the die to rotate. The working mechanism is enclosed within the body *A*, see Fig. 8, which carries the cam operating blocks. The head *B* holds the chasers *C*, which have closing and adjusting cams milled on their outer ends that bear against the cam operating blocks *D*.

The chasers *C* are held in place by screws *E*, and they can be removed without displacing any of the other parts. The adjustment of the chasers is controlled by a fine-pitch screw, the amount of adjustment being indicated by the micrometer graduations *F*, Fig. 7. The chasers and the cam surfaces controlling the closing of the die are hardened and ground, and the wide bearings on the cam surfaces hold the chasers firmly in position when the die is closed.

Two positions of the die are illustrated in Fig. 9, the view to the right showing it closed, and the one to the left open. This opening die is operated by a shoe *I*, Figs. 10 and 11, engaging in the groove *S*, Fig. 7, which shifts the shell *A* and tapering cam *D* with relation to the chasers, thus causing the latter to move inward or outward, as the case may be. The chasers are so designed that they cut a practically perfect thread without the aid of a follow-up cam. No springs are connected to the parts on which the adjustment of the dies or the operation of the closing cams depends. Chips are prevented from entering the head by cap *G*, see Fig. 8, and the die may be thoroughly cleaned simply by removing the screws *H* and cap *G* and washing it in kerosene. One wrench is all that is necessary for taking the die apart.

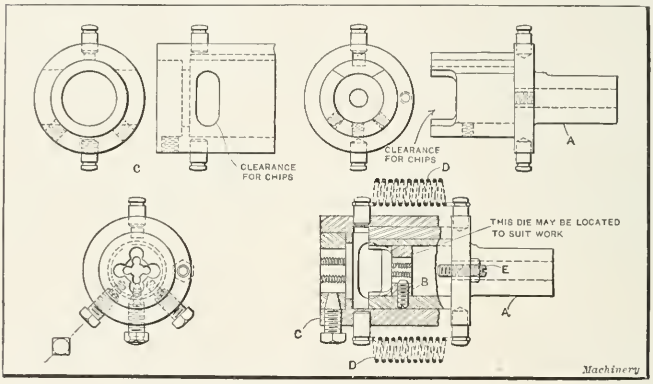


Fig. 6. Telescopic or Combination Die- and Tap-holder

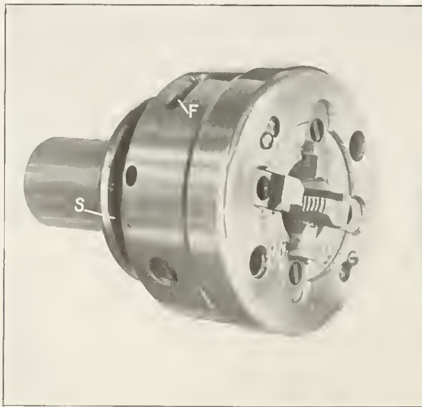


Fig. 7. Self-opening Die for Use in the "Acme" Automatic

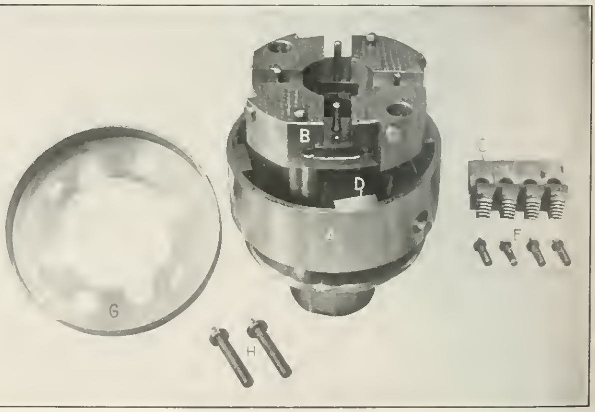


Fig. 8. Self-opening Die dismantled

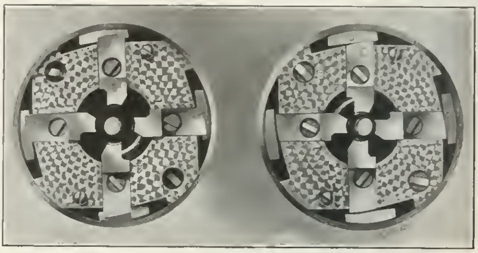


Fig. 9. Self-opening Die in the Open and Closed Positions, showing Operating Mechanism

The mechanism for operating the self-opening die illustrated in Figs. 7, 8 and 9, is shown attached to the machine, and in two working positions, in Figs. 10 and 11. Fig. 10 shows the attachment in the position it occupies when the die is closed and ready to start on the work, whereas Fig. 11 shows the operating mechanism about to act and open the die at the completion of the thread. This self-opening die is held in and rotated by the threading spindle in the usual manner, and is connected to the operating attachment by a shoe *I*, which fits in the groove *S*, Fig. 7, as mentioned. Another shoe *J*, similar in shape to shoe *I*, is connected to the rear end of the threading spindle, and is held on a spindle *K* (being adjusted by check-nuts), which is retained in the bracket *L* attached to the end-working tool slide.

In operation, as the end-working tool slide advances, the chasers in the die come in contact with the work and start to "lead" on. When the pitch of the thread is greater than the forward advance of the tool slide, the spring *M* is compressed by the threading spindle being withdrawn; this action, of course, carries forward the two shoes *I* and *J* at the same speed. When the die chasers have advanced on the work to the required distance, the sleeve *N* comes in contact with adjustable stop *O* held in bracket *P*. This bracket is provided with the adjusting screw shown, and is attached to the casing enclosing the cylinder. When the die starts to cut, the shoe *I* stops and holds the sleeve *N*, while the head and chasers, following the lead of the thread, advance until they come out of contact with the cam-operating blocks, allowing the head to spring open. Then as the end-working tool slide drops back, the lever *Q* striking the rear dog *R* acts on the rear check-nut *T*, while the shoe *I* holds the casing from moving back, pulling the head back into the casing and closing the die, ready for cutting the next thread.

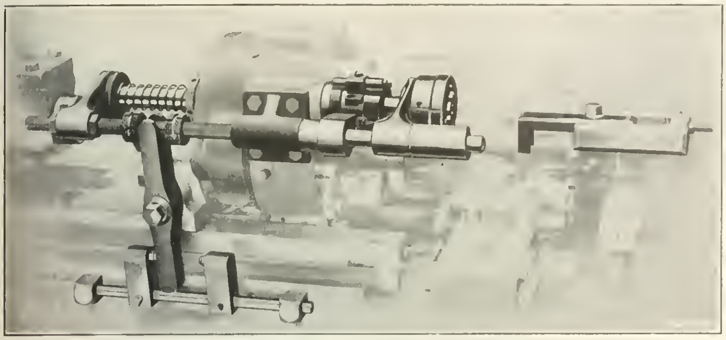


Fig. 10. National-Acme Self-opening Die Attachment, showing Die closed and ready to start on the Work

Drills, Reamers and Threading Dies

For general drilling in the "Acme" automatic, the ordinary commercial left-hand twist drills are used with good results, although there are times when a straight fluted, half round or gun drill would give better results, especially for deep-hole drilling. The greatest difficulties met with in drilling deep holes are those due to the clogging of chips and to the point of the drill heating and binding in the hole. To avoid these difficulties, the lip of the drill should be ground so that the chips will be coiled close, or in other words, so that a compact chip will be produced. For deep-hole drilling in brass, a straight fluted drill is preferable to a twisted one. The clogging of chips, however, is seldom encountered in the "Acme" automatic in drilling deep holes, owing to the method of tooling, which on many pieces provides for the use of two or more drills. When drilling deep holes, it is general practice to cut the lead cam into sections, and put on extra backing-off cams, so that the drills are drawn out of the hole and flooded with oil, cooling them off and removing the chips.

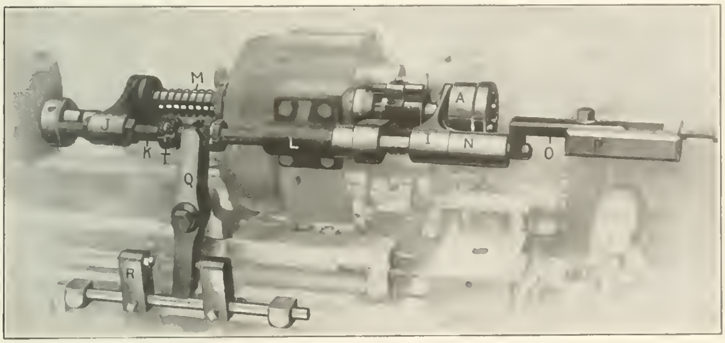


Fig. 11. The Self-opening Die Attachment in the Tripping Position

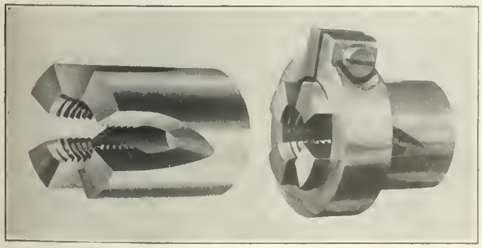


Fig. 12. Type of Spring Threading Dies used in the "Acme" Automatic

Reamers of the "rose" type are generally used in screw machines for producing straight holes, and are made to cut only on the ends which are beveled to an angle of 45 degrees. The body is slightly tapered back from the end to provide for clearance, and is furnished with grooves having the edges rounded, to carry away the chips and conduct the oil into the hole. For brass, the cutting edges of the reamer are made parallel with the axis, but for machine steel the reamer gives better results when the flutes are cut helically. A spiral of about one turn in twelve inches is used to advantage. For reaming tapered holes, a reamer having serrated flutes gives the best results, and when the taper is steep—having an included angle greater than thirty degrees—the finishing reamer should be preceded by a stepped counterbore.

The two principal types of dies used are shown in Figs. 3 and 12. In Fig. 3, *E* is a round split button die, whereas in Fig. 12, two views of a spring or mill die are shown. The die to the right is shown with an adjusting collar on it. The button type of die is cheaper to manufacture, but when dull is difficult to sharpen (especially the smaller sizes) and must be discarded. The spring die, on the other hand, is more expensive to make, but has the advantage of being more easily sharpened. The cutting edges are ground by means of a knife-edge wheel inserted between the prongs. [For additional information on this subject, see MACHINERY'S Reference Book No. 103, "Automatic Screw Machine Practice."—EDITOR.]

Accelerated Reaming Attachment

For reaming holes which exceed in depth the travel of the end-working tool slide, an accelerated reaming attachment (shown in Fig. 13 and in detail in Fig. 14) is used. This attachment is held in the "fourth" end position in the tool slide, and consists of the regular cast-iron collet *A* which fits in the hole in the tool slide. It is also furnished with a flange which provides a means of fastening it to the face of the tool slide by screws, and it is, for this attachment, steel bushed. The reamer holder *C* is a sliding fit in the steel bushing *B*, and is furnished with a loose cap *D* in which the reamer is held by the set-screw shown. The cap *D* is held to the holder *C* by two shoulder-head screws, the bodies of which are 1/32 inch smaller in diameter than the holes in the cap, thus allowing the cap to "float" a slight amount.

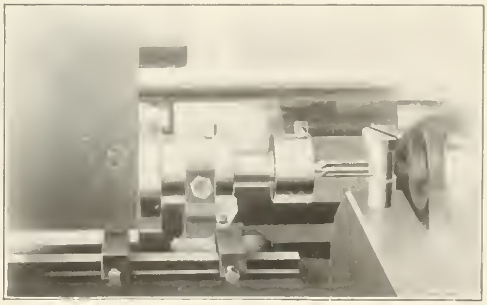


Fig. 13. View showing the Accelerated Reaming Attachment in its "Out" Position

A stud *E* screwed into the shank of the holder *C* and working in an elongated slot in the bushing and collet, projects through from the under side of the collet and works in an elongated slot in the lever *F*. This lever is fulcrumed on a screw which is located in either holes *G* or *H*, depending on the excess amount of travel required, and is the medium used for accelerating the travel of the reamer. To increase the travel, the screw is placed in hole *H*, and to reduce the travel, the lever is moved back so that the screw would take the *H* position. In the illustration, the lever is shown in the intermediate position.

The bracket *I* in which the lever is fulcrumed is fastened to collet *A* and, of course, advances with the end-working tool slide. The rear end of lever *F* is provided with two hardened screws rounded on the heads, which come in contact with the dogs *J* and *K* when the device is in operation. These dogs are adjustable on the bracket *L*, fastened to the gib *M*, which, in turn, is held to the bed of the machine.

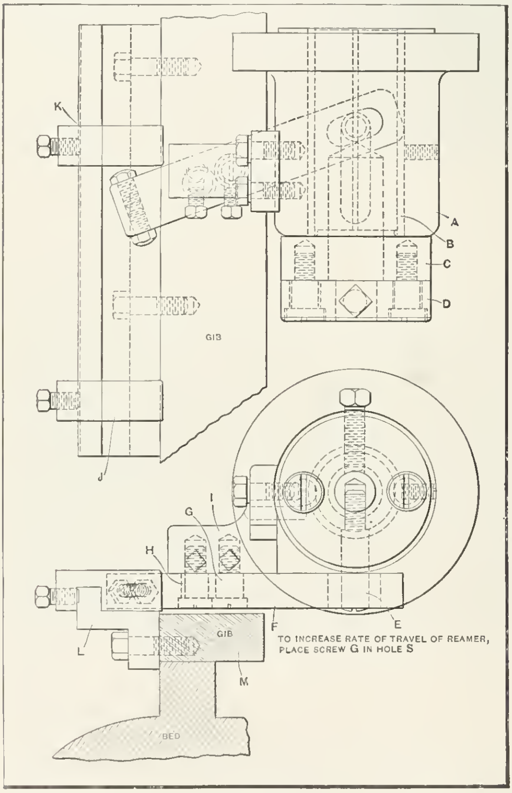

K
A
B
C
D
GIB
J
I
G
H
F
E
L
GIB
M
BED
TO INCREASE RATE OF TRAVEL OF REAMER, PLACE SCREW G IN HOLE S

Fig. 14. Illustration showing Construction of the Accelerated Reaming Attachment shown in Fig. 12

In operation, as the end-working tool slide advances, the round-headed screw in the front face of the lever comes in contact with dog *J*, and as the tool slide continues to advance, this dog acts upon the fulcrumed lever, drawing out the reamer holder and accelerating its movement. The position of dog *J* on the bracket, and also the location of the screw in holes *G* or *H*, determines the amount of excess movement given to the reamer. When the tool slide drops back, dog *K* returns the reamer holder by means of lever *F* to its "back" position.

* * *

The word "patent" as referring to an industrial monopoly, granted by the State, was used the first time in England in 1331. This first patent was granted by a so-called "letter of protection," or, as it was termed in the learned language of that time—Latin—"litterae patentes" (open letter). From the latter word has been derived the word "patent" in its present-day meaning.

LETTERS ON PRACTICAL SUBJECTS

BY J. F. WINCHESTER[*]

The "Letters on Practical Subjects" as printed in MACHINERY is a department that probably receives more attention from the general reader than any other part of the paper. I do not mean by this that the other articles are not much read, or are not full of up-to-date information, but that the average reader is not generally interested in many of the lengthy articles on special subjects. Lengthy articles on special subjects cannot be eliminated in any mechanical paper, however, for it has to provide for a wide diversity of interests, and any special article is bound to interest a class which receives it with pleasure and makes a detailed study of it, no matter how remote it may seem to mechanics in the general lines of work.

I have met men who have passed over some of these special articles without a thought that they contained information that might be of value to them, but who after a month or two would find a comment in "Letters on Practical Subjects" and then realize that they should look up their back copies and read the article carefully.

To my mind this department of MACHINERY is to the busy mechanic what the financial review or current events column in the week-end daily paper is to the busy business man, for in it he finds condensed information that he can easily assimilate and apply to his problems. Its columns recall past experiences of men, they give up-to-date shop practice and kinks that are applicable to almost any machine shop, and induce men to relate their experiences, who if called upon for a lengthy article, would decline.

Some of the articles in the December number of MACHINERY were especially interesting to me as they brought out points in an indirect manner that I have discussed with men both in and out of the shop. One thought brought out in "A Comment on Quarter Turn Belting Alignment," was on the value of a technical education to a mechanic, a subject that is usually thoroughly discussed by the mechanic who is taking an evening school or special correspondence course and the man who believes that he can solve his problems in a practical manner, as the millwright did, or leave them to the foreman. Practical men with an aptitude for their trade solve many perplexing problems under probably as unfavorable circumstances as the millwright did. Yet this example shows how considerable time, money and energy would have been saved if those concerned had devoted only a small amount of time to technical study of the problems affecting their trade.

The letter "Comparison of Selling Methods" brought out an interesting phase of the business side, a side that probably only a small percentage of the readers come in intimate touch with, but one that, nevertheless, is of interest to us all. The cost of practically the same machines differed in favor of firm No. 1, which is a consideration that would swing the sale to it in a great many instances, for cost in many cases is considered before merit. The salesman of firm No. 2, however, appears to have been backed up by a modern service department. Engineering information such as is usually asked for in such instances, does not emanate from the sales force, but from the engineering force that constitutes a service department. It was the harmonious relations of these two departments that made the sale possible in this case. No far-sighted firm will object to paying an extra amount to such an organization, for it always has a corps of specialists to call upon to help and advise on any perplexing problems that arise. Mr. Henry speaks of twentieth century methods. Did he apply such methods in wishing to pay cash for the article? Is not payment in thirty to ninety days in such cases considered cash? And is not the prestige that comes from meeting payments when they are due on such notes worth more than the prestige that comes from paying cash?

* * *

There is a great deal of difference between the salesmanship required to make a customer want to buy the goods you have to sell, and that required for merely selling them to him. It may seem like the same thing, but it isn't.

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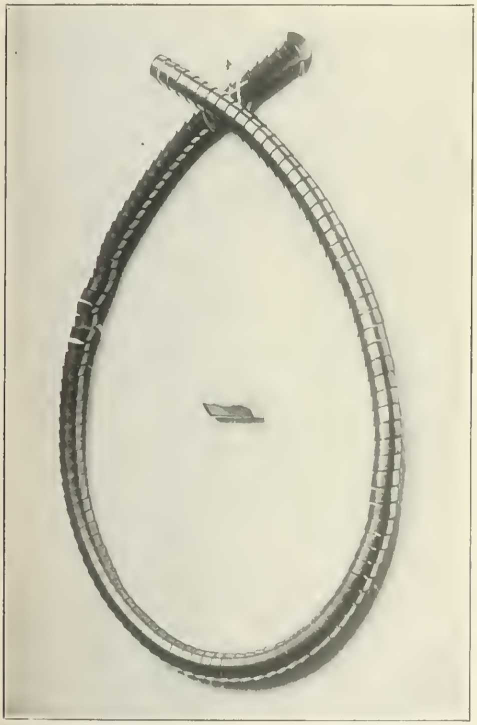
[*] Address: 469 Prospect Place, Brooklyn, N. Y.

NEW MATERIAL FOR LATHE TOOLS

BY ELWOOD HAYNES

For some years I have been interested in searching for an untarnishable alloy which would take a cutting edge. After a number of researches on the alloys of copper with other metals, I found that practically all of these would become discolored in the presence of moisture and sulphureted hydrogen. Later, I turned my attention to the alloys of nickel with other metals, and as early as 1891, I succeeded in making an alloy of nickel with tungsten by melting the metals together in a small magnesia crucible. Later, alloys were made of nickel and metals of the chromium group. In 1899, I discovered that an alloy of nickel and chromium would resist oxidation to a most remarkable degree. I immediately afterward discovered that an alloy of cobalt and chromium would not only resist oxidation, but was extremely hard, and at the same time rather tough. In 1907, I took out patents on the alloys of nickel with the metals of the chromium group, and also on the alloys of cobalt with the same metals. I have since had patents allowed on practically all possible combinations of cobalt with chromium, molybdenum, and tungsten. The alloys of cobalt and chromium, when properly handled, can be forged at a bright red heat, and be formed into table and pocket knife blades, as well as cold chisels and other useful forms. These alloys retain their brilliancy after polishing under all atmospheric conditions, and are not affected in the slightest degree by culinary operations nor by fruit acids; they are likewise immune to hydrogen sulphide and other corrosive gases.



A 3-8 inch Square "Stellite" Lathe Tool and Shaving weighing 1.2 Pound cut from a 2-inch Nickel-chrome Steel Bar in One-half Minute

About two years ago I became interested in the employment of alloys of cobalt with chromium and other metals in the manufacture of lathe tools. After numerous tests and experiments, an alloy was produced which shows most remarkable qualities in this respect. Either molybdenum or tungsten is added to the cobalt-chromium alloy to act as a hardener. These alloys are usually cast in the form of square bars which need only be ground to form to fit them for immediate use. They are held firmly by means of a tool-holder, and have shown an endurance under high speed which is truly wonderful.

A few practical examples will perhaps indicate the qualities of these alloys when employed for lathe tools. First, a high-speed steel tool, made from a ⅜-inch square bar of what is known as "dollar" steel, was employed in turning cast-iron gears to form. These gears were very hard, and afforded a severe test for lathe tools. The "dollar" steel would do about half the turning on one of the gears without sharpening. A "Stellite" tool of the same dimensions turned 11 of these gears to form, and was still in good condition. The high-speed "dollar" steel turned 26 gears to form in ten hours, while the "Stellite" tool turned 49 gears to form in the same time. Numerous other tests were made in which the efficiency of the "Stellite" tool over high-speed steel was repeatedly demonstrated.

It was soon discovered that a lathe which would run with sufficient speed and power to tax high-speed steel to its limit, would frequently stop when a "Stellite" tool was used, owing to the heavy load imposed; for example, a lathe driven by a three-inch belt would readily carry its load on back-gear, but would not run fast enough to reach the limit of the tool under any reasonable cut. If, on the other hand, the lathe was run on direct drive, either the belt or clutch would slip. Recourse was then taken to a lathe driven by a four-inch belt, but the same result frequently occurred. Finally, a test was made on a large "American" lathe driven by a six-inch belt through a system of gears. By means of this machine it became possible to drive at high speed without stalling the machine. In the lathe was placed a bar of nickel-chrome steel, and the lathe set at a speed which would just tax the cutting quality of the best high-speed steel tool. The lathe was then run at 2.66 times its former speed, and the "Stellite" tool applied. It removed a very smooth spiral shaving which showed a uniform blue color throughout its length. When the high-speed steel tool was applied at this speed, its edge was instantly destroyed. Repeated cuts were made with the "Stellite" tool, which cut off shavings weighing as much as 2.4 pounds, in one minute. Tests were later made on a hard nickel-steel bar which had been rejected because it "could not be worked". This bar was about 3¼ inches diameter, and about 30 inches long. It was placed in a heavy, Lo-swing lathe, and run at a speed which immediately destroyed the edge of a tool made of high-speed steel. The "Stellite" tool was then applied, which removed a heavy blue shaving from the bar at such a rapid rate that it was found difficult to manage the shaving. Within a few minutes nearly half of the bar was turned away, while the edge of the tool remained in excellent condition. Another test was made on a small lathe which was running normally at what was considered a fairly high speed for a high-speed steel tool. Under these circumstances, the lathe was turning regularly one steel bar in one minute and forty seconds. The high-speed steel tool was replaced by one of "Stellite," and the speed of the lathe increased until a bar was turned in 28 seconds. This could be done regularly, but the lathe operator afterward reduced the speed to one bar in 40 seconds. It will be noted that in this test, it was a question of *changing* bars rather than *turning* them. In another test not witnessed by the writer, but reported by a lathe builder, it was found possible to turn semi-steel gear wheels at the rate of only 40 feet per minute by means of a high-speed steel tool, while a "Stellite" tool turned them at the rate of 120 feet per minute.

In my opinion, the alloy will not, however, totally displace high-speed steel, since there are many instances in which rapid turning is impossible, owing to the nature of the work. When it is simply a question, however, of rapid cutting at high speed, "Stellite" certainly shows a great advantage over any high-speed steel ever produced.

* * *

In the movement for the safety of employes, fire prevention is one of the more important items. Over 5000 people are killed and 50,000 are injured annually in the United States as a result of fires. Most of these are preventable.

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[*] Address: 305 North Washington St., Kokomo, Ind

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

FINISHING MACHINE PARTS

While it is true that "finish" is a distinct aid to selling a machine, it is equally true that the longer the machine retains its original appearance, the easier it will be to get "repeat" orders. It is not sufficient to see that a machine is given the proper quantity of filling; the filling must be applied in such a way that it does not peel off and leave a rusty surface to spoil the appearance. The writer has often marveled at the lack of care which is evidenced on the part of some machine tool builders in this respect, as it is by no means an unusual sight to see large areas of filling stripped off a machine. Such cases show that the manufacturer is unacquainted with the fact that paint will not stick to a rusty surface; this is particularly true if that surface happens to be somewhat damp at the time that the paint is applied.

At this point it will not be out of place to cite the practice of certain British machinery builders in finishing their products. The method may be old, but if so, there is sufficient evidence that a recital may "bear fruit" in refreshing the memory of those who do not use it. The method is simply that of painting the castings immediately after dressing off the sand in the foundry, one coat of paint being sufficient to protect them up to the time of their appearance in the machine shop. There is, of course, no necessity to waste paint on parts that are to be subsequently machined.

As time goes on, there seems to be a tendency to modify the design of many classes of machinery to avoid what is termed "unnecessary polish." To some extent, this is right, but there are cases where the application of paint instead of polish goes a long way toward spoiling the appearance of the machine. This is particularly true of the parts around the tools, where the chips exert abrasive action upon the paint; what is the use of painting these parts if the paint will not last? Of course it would require a lot of time to machine such parts, but if we revert to the old practice of grinding and polishing, which is quite as cheap as painting if the cost of filling, rubbing down, and varnishing is considered, the expense will not be great. Here, again, the practice of a certain British firm may be cited. All of the parts subject to damage from chips or from the overflow of oil are finished straight from the black by sand blasting. Care is taken to use nothing but an extra fine facing sand in the foundry, so that a good smooth surface is produced on the castings. The hardened work is treated in the same way on parts that are not to be subsequently ground. This firm also makes a practice of sand blasting the heads of set-screws instead of coloring them in some way; set-screws finished by this method are not marred by a wrench to the same extent as those having colored heads.

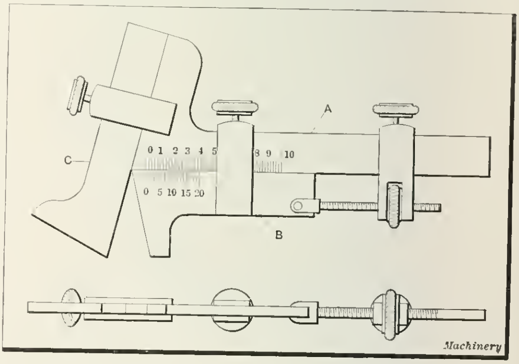
If one is to regard finish from the point of view expressed in the editorial in the November, 1912, number of MACHINERY, *viz.*, as "an outward manifestation of the quality of the materials and workmanship put into a machine," it is to be feared that some machine tool builders would make a rather poor showing. It does not necessarily follow, however, that a badly finished machine is poorly constructed. Every argument has two sides, and there are certain British firms which make a boast that no unnecessary time or money is spent on finishing machines. There are also purchasers who declare that they do not want "fancy finish" which they must pay for. One of the former goes to great extremes; for quality, his reputation is the best, for appearance the worst. Not only does this manufacturer limit the finish on his machines to one coat of paint, but no time is spent on fancy shapes. Every consideration is given to the form most convenient for the molder, even to the extent of leaving sharp corners in a great many places. If a gear guard can be produced more cheaply from sheet metal, no neat cast-iron guards are allowed to grace the machine. Homogeneity of design is of no consideration whatever, as box forms and ribbed forms are indiscriminately intermingled. Chucking pieces are left on, as it would cost money to remove them from the work. But here is the rub. Without a doubt, this manufacturer would increase his sales—aside from his particular established trade—by improving the appearance of his products. But the argument is advanced that a machine which is equal to the service required of it, is not the best available on the market unless it is the cheapest. This manufacturer has failed to find that the dictum that the workman takes more care of a nicely finished machine is true in his own shop; hence it is likely that it will not be true in other shops. He is undoubtedly losing by his stand, but being an altruist he won't give way, for he declares that the right must ultimately conquer. His motto is "What is right looks right." Now here's a point worthy of discussion. How far is it desirable to carry finish and art in the design and construction of machinery? Indeed, has art any place in modern manufacturing? The writer has considered the pros and cons of this problem and has personally arrived at the conclusion that he has arrived at no conclusion whatever. Can others help?

CAMERONIAN

AN IMPROVED GAGE FOR TWENTY-NINE DEGREE THREAD TOOLS

The purpose of this article is to describe a gage for the measurement of the 29-degree thread tool, so that an accurate tool may be made for cutting these threads. The fixed gages for this purpose do not provide for the degree of accuracy that is often necessary, for they do not give the width of the point of the tool exactly. A variation of 0.001 inch or more often exists, and although this cannot be seen by the eye, it is sure to give trouble—especially in the case of a hardened worm.

The remedy for this difficulty was devised in the gage shown in the illustration, a description of which follows. The gage consists of a main piece *A* on which the slides *B* and *C* are made adjustable. The head of *A* carries a clamp for *C*, the piece *C* being adjustable so as to extend along the side of a long tool, thus insuring a square point on a tool of coarse pitch. This blade *C* is held to the correct angle by the front face of *A* which is ground to the proper angle with its base. The adjustable slide *B* is controlled by a clamp and an adjusting screw. The front edge of *B* is ground in such a manner that when the vernier reads zero, the space enclosed by *B* and *C* forms a sharp 29-degree angle. The gage is easily set for the different widths of tools by means of the vernier, which is one inch long and provides sufficient adjustment for all worms ordinarily met with. A point in favor of this tool is that it is only 1/16 inch thick. This does not permit any canting of the tool in the gage. Another important point is that the end of blade *C* is ground to the proper angle and can be easily removed and used as a gage for the purpose of setting the tool in the lathe.



Improved Form of Gage for 29-degree Thread Tools

This gage finds its field of usefulness in measuring thread tools of the "Acme" or "worm-thread" type, in measuring cutters for the thread milling machine, and as has already been stated, as a gage for setting the tool in the lathe. In this connection the method of figuring the width of point for the tool for these two styles of threads might be mentioned. The "Acme" is not so deep as the "worm-thread" and so, for a given pitch, it is wider on the top of the thread, a difference of 0.0357 inch in the case of a one-pitch thread. For the "Acme" thread, which is of the same depth as the corresponding square thread:—

Width of point of tool for screw thread in inches =

$$\frac{0.3707}{\text{Number threads per inch}} - 0.0052.$$

$$\text{Depth of thread in inches} = \frac{1}{2 \times \text{No. threads per in.}} + 0.010.$$

For the "worm-thread," the same rules will not apply. For this thread:

$$\text{Width of bottom of screw thread} = \frac{0.310}{\text{No. threads per inch.}}$$

$$\text{Depth of thread} = \frac{0.6866}{\text{No. threads per inch.}}$$

A common mistake is to set the top face of the tool, when used in a lathe, parallel with the axis of the worm to be cut. The proper way is to set it at right angles to the lead of the worm, thus making a cut of the same width as the tool, which is impossible if the tool is set as first described. This gage is intended to be used more as a piece of the shop equipment than as an individual tool to be owned by the workman. The vernier may be cut accurately enough in any good milling machine, and a good mechanic should be able to make this tool at a reasonable cost. EVERETT CHIPMAN

Beverly, Mass.

A DIFFICULT BORING OPERATION

There is probably no class of work that taxes the ability of machine shop superintendents to a greater extent, than a job which is beyond the capacity of the shop's equipment. In most shops, however, work of this nature is constantly met with and were it not for this fact, the workmen in such establishments would become mere automatons instead of skilled mechanics. It is generally found that the ingenuity of mechanics is far more highly developed in shops where the facilities are limited and the work varies to such an extent that all production problems must be carefully planned and economically executed.

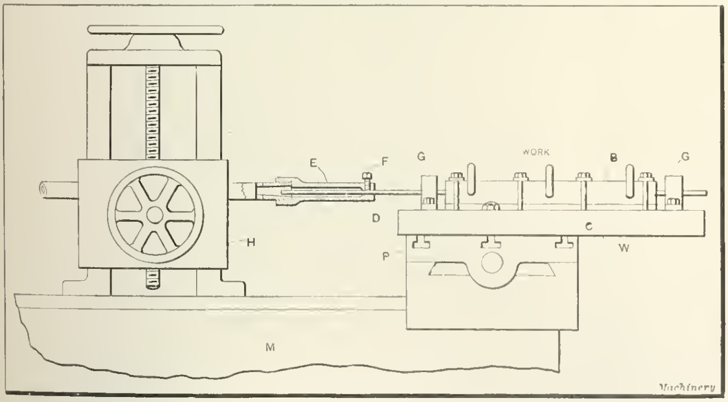


Fig. 1. Boring Mill equipped with Special Extension Sleeve for boring Long Work

We were recently asked to bid on a job which was decidedly perplexing because we had no boring mill of sufficient capacity to handle it. This made our bid so high, that we did not expect to receive the order; in due time, however, the order was received and handled in the following manner, which produced excellent results. The operation which caused the difficulty was that of boring a hole 1¼ inch in diameter by 29 inches in length, which had to be finished within 0.001 inch of size. Our boring mill spindle had a travel of only 19 inches, so that it became necessary to provide some special means of securing the additional 10 inches; to be on the safe side, we allowed 12 inches, the method by which this was accomplished being as follows: The work, which is shown in Figs. 1 and 2, consists of three parts, *A*, *B* and *C*, *A* and *B* being the side pieces and *C* the bottom plate. The arcs were roughed out in the milling machine and all of the pieces were accurately planed so that they would fit together properly. After being placed together as shown in Fig. 2, it was necessary to bore the 1¼-inch hole through the entire length of the work as previously mentioned. The bottom plate *C* was not over ½ inch thick.

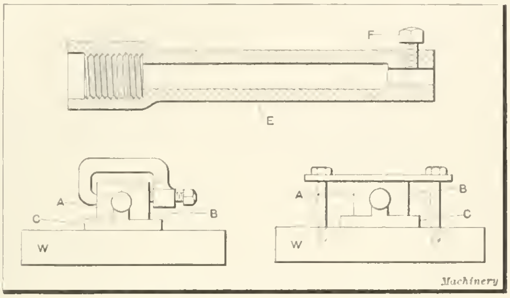


Fig. 2. Sleeve Extension and Clamps for holding the Work

The special equipment necessary for performing this operation consisted of two guides *G*, a bar *D*, ⅞ inch in diameter, and a sleeve *E*. This sleeve was very carefully bored, turned and threaded to fit the mill spindle as shown in Fig. 1. The hole through the sleeve was ⅞ inch in diameter at the front end, the remainder of the hole being chambered out to a slightly larger diameter. The bar *D* fitted accurately in the ⅞-inch hole in the sleeve and was clamped in position by the set-screw *F*. The work was set up on the extension table *W*, which was bolted to the platen *P*, the guides *G* having been previously placed in position and bored to receive the bar *D*. The method of clamping the three parts of the work *A*, *B* and *C* together is clearly shown in Fig. 2 and also the method of securing it to the extension table. The boring mill head *H* was previously set at the proper height in order to bore the guides *G*, and the sleeve *E* was then screwed onto the spindle. The holes for the cutters were now laid out and drilled in the bar *D*, three cutters of round stock being used. The bar *D* was then mounted full depth within the sleeve *E*, and with the cutters set in the proper position, the cut was started. When the spindle had traversed through its full 19 inches, the set-screw *F* was released, and the spindle backed out to the end of the bar *D* which remained in a stationary position in the work. The set-screw *F* was then tightened again and the cut continued for the remaining 10 inches. The mechanic who did this work was exceedingly careful and succeeded in finishing the hole very smooth, and well within the estimated time. We were allowed a limit of 0.001 inch but, as a matter of fact, the hole was finished within 0.00025 inch of the standard size from end to end.

Waterbury, Conn. WALTER E. FLADD

HOW TO FIX A BUSHING ON A PROPELLER SHAFT

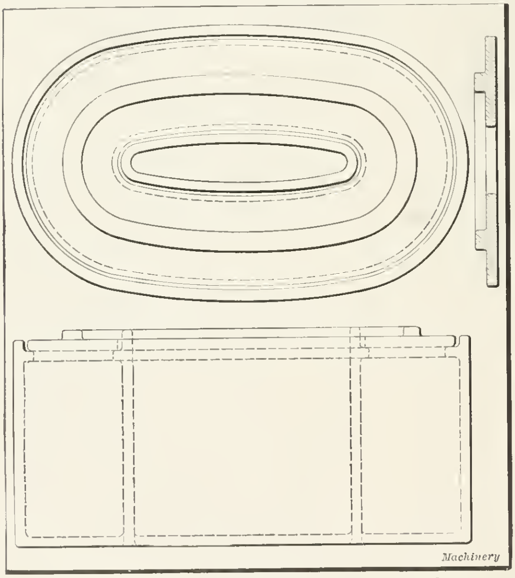
In the December issue of MACHINERY, S. H. S. wished to learn of a satisfactory method of fixing a bushing on a propeller shaft. The writer would suggest putting a zinc ring or bushing between the outside bushing and the propeller, as he believes that the loosening of the bushing referred to is due to a chemical action between the salt water and the bronze. This method has been used in a case where the zinc bushing was mounted on an axle steel shaft in a bronze bushing, and gave very satisfactory results where the propeller was running in salt water. G. BRUUN

Wilkinsburg, Pa.

A CASEHARDENING BOX

The illustration presented herewith shows a novel design of casehardening box which is provided with a central space which allows the heat to be applied from both sides. By this means it is possible to bring the work to the required carbonizing temperature much more rapidly than when the regular type of casehardening boxes are used. The box shown in the illustration was made for use in casehardening piston pins and similar machine steel parts, but the same design could be used in making casehardening boxes for a variety of other purposes.

Experience has shown that the shape of this box is extremely satisfactory both in handling and packing in the heating furnaces. The boxes are made of steel castings, as this construction has been found to last longer and stand the intense heat for a longer period of time. The cover is ribbed and the double walls of the box add greatly to its strength.


Machinery

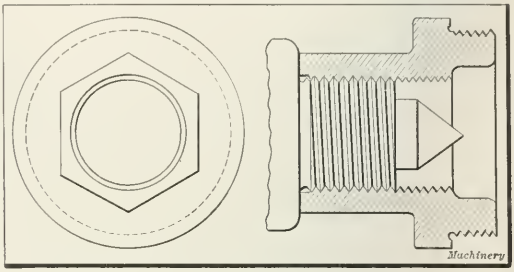
Casehardening Box with Central Opening to give Equal Distribution of Heat

Experience with this box has shown that the increased uniformity of heat distribution is the means of securing a much more uniform product, as the depth to which the work is carbonized is very nearly the same in all cases. There is also a saving of carbonizing compound and fuel because the heat enters to all parts in a much shorter time than is required where the ordinary type of casehardening boxes are used.

M. W. W.

A DEVICE FOR FACING PIPE FLANGES

The illustration shows a very simple arrangement for facing pipe flanges. The device is threaded internally to screw onto the lathe spindle and externally to receive the work, and is made from an iron casting with a hole through the center, bored and threaded to screw onto the spindle of an ordinary engine lathe, as shown in the illustration. The outside is turned to form a collar or hub for the work to be screwed up against. The section of the device to the left of the hub is cast hexagon, in order that an ordinary wrench may be used to screw it on or off the lathe spindle. The part to the right of the collar is threaded to receive the work, which, when screwed up against the hub or collar, can be conveniently faced on the lathe. No truing-up is necessary, and the construction is sufficiently rigid for heavy work. The flange is released from the holding device by using a bolt in one of the holes, the bolt being struck with a block of wood to back off the flange. When the flange has no holes, there is usually a lug cast on the outside, against which a tool can find a bearing. This tool can then be struck with a hammer to back the flange off the jig. The writer has made these holders in sizes ranging from 4 to 14 inches, and uses them with satisfaction in one of the largest pipe and fitting shops in the city of New York.

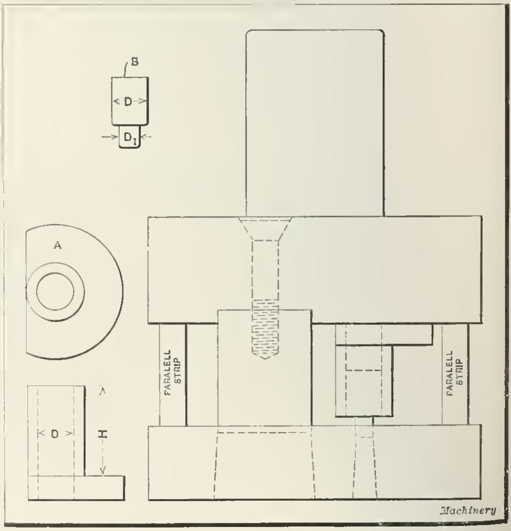

Machinery

Jig for facing Pipe Flanges on a Lathe

Brooklyn, N. Y. GEORGE E. OWEN

LOCATING PUNCHES IN TANDEM DIES

In making tandem dies, considerable trouble is often experienced in getting the small punches to line up properly with the holes in the die. This is especially true when the punch-holders are made of cast iron, as the sand-holes and soft places cause the drill to run out of square, which frequently makes the method of spotting holes through the die impossible. Another method of doing this work consists of placing a jig button on the punch-holder in exactly the same position as the hole in the die with which it is to mate.



Machinery

Method of Locating Punches in Tandem Dies

The punch-holder is then set in a lathe and the button is made to run dead true. The button is next taken off and the hole is drilled or bored to the required size for the shank of the punch. This method requires very careful measurements to be made which, of course, involves a considerable amount of time.

The method to be outlined in the following description does not require any measurements to be made, and the writer has found it convenient to make the shanks of punches of some standard size, as 3/16, 1/4 inch, etc. The first step is to make the guide *A*. Satisfactory results can be obtained with guides made of cast iron, although it would be better to make them of steel, hardened and ground. The important point is to get the guide hole square with the bottom of the flange; the height *H* should be ⅛ of an inch less than the height from the surface of the punch-holder to the end of the punch, and the wall around the hole is best made ⅛ inch thick. The flange is made about 1½ inch in diameter by ¼ inch thick and is cut away on one side to enable a hole to be made close to a large punch.

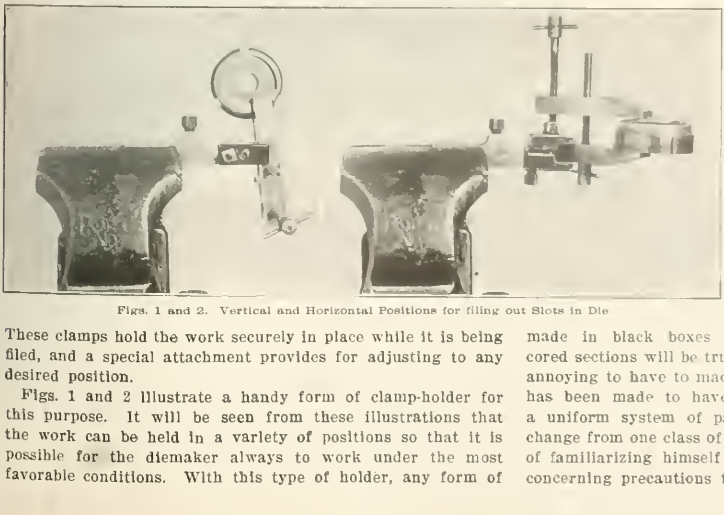
The hole in the guide is the same size as the shank of the punch which is to be carried by the punch-holder. The next part to be made is shown at *B;* it consists of a small piece of cold-rolled steel about ¾ inch long. The large diameter *D* is turned so that it will push into the guide without shake, and the small diameter D_1 so it can be entered into the hole in the die with a light tap. The small end is made about ¼ inch long and the large end ½ inch in length.

In setting up a job, the small end of the piece *B* is fitted into the die and the large end into the hole in the guide, as shown in the illustration. The large punch is next fastened in the holder and then lowered into the die. Two parallel strips are then placed between the die and punch-holder, which are of sufficient height to keep the holder from striking the guide. The guide is then drawn up against the punch-holder to which the flange is secured with two parallel clamps. The die is now removed and draws the pilot from the guide; the holder can then be turned up and spotted through the guide with a drill of the proper size to fit the hole. The hole is drilled to the required depth and of a diameter 1/64 inch smaller than the required size, the final finish being obtained with a rose reamer. This type of reamer is used to prevent scraping. If the reamer is a proper fit in the hole in the guide, the hole in the holder will be absolutely square with the surface and line up exactly with the hole in the die. This operation must be repeated for each hole that is required, and after the method has been used in a shop for some time, the necessary guides and plugs for any size of punch will have accumulated, thus saving a considerable amount of time and labor in making punch-holders.

Baltimore, Md. JAMES BARKER

PARALLEL CLAMP-HOLDER

In filing out irregular shaped dies, it is important for the diemaker to have his work held in such a manner that he can reach it conveniently and also see the layout he must follow. For this purpose the average diemaker uses specially constructed parallel clamps in connection with a bench vise. These clamps hold the work securely in place while it is being filed, and a special attachment provides for adjusting to any desired position.



Figs. 1 and 2. Vertical and Horizontal Positions for filing out Slots in Die

Figs. 1 and 2 illustrate a handy form of clamp-holder for this purpose. It will be seen from these illustrations that the work can be held in a variety of positions so that it is possible for the diemaker always to work under the most favorable conditions. With this type of holder, any form of toolmakers' parallel clamps can be used. This, in itself, is quite important, as it does away with the necessity of using a specially constructed clamp for the purpose of filing out dies. The design will be readily understood by referring to Fig. 3, where it will be seen that the screw *A* allows the position of the clamp to be adjusted as desired. The tool is of a compact form and takes up very little room in the tool case.

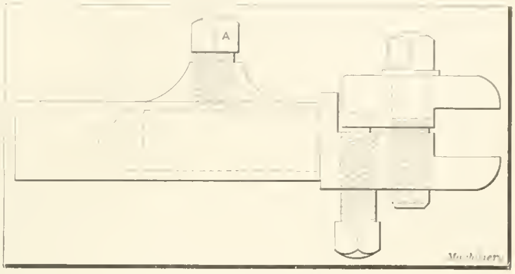


Fig. 3. Design of Holder for Parallel Clamp

Waterbury, Conn. CHARLES DOESCHER

COMMENT ON PATTERN COLORS

Mention was made in the November issue of MACHINERY, of a uniform system of painting patterns for steel castings that has been adopted by the Steel Founders Society and the American Society for Testing Materials. It appears that the selection of red for the pattern color of sections that are to be finished is ill-advised, because it is at variance with the almost universal use of colors on patterns. However, this objection would not be so serious if the system could be adopted by founders in other lines. It does not seem possible, however, that the patterns used in other than steel foundries will be changed in color, and if two distinct systems are to be used the natural result will be that a matter which is already bad enough, will be still further complicated. There seems to be no logical reason why patterns for different metals should be colored according to different systems; all patterns should have the same system of colors.

The most generally accepted pattern colors seem to be yellow for sections that are to be machined, and black for sections that are not to be machined. These colors are now so generally used that an experienced molder recognizes them instantly. Red is the generally accepted color for core-prints and stop-offs, and serves as an order to the molder to use particular care to see that these parts are properly formed. Core-prints painted yellow on the ends, indicate that the cored section is to be machined, and core-prints painted black on the ends indicate that the cored section is not required to be machined. Core-boxes are painted the same as patterns—prints red and body part yellow or black, to indicate where the castings are to be machined and where they do not require machining. Stop-offs are painted red all over and are readily distinguished from core-prints.

Founders and molders should understand that the sections of a casting corresponding with yellow sections on the pattern, must be clean, sound and free from defects; otherwise much unnecessary work will be required to get the casting into the desired condition. Particular care should be taken to have cores made in black boxes produced in such a way that the cored sections will be true to the pattern, for it is particularly annoying to have to machine castings when special provision has been made to have them come out correctly. Where a uniform system of pattern colors is used, a molder can change from one class of work to another without the difficulty of familiarizing himself with a new system. The preceding, concerning precautions that must be taken, will apply in all classes of founding if a uniform system of pattern colors is used. This is but one of the numerous points in favor of uniformity.

J. R. Rand

Springfield, Mass.

SECTIONING DRAWINGS

In drawing assembly views, it is often necessary to show large portions of a machine in section. The cross-hatching method is tiresome and time-wasting. A satisfactory method of showing cross-sections, which is used in a large plant, is as follows: A tinting ink is used made from ordinary black Higgins ink with sufficient alcohol added to thin it. A test may be applied to some white paper. When the ink dries a light brown, it is of the proper constituency. This ink or paint is applied to the reverse side of the tracing on the parts which are to be shown in section, using a small camel's hair brush. On the blueprint this sectional view shows a cloudy bluish white, which is very readily distinguished.

New Britain, Conn. J. M. Henry

[Another method, equally simple, which gives very similar results, is to merely rub over the parts shown in section on the back of the tracing with a soft pencil. On the blueprint this will also show as a bluish white. The pencil method has an advantage over the ink or paint method, as the latter has a tendency to wrinkle the tracing cloth if the thin ink is applied too liberally.—Editor.]

TOOLS FOR FITTING TUBES TOGETHER

The writer once designed a fixture and tools for use in milling the ends of tubes, when making joints in bicycle frames, and as they possessed some features of novelty, it is thought that they might be of interest to readers of Machinery. The general plan of the fixture and tools is shown in Fig. 1, a front and side elevation of the fixture in Fig. 2, and the form of cutter employed and the method of securing it in the milling machine spindle in Fig. 3.

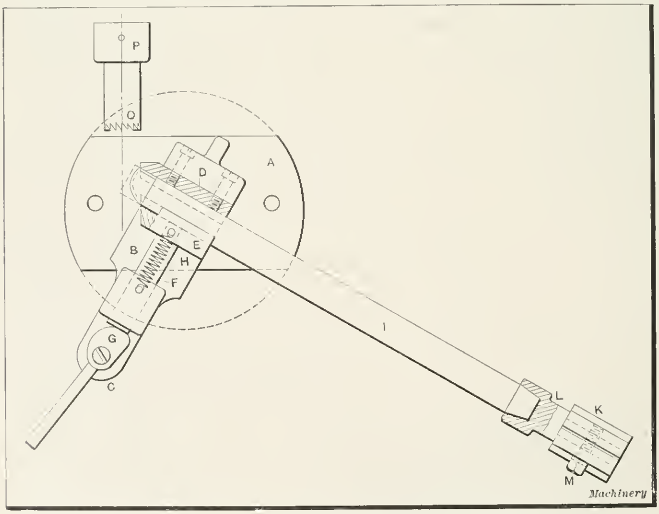


Fig. 1. General Plan of the Fixture and Tools, showing Method of clamping and milling Tubes

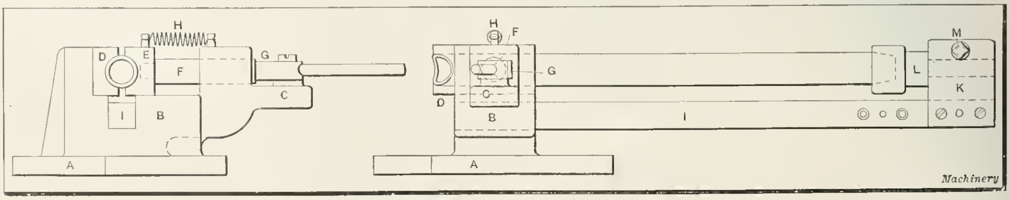


Fig. 2. Front and Side Elevations of the Tube Milling Fixture

The tube-holding fixture consisted of a cast-iron frame, having a base-plate *A*, with an upstanding block *B* cast integral with it and having an overhanging lug *C*. A fixed jaw *D* was fastened to the block *B* by screws, and a movable jaw *E* was carried on a stem *F* which was movably mounted in the projection of the block *B*. A cam *G*, operated by a handle, was employed to move the jaw *E* against the tube to be milled, and a tension spring *H* operated to withdraw the jaw and stem when the cam *G* was reversed. A slot was milled in the block *B* midway between the jaws, and in it was secured a bar *I*, extending to the right. The bar *I* supported a block *K*, which had a socket member *L* secured to it by means of a suitable clamp and clamp-screw *M*. As most of the tubes had one end tapered, this form of socket member was most used; but some of the tubes were also formed with both ends milled, and special plug members, adapted to fit the clamp at one end and the tube at the other, were made for such tubes. Some were merely plain cylindrical plugs with square collars, and others had collars formed at an angle, according to whether the tube to be supported was milled on a bevel or was merely a square-ended blank tube.

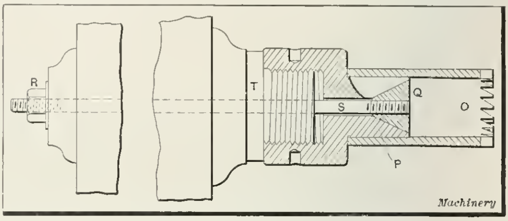


Fig. 3. Type of Milling Cutter used and Method of securing it in the Machine

In making tubes of different degrees of bevel, it was found desirable to make a fixture for each different bevel, so that no inaccuracies would be introduced in changing the fixtures from one angle to another. By making the base-plate *A* circular, as indicated by the large dotted circle, it was found that considerable pattern work was saved. All of the castings were made with the circular base-plate, and segments were then sawed off to obtain the form shown in Fig. 1, or forms similar to it but at different angles The fixtures were arranged for different lengths of tubes by changing the position of the block *K* on the bar *I*. This block was secured on the bar by a dowel pin and screws, and each length of tube was provided for by having a special dowel pin hole and special screw holes for it in the bar *I*. The fixtures were mounted on the knee of a hand milling machine, and the work fed to the cutter by means of the usual hand lever. The relative positions of the cutter and fixture are indicated in Fig. 1, and the line of feed movement of the work is indicated by the dot-and-dash line drawn through the center of the cutter. The type of cutter used and the method of securing it to the milling machine spindle are shown in Fig. 3. The cutter *O*, which is practically a hollow-mill, is gripped internally by means of three jaws *P* that are formed by making radial saw cuts toward the central hole. The jaws are expanded by means of the wedge *Q*, which is drawn against them by tightening the nut *R* on the threaded rod *S* in the spindle *T*. The chuck is screwed onto the nose of the milling machine spindle by means of a spanner wrench. C. D. K.

BENDING APPLIANCES FOR SHEET-STEEL PANELS

There are various methods in use for bending sheet-steel plates which have been made necessary on account of the fact that many types of bends cannot be produced satisfactorily with the ordinary bending rolls. For this reason, various appliances have been devised for producing special kinds of work. Cast-iron bending blocks are often made, and will soon pay for themselves where a quantity of work has to be bent to a standard shape.

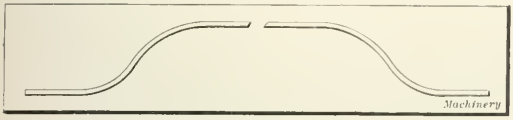


Fig. 1. Sheet-steel Panel with Double Bend at Ends

Fig. 1 shows a sheet-steel panel which is made with a double bend at each end. The work of producing these panels was a matter of considerable difficulty until the bending device shown in Fig. 2 was designed for use in this operation. Referring to the illustration, the method of using the machine may be briefly described as follows: One end of the stock is placed against the block *D* and secured in this position by the clamp *B*. It is then bent over to the position indicated by full lines at *A*; this forms the first part of the bend. The movable block *C* is now brought over to the position indicated by the dotted lines, and is clamped in place by the arms *E*. The free end of the stock is then brought back to a vertical position, thus forming the second part of the bend. The work is now released from the machine and the bends at the opposite end are formed in exactly the same way.

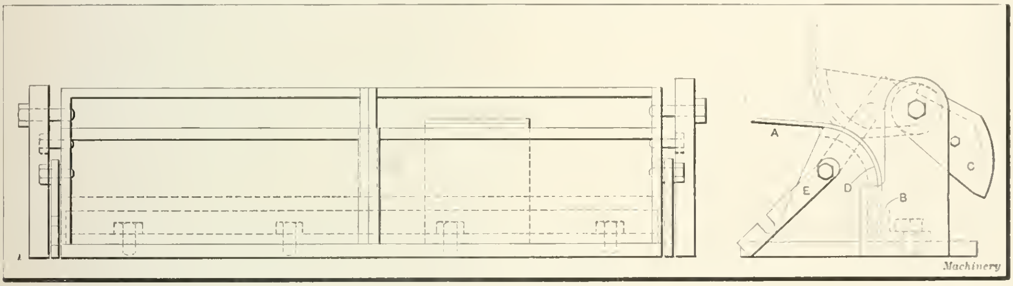


Fig. 2. Machine designed for Rapid and Accurate Duplication of Double Bends

This appliance has been used by the writer for a considerable length of time and has proved a very satisfactory method of producing these sheet-metal panels. The thickness of the stock used is between 0.064 inch and 0.104 inch; 0.080 inch is the most common thickness used for making car projection panels which are required to have true curvatures. It is important to have the work securely held by the cast-iron clamp *B*; if this precaution is not taken, variations in the composition of the steel plates will lead to inequalities in the radii of the bends. The bend of the more ductile sheets will be different from that of the tough sheets, as the ductile material naturally bends more easily. Ductility is not always an advantage however, for if the sheets are too ductile, a greater amount of leveling has to be done. This leveling requires great care on the part of the workman, because the appearance of the panel will be ruined if he does not observe the necessary precautions. In order to secure the best results in leveling, the hammer should be used as little as possible, and never directly upon the material. The best method consists of using a hardwood block about 3 inches square and 12 inches in length. This block can be safely struck without danger of producing any indentations in the work. The sheet steel that is best suited for various bending operations should be of medium toughness. Such stock does not require the amount of leveling that is necessary in the case of extremely ductile sheets. Brittle and blistered steel sheets should always be avoided, as they are of an inferior quality, and when such sheets are subjected to bending, the ductile material tends to slip over the less ductile portions, thus causing the work to break.

Foreman Plater

DRAW-CHUCK FOR PISTON-TURNING

An arrangement that brings the principle of a hook-bolt into machine tool design is shown by the accompanying illustrations. Fig. 1 shows a lathe spindle with a piston in place; *A* is a steel ring on which the open end of the piston is placed after being bored, this ring being forced onto a suitable spindle nose cap. The hook-bolt *B*, shown in detail in Fig. 2, hooks around the bosses *C* and a pull-back rod *D* with a handwheel on the end goes through the spindle.

When placing a piston in the machine, the handwheel *E* is turned in the direction of the arrow enough to allow the hook on the end of the rod to pass around the bosses, and is then tightened, drawing the piston firmly against the steel ring *A*, and thereby bringing it into place. This arrangement obviates the use of the pin that is usually passed through the holes in the bosses *C*, and is considered superior, as it saves the operator the trouble of removing the pin every time he puts a piston on the machine. Server

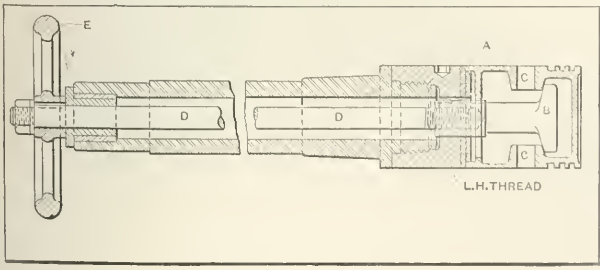


Fig. 1. Draw-chuck for Piston-turning

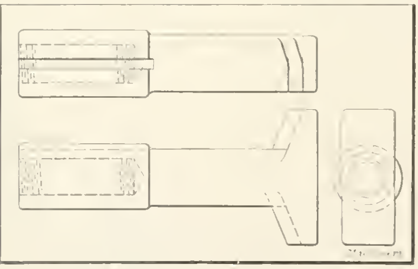


Fig. 2. Details of Hooking Clamps

BORING MILL ATTACHMENT

The engravings shown in connection with this description illustrate a convenient boring-mill attachment for use in crowning pulleys and band wheels. This attachment is of particularly rigid construction and provides a means for the rapid production of duplicate work. The taper shank fits in the spindle of the boring mill, while the lever *A* is pivoted to the frame of the machine. Lever *B* is pivoted on lever *A* and carries an eccentric *C*, which fits into the tool-slide of the attachment. When the spindle of the machine is fed down, this eccentric gives the tool *D* the necessary transverse throw to produce the crown on the pulley. The arrangement of the eccentric is such that the tool point moves away from the center of the pulley during the first half of the downward feed. At this point it is at the top of the crown on the pulley; it then begins to move toward the center of the pulley until the down stroke is completed. M. W. W.

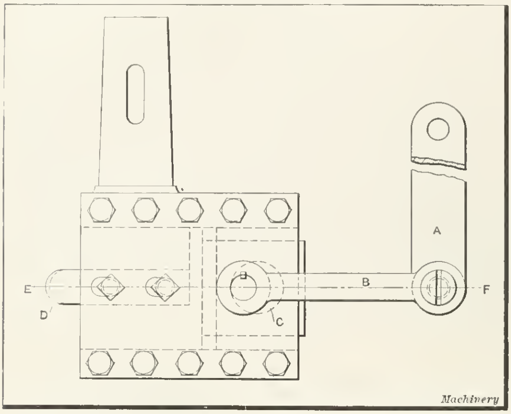


Fig. 1. Boring Mill Attachment for crowning Pulleys and Band-wheels

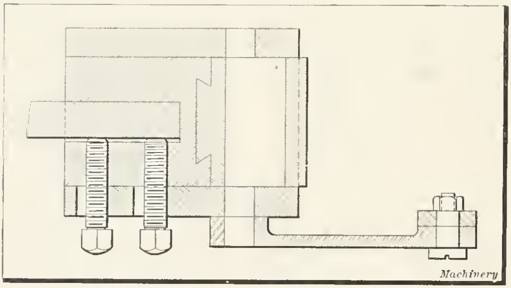


Fig. 2. Sectional View showing Eccentric for Transverse Feed

DRILLING HOLES IN GLASS

The writer has used a method for drilling holes in glass which differs considerably from the one published in the December, 1912, issue of MACHINERY. Instead of using a special tool, an ordinary twist drill was employed with satisfactory results. The edges were ground very slightly, to produce a cutting edge which had a negative or zero rake; the drill was driven at a comparatively slow speed. Screw cutting oil was used to lubricate the tool, just enough oil being used to keep the point of the drill from becoming dry; the oil formed a paste with the chips, which assisted in cutting the hole, the result being practically a case of "glass cut glass."

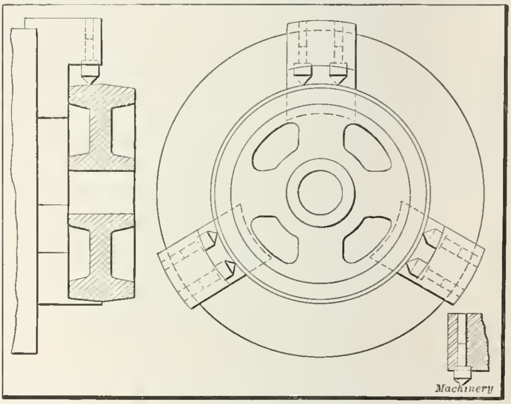
On one occasion it was necessary to drill a 3/16-inch hole in one hundred glass blanks ½ inch in thickness. The preceding method was used with a drill speed of 125 R. P. M., a sheet of blotting paper being laid under the blanks to take up any unevenness in the face of the glass. That this method proved successful will be seen from the fact that there were only three or four pieces out of the hundred that showed any checking on the side where the drill cut through. Another glass working job which sometimes comes to the machine shop, is that of smoothing off the edges of panes of glass which have been cut with an ordinary glass cutter. Anyone who has tried to do work of this kind on an emery wheel, knows of the difficulty that exists in finishing the work without breaking it. However, if such a job is done on a disk wheel, the edge can be straightened up and the corners rounded with surprising rapidity and without any particular danger of breakage.

Middletown, N. Y. D. A. HAMPSON

CHUCK JAWS FOR HOLDING DROP-FORGINGS

The accompanying illustration shows a type of improved chuck jaws especially devised for holding drop-forged gear blanks. The improvement simply consists in providing the regular chuck jaws with pointed gripping pins. In the case shown, the jaws are drilled and reamed with holes about ¼ inch in diameter. These holes are then counterbored at the end nearest the work to about ⅜ inch diameter. Pins are made to fit these holes; the parts of the pins that fit into the smaller diameter of the hole should be a press fit. The pins should be hardened, and the gripping end, which should have a taper of about 30 to 45 degrees on each side, should be ground to a sharp point and should be kept sharp at all times. The pins should be carefully lined up with one another. The device, when well made, will hold the gear blanks so tightly that there is no danger of slippage. Care must, of course, be taken to have the gear blank rest firmly against the face of the jaws. FRED FRUHNER

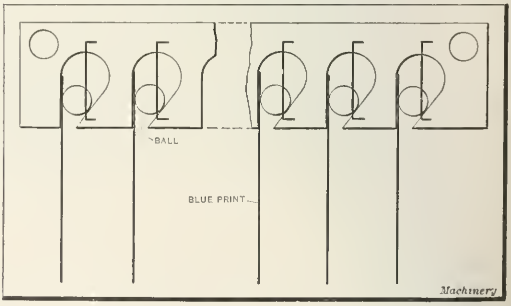
Milwaukee, Wis.



Improvement in Chuck Jaws for holding Drop-forged Gear Blanks

BLUEPRINT DRYING RACK

The apparatus shown in the illustration is employed by the writer for holding blueprints during the process of drying, the prints in question being of no great width. It consists of a wooden rack with about thirty-six slots, of the shape shown in the illustration, cut in its under side; one side of each slot is vertical and one inclined at an angle of about 60 degrees to the horizontal, the two sides being connected by a circular arc. Each slot contains a small hardwood ball, which naturally tends to fall to the bottom or mouth of the slot. The width of this part of the slot, however, is less than



Rack for Holding Blueprints while drying the diameter of the ball, so that the latter cannot drop out. Hence, instead of dropping out, the ball exerts a pressure on each side of the slot so that when the end of a blueprint is placed in position against the vertical face and the ball is allowed to fall to the bottom of the slot, the pressure exerted on the vertical face is quite sufficient to hold the print in place. To prevent the balls from falling out of the slots sideways, wires are secured to the rack opposite the middle of each slot, as shown in the illustration.

The two principal advantages possessed by this piece of apparatus are: 1. The facility with which the ball is flipped up out of the bottom of the slot to release the blueprint. 2. The fact that every particle of water is allowed to drain off the print without defacing it in any way whatever. This apparatus can also be employed in drying large blueprints, though in this case, it would be advisable to use two racks and suspend the prints from two points, in order to keep them as flat as possible. In this case, the two racks should be placed on an adjustable frame so that different sizes of prints could be accommodated. One of the racks could be fixed in position and the other made movable, one being arranged so that it is a little higher than the other. This precaution allows the prints to be so arranged in the racks that the bottom edges of the prints are not quite horizontal; the water on the prints will then flow to one corner and so drain away more readily than if the edges were horizontal.

Sheffield, England. George W. Burley

GENERAL DISTRIBUTION OF CATALOGUES

I certainly agree with your editorial note in connection with the letter from Yamatake & Co., Tokio, in reference to the general distribution of catalogues in Japan. It would be a great mistake for American machinery manufacturers to turn down these requests for catalogues, even though a large number do come from students. The writer was connected with the machine tool business in Japan long enough to secure actual orders from men who as students had been supplied with catalogues by manufacturers. It would be well, however, if manufacturers in America did realize that a large number of these inquiries were from students, and not bother their agents with follow-up letters as to whether the business was secured or not. John S. Nicholl

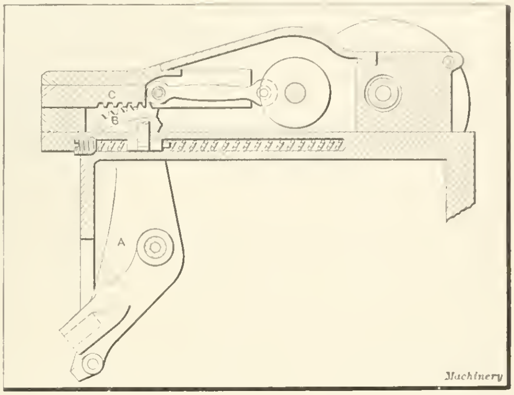
Boston, Mass.

TAKING OUT BACK SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

The writer wishes to offer a comment on a statement by Mr. Nevin Bacon in the November issue, relative to taking out a back shaft. Mr. Bacon states, "If a back shaft is taken out and replaced in such a manner that every gear does not mesh with the same teeth as it did before the shaft was removed, then the machine will be 'out of time' and the entire job will have to be set up again." Since the writer knows that Mr. Bacon has had experience in replacing back shafts on B. & S. automatic screw machines, it seems peculiar that he should make the statement that the job would simply have to be set up again to overcome the difficulty. Mr. Bacon will have to admit, upon second thought, that in case a back shaft is not properly replaced, the machine will not be in operating condition, because no matter to what extent an operator may change his job on the machine, all of the clutches, gearing, and cam-actuated engaging arms will refuse to do their part. All B. & S. automatic screw machine operators will agree with this statement—hence the criticism.

In connection with this discussion, the writer wishes to state that if the rack *C* is removed and is not replaced in mesh with the same teeth of the segment gear *B* on the bell-crank lever *A* as were in engagement before removal, the distance of travel of the turret tools will be different from that before the adjustment was made. An operator is often confronted with a screw machine job that gives trouble because the part to be made is too long for the distance between the spindle and turret, so that there is not sufficient clearance for the turret tools when tripping away from the work. In this case, it is advisable to mesh the teeth of the rack *C* with different teeth of the segment gear *B* than were previously in engagement; this will allow a greater distance between the turret and spindle and still permit the machine to be operated without danger of breakage. This method of production will effect a great saving over the cost involved in producing such pieces on a hand screw machine. J. Harmon

[Mr. Harmon is correct in his statement regarding the relation of the work to the timing of the back shaft, but should modify his statement in regard to the rack operating the turret. His statement applies to the Nos. 00 and 0 machines only; the No. 2 machine has an adjusting screw which provides for the use of tools of various lengths in the turret. It should also be mentioned that in making such an adjustment of the engagement of the rack and segment gear, the stop for the rack must be set out in order to allow the rack to travel further back and thus increase the distance between the face of the turret and the chuck for the accommodation of longer tools. Such a method of increasing the capacity of the machine is but a makeshift at best, and its use is not to be recommended. While there is probably no danger of damaging the machine, this adjustment of the rack and segment gear creates a tendency for the rack to bind, which certainly is not a desirable condition in the operation of the machine.—Editor.]



Mechanism of Turret Slide of a B. & S. Automatic Screw Machine

TO BROWN RIFLE AND PISTOL PARTS

The following formula for browning rifle and pistol parts is offered by the writer because he has found that it gives very good results. The method of procedure is as follows: Coat the metal to be browned with a solution of copper sulphate, either by dipping or with a camel's hair brush. When the metal is well coated or plated with copper, wipe it dry with clean cotton waste or a cloth. Then apply ammonium sulphide solution by dipping or with a brush, being careful to cover all parts touched by the copper sulphate solution. After the ammonium sulphide has acted for about thirty seconds, dry the work by normal pressure on the surface with clean waste or a cloth. No heat is required for the above process.

The copper sulphate solution is made up as follows:

25 per cent copper sulphate, ($CuSO_4$)
74 per cent water, (H_2O)
1 per cent muriatic acid, (HCl)

The ammonium sulphide solution is made by dissolving chemically pure $(NH_4)_2S$ in water.

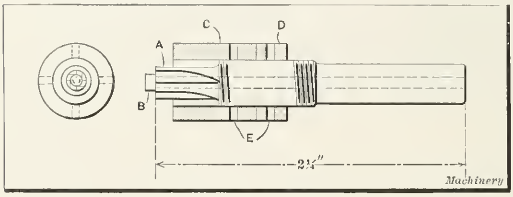
The color produced will be similar to the browning done at the Springfield Armory, and is due to the copper sulphide, produced on the outside surface of the copper plate previously deposited by the chemical action between the copper and ammonium sulphide. The copper sulphide is a stable compound and affords good protection to the metal browned in this way. The copper plating beneath the sulphide also provides a safeguard against rust. The same result could be used for browning other classes of work.

Hartford, Conn. Charles F. Scribner

AN ADJUSTABLE COUNTERBORE

In the accompanying illustration is shown a counterbore which is adjustable as to the depth of the hole. It consists of the part *A* which has teeth cut on it for ½ inch of its length. Just above this is a threaded portion, ⅝ inch long, and above this, a straight shank, slightly less in diameter than the root diameter of the threaded part. A hole is drilled through the center of *A* into which is fitted the removable pilot *B*.

A collar *C* screws onto *A*, and the position of this collar is adjusted for the depth of the hole to be counterbored. A check-nut *D* prevents the collar from turning after being adjusted to the required position. The collar and check-nut are round and they are turned by a piu inserted in holes *E*.



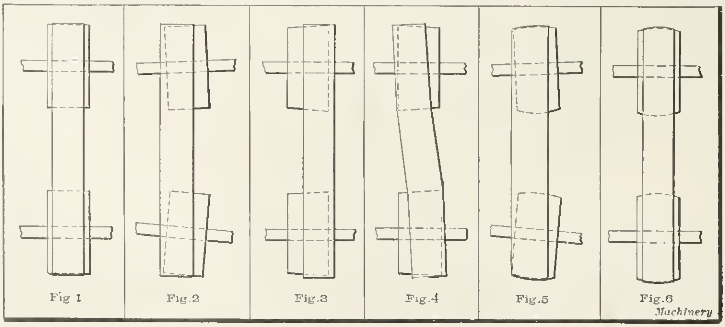
An Adjustable Counterbore

In use, the counterbore enters the hole until the collar reaches the work; this stops the progress of the cutter. This tool has been found very useful when two holes are to be counterbored in the same piece, but when these holes are on different surfaces and thus at different levels. In order to use the usual spindle stops, in such a case, two counterbores would be required and two spindles of the drill press. Several different sizes of semi-finished parts for these tools are made up in quantities and carried in stock ready to turn the cutter to size, mill the teeth, fit the pilot, harden and grind. They can thus be made up very cheaply. A. M. Rochester

COMMENT ON DIRECTION IN WHICH BELTS TEND TO RUN OFF PULLEYS

In the October number of Machinery, T. J. C. states: "It is common experience, noted by all mechanics, that an open belt running over pulleys mounted on shafts in the same plane but out of parallel, runs to the 'high side'." The layout accompanying this discussion shows the shafts out of parallel and the belt on the "high side." The "high side" is the term applied to what is properly the longer distance between shafts that are out of parallel, and belts will not run to the "high side" but to the "low side" or shorter distance between the shafts.

Let us start with pulleys that are straight face and of equal diameter for the full width. When shafts are parallel and the pulleys are in line, the belt will run in its proper place on these pulleys. This condition is shown in Fig. 1. When the shafts are out of parallel and the pulleys are in average line, as shown in Fig. 2, the belt will run to the "low side" or the end where the shafts are nearer together. With cone-face pulleys—pulleys having a straight face but larger in diameter at one end than at the other—when the shafts are parallel the belt will run to the larger diameter. This larger diameter is the high part of the pulley, but is not necessarily the "high side," and it must not be confused with the term "high side" as applied to the alignment of shafting. Two conditions are possible for this case, as shown in Figs. 3 and 4. With crown faced pulleys mounted on shafts that are out of parallel, as shown in Fig. 5, the belt will run toward the "low side." When shafts are but little out of parallel, the tendency to run toward the "low side" will not be noticeable, for the crown will keep the belt at the center of the pulleys. The same results take place with shifting belts running from straight face pulleys on main shafts to straight or crown face tight and loose pulleys on countershafts or machines. Fig. 6 shows crown face pulleys in line on shafts that are parallel, and in this case the belt will run to the centers of the pulleys. The tendency is for the belt to run to the larger diameter.



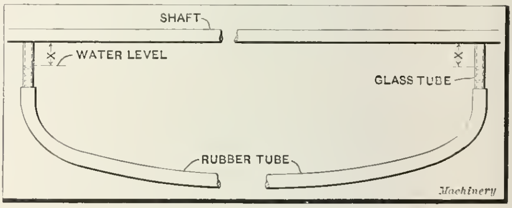
Figs. 1 to 6. Diagrams showing Direction in which Belts tend to run off for Different Types of Pulleys and Alignment of Shafting

In the preceding discussion, it has been assumed that the belts are straight and that both edges are the same length. Belts with one edge longer than the other will not run in their proper places on pulleys that are properly aligned on parallel shafts. Crown face pulleys should be the same diameter at both ends with the larger diameter at the center of the face. T. J. C. in his comment mentioned an open belt. The same general results will obtain with crossed belts but the lead will be affected to some extent by the crowding of the belts at the crossing point. J. R. Rand

Springfield, Mass.

METHOD OF LEVELING LINESHAFTING

Long lengths of lineshafting can be leveled by the use of the apparatus illustrated herewith, which will be seen to consist of a piece of rubber tube or hose that is long enough to reach nearly to the ends of the shaft which is being leveled. A piece of glass tube is fastened in each end, with six or eight inches projecting from the rubber tubing. Water is poured into the tube until it is nearly filled, the level at either end being situated in the glass tubes. Two small corks are then used to prevent the water from being spilled while moving through the shop.



Apparatus used for leveling Lineshafting

The principle upon which this apparatus works depends upon the well-known fact that water seeks its own level. Consequently, it is only necessary to place the ends of the glass tube against the lower side of the shaft and measure the distance *X* between the shaft and the water level in each glass tube. If the shaft is level, the distances *X* must necessarily be equal, and the amount of any inequality which is exposed is easily determined. Two men are required to level shafting by this method, one man taking measurements of the distance *X* at each end. This device can also be used to determine the level of shafting which passes through a wall, as the tube can be taken around so that the ends are brought into contact with the shaft on each side.

Fort Atkinson, Wis. E. L. White

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

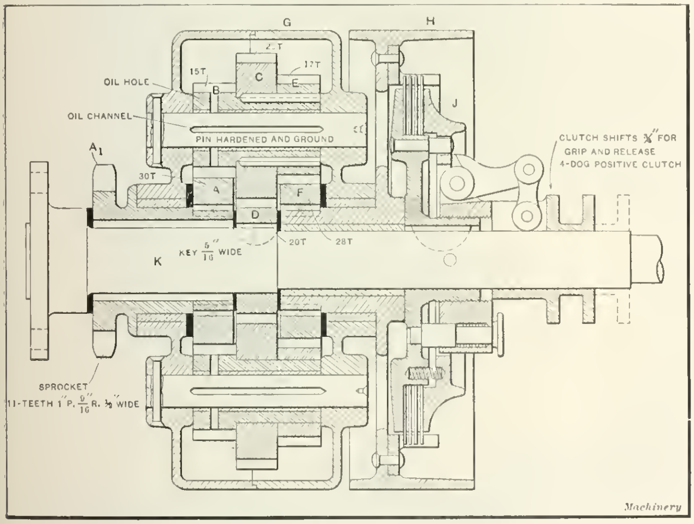
CAM GRINDING INDEPENDENT OF WHEEL WEAR

C. D.—Machines are available for grinding small gas engine cams accurately, but I have never seen a machine for grinding large gas engine cams that did not produce forms varying with the size of the wheel. Consequently, wheel wear vitally affects the shape of the cam. I would like to see a description of a cam grinding machine for large cams that produces fixed shapes independent of wheel wear.

If any reader can furnish a description of a special cam grinding machine that meets the want of our correspondent, we shall be glad to receive it.

SPEED RATIOS OF AUTOMOBILE PLANETARY GEAR

G. M. G.—The illustration shows an automobile planetary transmission gear which provides two forward speeds and one reverse speed. Gear *A* mounted on the sleeve with the sprocket A_1 has 30 teeth; the gear *B* engaging with it has 15 teeth; gear *C*, 25 teeth; gear *D* keyed to the shaft *K*, 20 teeth; gear *F* mounted on the extended hub of clutch drum *H* has 28 teeth; and gear *E* meshing with it, 17 teeth. By clutching the drum *G*, slow forward motion is communicated to sprocket A_1; by throwing in the clutch *J*, high or direct speed of A_1 is obtained; and by clutching *H*, the reverse motion of A_1 results. In the designing of this gear we have had considerable discussion and difference of opinion over the ratios that will be obtained, especially on the reverse. Will you kindly submit the drawing to the readers of MACHINERY as an example of interesting planetary transmission and let them calculate the ratios?


G
H
25T
17T
15T
C
E
B
OIL HOLE
OIL CHANNEL
J
PIN HARDENED AND GROUND
A_1
CLUTCH SHIFTS ⅜" FOR GRIP AND RELEASE 4-DOG POSITIVE CLUTCH
30T
A
F
D
KEY 5/16" WIDE
20T
28T
K
SPROCKET 11-TEETH 1" P. 9/16" R. ½" WIDE
Machinery

A.—The gear offers little difficulty as a problem in ratios when analyzed by the method that has been explained several times in MACHINERY, excepting that a supplementary calculation is necessary to find the reverse speed. However, it is offered for solution and answers are requested.

TO FIGURE THE RISE OF STEEP GRADES

A. L. D.—A garage here in San Diego, Cal., has a balcony for the storage of motor cars. The cars are driven up an incline to the balcony under their own power. The height of the balcony from the floor is seven feet ten inches and the length of the incline between perpendiculars is eighteen feet. The question is how to figure the ratio of lift to car travel. I claim that the length of the incline or hypotenuse of the angle made by the incline with the floor should be taken as one member of the ratio, but others say that in figuring grades the distance between perpendiculars is always taken.

A.—The distance between perpendiculars is always used in calculating all ordinary railway and highway grades, the grades being expressed as rise percentages of the horizontal distance. The percentage of rise in the case cited is 43.5 per cent. But in grades as sharp as this the car travels a perceptibly greater distance than that between perpendiculars, being in this case, nearly nineteen feet seven inches. Hence the rise should be figured in terms of the incline, or as the sine of the angle instead of the tangent as is the general rule.

PROVING NARROW-CAVITY DROP-FORGE DIES

T. C.—I recently sunk a drop-forge die for a bayonet, and have experienced great difficulty in securing a satisfactory lead proof from same. The bayonet is 13 inches long and 0.060 inch thick in the blade. I used a 0.015-inch shim between the dies to allow for air vent and heated the die so that it would melt solder before pouring the proof. I have tried lamp-black, powdered chalk and greases of different kinds to prevent adhesion of the molten metal; also lead and rosin, and six per cent tin in lead and babbitt metal with poor results.

Answered by J. W. Johnson, Revere, Mass.

The difficulty of obtaining a good lead proof from a narrow-cavity die, is sometimes caused by not having the sprue of sufficient size. The sprue should be large enough to hold the piece on the bar until forged; it should not be too long and should be smoothly finished and well chalked. If the lead is allowed to strike the gate and run into the sprue while proving, it will be chilled before it goes into the impression, and for that reason sometimes will not fill it out properly. Again, if the lead is heated too much, it will not run well. The lead should be clean; a good plan is to throw a little powdered rosin in the ladle before pouring, and skim off the top. The lead should be poured directly into the sprue in a steady stream and not too rapidly or it will choke. The piece of thin cardboard between the dies on each side of the impression is good to let the air out freely, but the resulting proof will not be exact, inasmuch as it will be thickened by the thickness of the cardboard stock. The dies should be well chalked all over the impression, the sprue and the gate, and it is well to warm the dies slightly also when the cavities are narrow. I have taken lead proofs as long as the one in question and have made the lead flow into cavities only 1/32 inch wide, or about one-half the thickness of the thinnest part of the bayonet. I think the cause of the trouble is in having too small a sprue in the dies.

* * *

NEW EQUITABLE BUILDING

The Equitable Life Assurance Society of New York has filed plans for a thirty-seven-story building, to cover the block bounded by Broadway, Pine, Nassau and Cedar Sts., New York, which will be the largest building in the world in point of floor area, although not the highest building. Its height—486.9 feet—will be considerably less than that of the Woolworth building in New York, which is about 750 feet. The new building will have forty-six public passenger elevators and will provide 1,100,000 square feet renting floor space. Announcement was made in the February, 1912, number of proposed plans for a building on this site—the site of the old Equitable building which was destroyed by fire January 9—that provided for a main structure of thirty-four stories surmounted by a tower of twenty-eight stories, making a total height of 909 feet. The plans for this building were not adopted, however.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LEES-BRADNER THREAD MILLING MACHINE

The Lees-Bradner Co., Cleveland, Ohio, manufacturer of automatic gear generators, has recently placed on the market a line of thread milling machines designed by E. J. Lees, which are shown in the accompanying illustrations. Fig. 1 shows a front view of the machine known as the "two-foot-six-size." This machine has a capacity for lengths of 2 feet 6 inches between centers, and will cut any lead from 20 threads per inch up to and including a lead having one turn in 96 inches. The swing over the cutter-slide is 10 inches, and over the ways, 16 inches. The thread milling is accomplished with a single form cutter, mounted on a spindle in a swivel head which has an angular adjustment of 180 degrees. The swivel head is set according to the angle of the thread to be cut, by means of graduations on the rear of the head and a vernier scale.

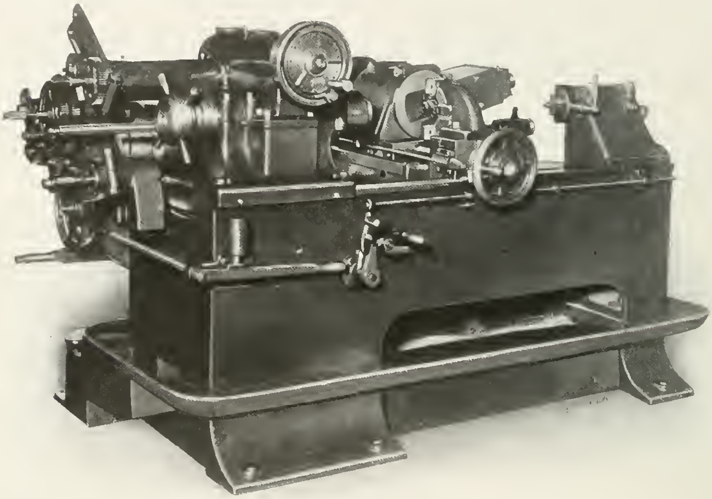


Fig. 1. Front View of the "Two-foot-six" Size Lees-Bradner Thread Milling Machine

Driving Mechanism and Main Head

This thread milling machine is driven by one belt from the countershaft which runs on a cone pulley at the rear of the machine, having four steps as shown in Figs. 3 and 5. This cone pulley, through a clutch mechanism, drives the back-shaft which transmits power to the cutter and, through change-gearing, rotates the work and lead-screw. The machine is started by pressing down a lever which passes at right angles through the bed and connects with a clutch on the back-shaft. The quick return of the cutter-slide, which is in a ratio of 60:1, is controlled by a lever shown at the extreme left-hand end of the machine in Fig. 1. A hand lever fitting on the squared shaft extending from the left-hand end of the machine is used by the operator in setting the cutter-slide in the proper position in relation to the work when setting up a new job. When everything has been set for a certain part, however, this hand lever is not manipulated at all.

For cutting multiple threads, the work-spindle is indexed by a dividing mechanism shown on the left-hand end of the machine in Figs. 1 and 2. Plates having various numbers of holes are provided for the different indexings of the spindle required. The indexing of the work is accomplished by hand at the completion of each cut, when cutting multiple threads. The spindle is indexed by means of a worm and worm-wheel, the latter being held rigidly on the work-spindle itself.

The work-spindle is made from a hammered tool-steel forging, ground inside and out, and carries a draw-in spring chuck having a capacity for 2¾ inches diameter. The hole passes completely through the spindle so that work equal in diameter to the capacity of the chuck and longer than the capacity of the machine can be operated upon by letting it project from the rear end of the spindle. The work-spindle runs in gun-metal bushings, the front bushing being 8½ inches long by 4¾ inches in diameter, and the rear bushing, 5½ inches long by 4½ inches in diameter. The spring chuck, which is of the draw-in type, is closed on the work by the handwheel shown at the rear of the spindle in Figs. 1 and 2. When it is necessary to hold the work on centers, a center which fits in the spring chuck is used for this purpose.

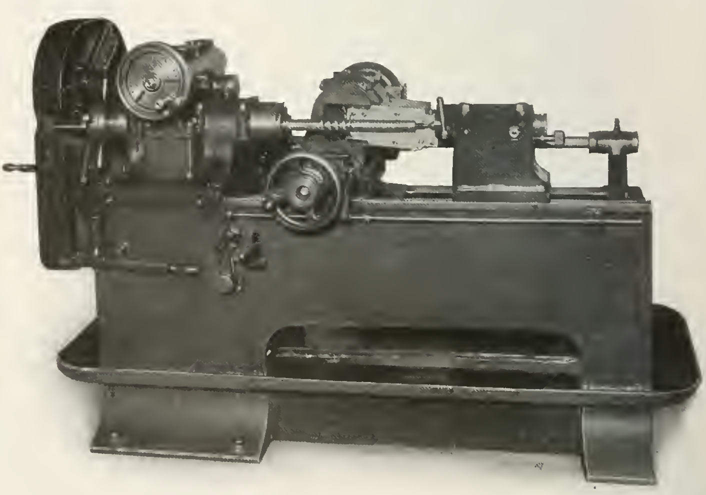


Fig. 2. Milling a Steel Worm One-inch Circular-pitch, Single-thread, in One Cut

The Cutter-slide

The cutter-slide, which is moved longitudinally along the bed by the lead-screw, is provided with three bearing surfaces of liberal proportions, see Fig. 5. A noteworthy feature in connection with this type of bed is the raised front which increases the depth of the bed and shortens the distance from the axis of the spindle to the bed, without increasing the swing. It also provides additional rigidity to the cutter-slide and tailstock. The drum in which the cutter-head proper rotates is of rigid design, and is cast integral with the cutter-slide.

The cutter-spindle is a vanadium steel forging, hardened and ground, and runs in a hardened and ground bushing. It is 1½ inch in diameter and is driven by a spur gear meshing with a gear made integral with the spindle and having a 3½-inch face. This cutter-spindle is so strongly built and rigidly supported that it will stand up to cut a thread having 1½-inch circular pitch in steel, in one cut. The absence of overhang of the cutter-spindle is one feature that is of prime importance in a thread milling machine which must take heavy cuts without chatter or vibration, and this is admirably provided for in the machine illustrated.

The depth of cut is obtained by moving the entire cutter-slide by means of the handwheel shown at the front of the machine. The means of accomplishing this adjustment is worthy of special mention. The screw operating the slide (at right angles to the axis of the work-spindle) is stationary, whereas the micrometer nut is operated by a handwheel, and by an ingenious interlocking arrangement the cutter can only be brought in to the depth for which it has been previously set. This obviates the possibility of an operator making an error in this respect, which could easily occur in cutting a multiple thread if no provision were made for retaining definite settings of the cutter-head. The entire cutter-slide can be operated longitudinally in either direction, and is stopped automatically.

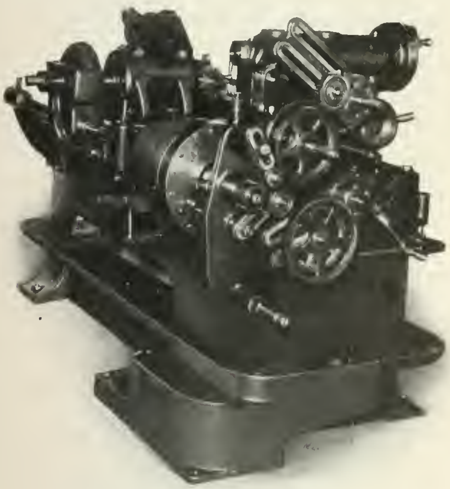


Fig. 3. End View of Thread Milling Machine showing Change-gearing Guard removed

Another feature in connection with the cutter-head that is of particular interest is the fact that, although the head can be swiveled through an arc of 180 degrees, the drive only turns two corners from the source of power. This is a feature which will be particularly appreciated by those who desire a machine having a powerful and accurate drive. The follow-rest shown in place on the machine in Fig. 1 is an independent unit and can be set to the work without loosening the other adjustments of the cutter-head. This follow-rest is designed to carry either a shoe or bushing support for the work and is attached to the cutter-slide, traveling with it.

Miscellaneous Details

The oil-pump for supplying the cutting lubricant to the machine is mounted at the rear of the bed, see Fig. 5, and the oil can only reach the pump reservoir after passing through three separate straining compartments. This prevents any dirt or chips from being forced through the pipe to the cutter.

This type of thread milling machine is built in various sizes, the difference in size being a variation only in the length of the bed. In many cases when cutting fine threads—20 threads per inch—a hob can be used, thus producing accurately threaded work at a rapid rate. On heavier pitches, as previously stated, a single cutter is always used.

Examples of Thread-milled Work

Fig. 4 shows an interesting group of various gears, thread shafts, etc., which have been cut in this machine. The tool-steel worm shown at *A*, which also appears in the machine in Fig. 2, is 1-inch circular pitch, single right-hand thread, and was completed in one cut—being ground after hardening. The spiral gear shown at *B*, and also set up in the machine in Figs. 3 and 5, has 12 teeth, 4-pitch, with a 45-degree helix angle. This gear, which is used on a No. 5 Lees-Bradner gear generator, was completed in one cut. As an illustration of what this thread milling machine will do, the following example is given: A forged-steel worm 6½ inches in diameter, 9½-inch face, 1½-inch circular pitch, 4½-inch lead, 3 threads, was finished complete and accurate in every respect in three hours. By a close inspection of Fig. 4, many interesting examples will be noted which indicate the wide range of work which this machine is capable of producing.

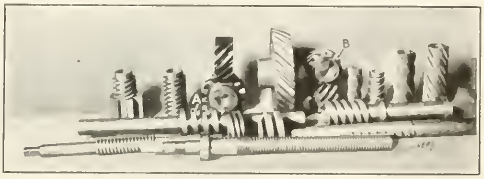


Fig. 4. Interesting Examples of Work produced on the Lees-Bradner Thread Milling Machine

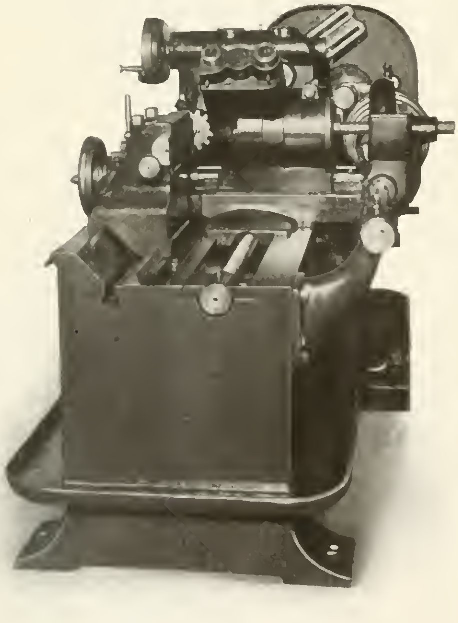


Fig. 5. End View looking toward the Dividing Head. Note Massiveness of Cutter-slide and Liberal Bearing Surfaces

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LEA-COURTENAY COLD METAL SAW

The Lea-Courtenay Co., Inc., 90 West St., New York City, has placed on the market the cold metal saw shown in the accompanying illustrations. Figs. 1, 2 and 3. An important feature of this machine is the arrangement of the swing arm which carries the saw. This arm is pivoted near the center of the frame of the machine and is so arranged that the arc through which the saw arbor travels is always below the surface of the work on the table. This design does away with the tendency of the saw to dig in and climb on the work, and as a result a material reduction has been made in the number of blades and teeth that are broken. A further advantage of this arrangement of the arm carrying the saw is that it has effected a considerable increase in the cutting range of the machine. The principle of this design will be readily understood from the diagram, Fig. 1, which shows the movement of the saw arbor and the arc through which it passes; the shaded section shows the available cutting area. These machines are adapted for both belt and motor drive.

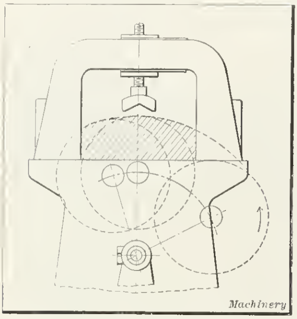


Fig. 1. Diagram showing Arrangement of Swing Arm on Lea-Courtenay Cold Metal Saw

Fig. 2 illustrates a machine driven by a variable speed motor which gives a cutting speed at the saw blade of about 35 to 50 feet per minute. The motor is mounted on an extension of the base of the machine and drives the main shaft through a silent chain. Power is taken from this shaft for three purposes: (1) To drive the saw blade; (2) To operate the power feed; and (3) To drive the pump which supplies cutting fluid to the blade. The drive for the blade is taken from the main shaft by means of a steel spur gear and pinion; a tool-steel bevel pinion is attached to the hub of the spur gear and the power taken from this pinion drives through a tool-steel bevel gear, vertical shaft and a second pair of bevel gears to the shaft carrying the sprocket which engages with the holes in the saw blade. A roller chain transmits power from the main shaft to the feed-box, and to guard against accidents through the saw binding, a slip gear is mounted on the shaft leading into the box. A spring presses the fiber frictions together with sufficient force to provide ample power. The tension of this spring can be adjusted by a hand-screw and will allow the feed to slip and protect the machine from being damaged in event of the saw binding. The feed-box provides ten changes which are easily obtained by setting a pull-pin in the desired position. This feed is very similar to the modern feed-boxes on quick change gear lathes. Both of the shafts through this box are made of tool steel. The movement of the swing arm is derived from the segment which meshes with the large worm on the vertical shaft. When the arm is to be fed forward, the tooth clutch at the bottom of this shaft, which will be better seen by referring to Fig. 3, is in engagement with the worm-wheel. When the saw has completed its forward stroke, a pin on the segment engages with an adjustable dog which trips the lower clutch at any predetermined point, and at the same time engages the upper clutch with the spiral gear; this reverses the direction of rotation of the worm and, consequently, returns the saw into position for the next cut. The clutches may be tripped independently of the dogs on the segment by means of the small hand lever shown in Fig. 2. This illustration also shows the vertical handwheel for adjusting the height of the saw blade. The pump for supplying the lubricating fluid to the blade is of the balanced vane positive type which does not require a check valve and will prime itself when the machine is started up. This pump is driven from the second roller chain running from the main shaft.

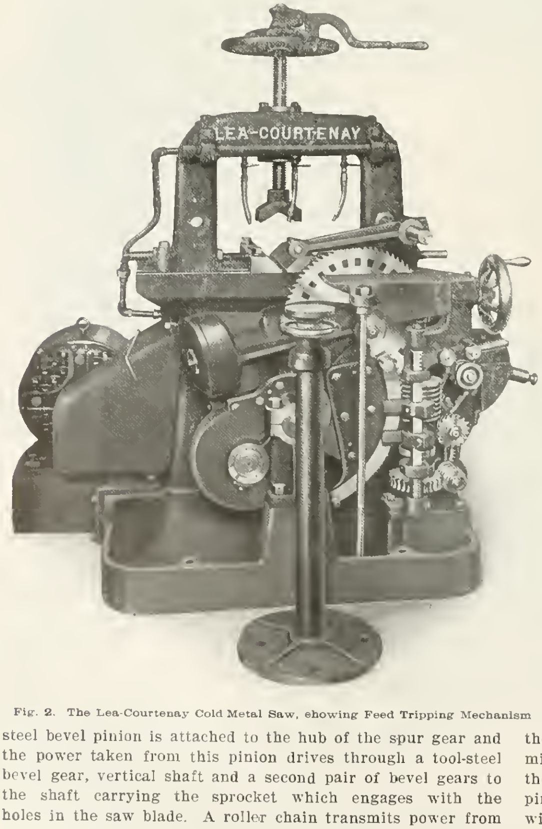


Fig. 2. The Lea-Courtenay Cold Metal Saw, showing Feed Tripping Mechanism

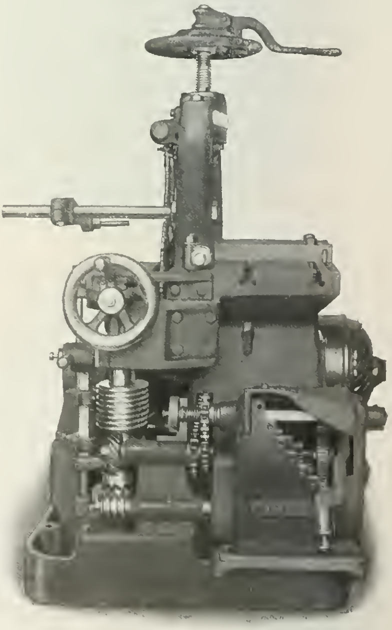


Fig. 3. Front View of Machine, showing Gear-box

Partly for convenience in manufacturing and principally to secure perfect castings, the frame of the machine is made in two pieces; the top part is joined to the base at a point slightly above the level of the tank which holds the lubricating fluid, and this design effectually prevents leakage. The two sections are bolted together. The top of the table has three T-slots; the outside ones are used for holding the V-blocks, and the middle one for holding work of irregular shape. The top of the table is also provided with two rows of holes for inserting pins to be used as work-stops. These machines are provided with swivel V-blocks which can be set at right angles to the saw blade for cutting work off square, or can be swiveled to cut off structural material at an angle within the range of the machine. In addition to the handwheel on the top of the screw, there is a cast-steel lever with a lug fitted to a spoke of the clamp wheel so that a permanent method of tightening up the work is always at hand. The lower end of the clamp screw is casehardened and fits into the upper V-block, which is a heavy steel casting with two grooves, one of 90 degrees and one of 120 degrees; the latter is used for holding very small work. Particular attention has been given to the selection of the best type of bearings for this machine. Bronze, babbitt, reamed cast-iron and ball bearings are used in different parts of the machine. The swing arm which carries the saw turns on heavy trunnions, one of which is mounted on the center of the frame, the other being supported on the outside by an outboard bearing. Provision has been made for ample lubrication of all bearings, and in three or four cases where the bearings are apt to be neglected a special type of oilless bearings has been provided.

GARVIN TWELVE-INCH CAM CUTTING MACHINE

The illustrations show a cam cutting machine adapted for cutting both face and barrel cams, in sizes ranging from 1 to 12 inches, which has been placed on the market by the Garvin Machine Co., Spring and Varick Sts., New York City. Fig. 1 shows the machine arranged for cutting face cams, and in Fig. 2 it is equipped with the barrel cam cutting attachment. The machine is similar to the standard design which has been developed by this company in its 24- and 36-inch machines. The spindle slide is mounted on balls which run in steel races, making it particularly sensitive. The drive is through a universal joint from the overhead countershaft, and with the belt on the eight-inch step of the cone pulley, the machine runs at 300 R. P. M. The rail slide is counterbalanced and operated by a rotary nut with ball thrust bearings, which gives a quick motion for the removal of the cutter and former pin at the completion of the cam. The spindle slide is clamped in position while making the change and is returned to a positive micrometer stop. The spindle bearings are similar in design to those used on this company's profilers. Provision has been made for instantaneous reversal of the feed or for disengaging the feed entirely. Eight changes of feed are secured by means of the change-gears. The machine can be readily changed from operation as a face cam cutting machine to a barrel cam cutting machine, or *vice versa*, as the fixtures can be readily removed or replaced. A floor space of 32 by 35 inches is occupied by the machine.

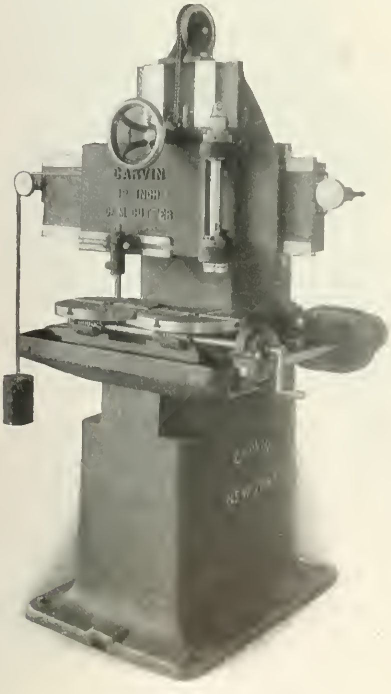


Fig. 1. Garvin Cam Cutting Machine set up for cutting Face Cams

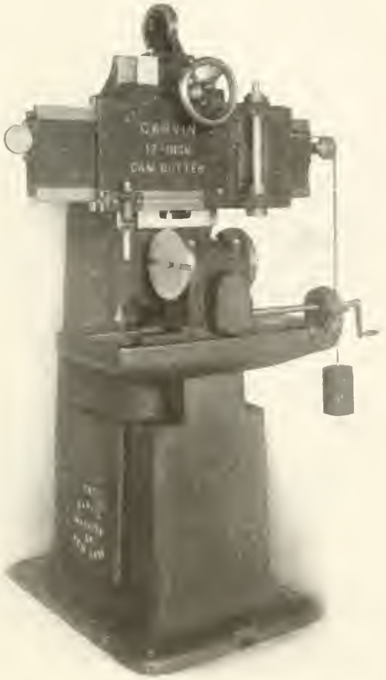


Fig. 2. Garvin Cam Cutting Machine set up for cutting Barrel Cams

BROWN ELECTRIC TACHOMETER

The Brown Instrument Co., and the Keystone Electrical Instrument Co., Philadelphia, Pa., are placing on the market a new electric tachometer to indicate, or record on a chart, the revolutions per minute of a rotating shaft or wheel. There are many operations for which it is desired to have an accurate speed indicator permanently connected to an engine or machine, to show at a glance the speed at which it is running, or to keep a continuous record of this speed on a chart. The electric tachometer has the advantage of being exceedingly accurate, and in addition, the indicating or recording instrument can be located at any desired distance from the shaft, the speed of which is to be measured. The instrument consists of a small magneto or generator, particularly designed for use with this tachometer and which generates 25 volts at 1000 revolutions per minute. The instruments have been designed with unusually high resistance—exceeding 3000 ohms in each instrument—so that the length of leads connecting the magneto or generator and the instrument has no effect on the readings; this also makes it possible for one, two or three instruments to be connected to the same generator without affecting the indications. This high resistance feature is exceedingly advantageous, for frequently after the generator and one indicating instrument have been installed, it is desirable to place a recording instrument at some convenient point, and this second instrument can be connected to the generator without recalibration.

The illustration shows the standard Brown electric tachometer, generator, leads and indicating instrument, as usually supplied. It is often desirable to operate a machine at a certain speed to produce the best results. For instance, in large machine tools where it is desirable to know the cutting speed, the use of this electric tachometer mounted beside the machine enables the exact speed to be noted at all times and maintained as desired. There are many tests that constantly have to be made for which an electric tachometer of this type will prove particularly advantageous. As an instance, we might cite the use of such instruments on war vessels and merchant ships, where it is particularly desirable to not only indicate the speed of the propeller shaft in the engine room, but also in the chart house and on the bridge. In the case of the U. S. battleships the small generator is driven by gears, direct from the main propeller shaft, and three indicating instruments are connected to a single generator to indicate the speed at various points about the ship. This is particularly desirable in maneuvering, where a space of say two hundred yards must be maintained between each ship. If a ship in the rear is gaining on the forward one, by signalling for one or two revolutions slower speed, the desired position can be maintained.

Brown Electric Tachometer

SCHUCHARDT & SCHUTTE AUTOMOBILE GEAR HOBBER

The gear hobbing machine illustrated in Fig. 2 has been built by Schuchardt & Schutte, Cedar and West Sts., New York City, to meet the requirements of automobile builders for a machine combining rapid and accurate production of gears from such metals as nickel-chrome and vanadium steel, heat-treated before machining. The machine is not intended for handling spiral gear work, and so it is not necessary to set the hob at the angles used in hobbing spiral gears; this has been the means of effecting an important improvement in the design of the machine.

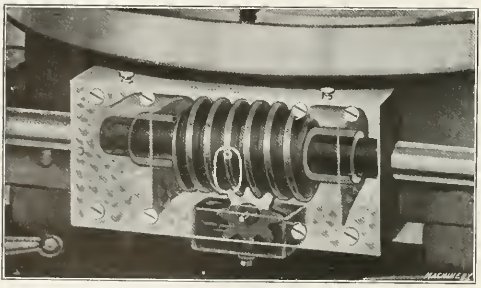


Fig. 1. Method of Lubricating Worm and Worm-wheel of Spacing Mechanism on S. & S. Gear Hobber

The new machine is designed with the hob below the center about which the cutter head is swung, and by this arrangement it has been made possible to have the hob as close as 5⅜ inches to the face of the upright. This design has served the double purpose of reducing the leverage and enabling the thrust upon the cutter head to be more firmly supported when the hob is being fed across the face of spur gears. The result is seen in a total absence of chatter or vibration when the machine is driving a high-speed steel hob at its full capacity. The weight of the machine has been increased over preceding designs so that its strength has been materially increased; this statement applies particularly in the case of the upright and the cutter head.

The machine is belt-driven by a three-step cone pulley of 3¼-inch face. The back-gears are located in the bed of the machine and there are six available speeds—three direct drive and three through the back-gears. The drive to the cutter is taken from the pulley shaft through a vertical shaft in the upright and two horizontal shafts which transmit power through three pairs of bevel gears and one pair of helical gears. One of the gears in each pair is of phosphor-bronze and the other of steel. The bevel pinion mounted on the pulley shaft also connects with a bevel gear on the shaft which transmits power to the feed mechanism and to the spacing mechanism. The gears for the spacing mechanism are mounted at the end of the bed behind the upright. These gears transmit power to the spacing shaft, which runs along the side of the bed and drives a worm-wheel on the table by means of a worm on the shaft. Fig. 1 shows the method by which this worm and worm-wheel are lubricated. The small wheel shown in mesh with the worm, dips into an oil reservoir and in rotating, carries up a continuous supply of oil to the worm. A felt wiper is in contact with the worm-wheel at the point where it leaves contact with the worm. This wiper removes superfluous oil and allows it to run back into the reservoir.

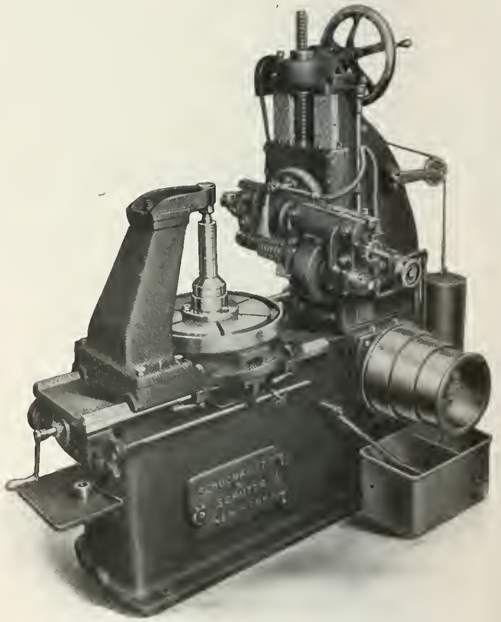


Fig. 2. Schuchardt & Schutte Automobile Gear Hobber for Spur and Worm Gears

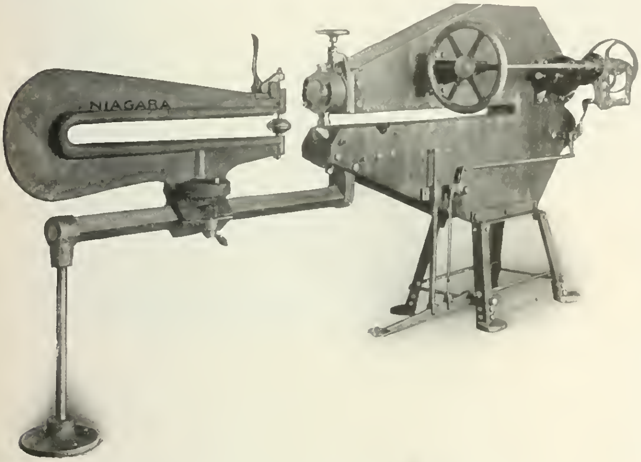
In hobbing worm-wheels, the table is fed in toward the hob by means of the feed-screw in the bed, which is driven from the shaft carrying the sprocket by means of a worm and worm-wheel. In the case of spur gears, the cutter head is fed down by means of a similar drive, the screw being located in the upright in this case. In this connection, it should be mentioned that the drive is secured by rotating a nut on the fixed feed-screw instead of turning the feed-screw in a nut. By means of this design, the nut pushes on the feed-screw and does away with all torsional strains in the screw. The feeds for both worm and spur gears are provided with automatic stops which throw out the drive when the cut is completed.

The table is provided with a rigid arbor support which is made an integral part of it. The table and oil tray are cast integral so that there is no space for chips to work into the bearing. The table feed-screw is provided with a handwheel for use in setting the table in to the correct position to give the necessary depth of cut in hobbing spur gears. The screw is of 0.200-inch pitch and is provided with a dial reading to 0.001 inch. The feed-screw is 1 7/16 inch in diameter.

NIAGARA ROTARY SHEAR

The rotary shear shown in the accompanying illustration has been added to the line of machines for working sheet metals built by the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is particularly intended for cutting irregular and reverse curves, but it is also suitable for cutting disks and rings, and for slitting metal along straight lines; consequently, it takes care of all classes of work to which rotary shears are applicable. In cutting irregular curves the shapes are scribed on the sheet, which is guided by the operator while being fed through the cutters. As both cutters are driven, the material is self-feeding and very little effort is required to follow the cutting line. The construction of the cutting head is such that the operator's view of the cutting line is unobstructed. The metal leaves the machine cut clean; it is not deformed or distorted and is practically without burrs.

The shears will cut curves and disks down to 1¼ inch radius. If the circle attachment is applied, disks and rings from 3 to 60 inches in diameter can be cut from a square blank. The upper cutter is fastened to the end of a vertical shaft journaled in a turret, which can be swung to the side to permit of removing the cutter for regrinding. The turret, with the shaft and upper cutter, can be raised and lowered by means of a screw and handwheel. The lower cutter is mounted on the end of an inclined shaft. Two pairs of bevel gears connect the cutter shafts with two horizontal shafts, which are driven from the pulley shaft by means of spur gears. A jaw clutch actuated by a foot treadle is provided to enable the operator to start and stop the machine at will. The shear has a variable speed gear drive, providing three different cutting speeds. It can also be operated through a handwheel, which is desirable in cutting difficult shapes, or for sharp corners when it is necessary to reverse the cutters. The cutting head has a throat 60 inches deep, and soft sheet steel up to No. 12 gage can be cut. These shears are built in different sizes for lighter or heavier work.



Niagara Rotary Shear for cutting Sheet Metal up to No. 12 Gage

INGERSOLL MILLING CUTTER GRINDER

The successful operation of any milling cutter depends almost entirely upon the accuracy with which it is ground. There are a number of cutter grinders on the market which will grind small milling cutters satisfactorily, but the grinding of cutters from 10 inches to 36 inches in diameter, accurately and rapidly, was a problem that remained for a large milling machine manufacturer to solve. In addition to the 24-inch patented face milling cutter grinder described in the September, 1911, issue of MACHINERY, the Ingersoll Milling Machine Co. has recently brought out a new grinder with a capacity for cutters up to 36 inches in diameter. This new grinder, which is shown in Fig. 1, will handle cutters as small as 4½ inches in diameter and from ¼ inch up to 4 inches face. One of the principal features of this grinder lies in its ability to grind the face, the side, and the corner of any milling cutter within its range at one setting of the cutter. The corner of the cutter may be round or angular as desired.

Particular attention has been given to convenience of operation in this new grinder, and it should meet the most exacting requirements. All controlling attachments are placed within easy reach of the operator's working position and all adjustments are graduated to thousandths of an inch. No extra attachments need be added to the machine to grind any face milling cutter within the capacity of the machine. The grinder can be arranged to be driven by either belt or motor as desired. When motor driven, a one horsepower motor is mounted on a base-plate fastened to the base of the grinder. For wet grinding an oil pump is furnished. The design of the grinder has been laid out with particular reference to wet grinding. The sides of the base are brought up sufficiently high so that the cutting fluid used will not be thrown out into the shop. Fig. 2 shows a grinder set in position for grinding

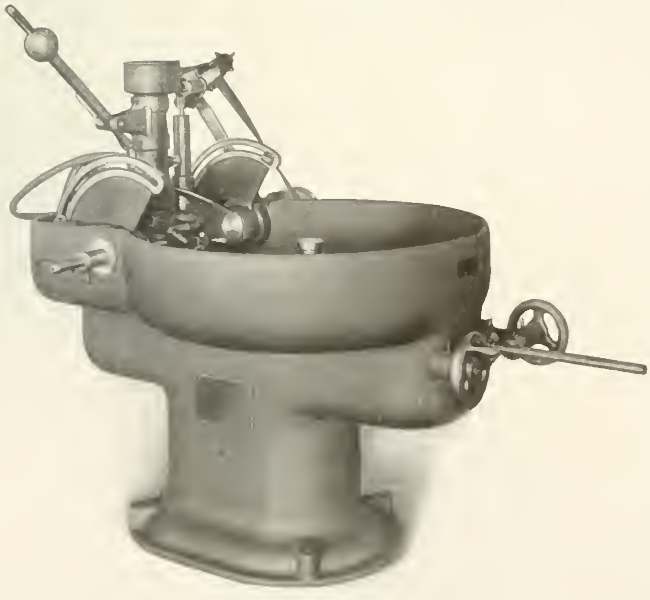


Fig. 1. Ingersoll Milling Cutter Grinder with Capacity for Cutters up to 36 inches in Diameter

a face milling cutter 30½ inches in diameter. The entire cutter is ground complete at one setting. This grinder is fully covered by patents and is manufactured by the Ingersoll Milling Machine Co., Rockford, Ill.

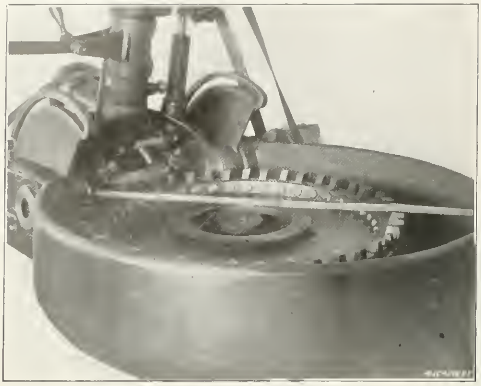
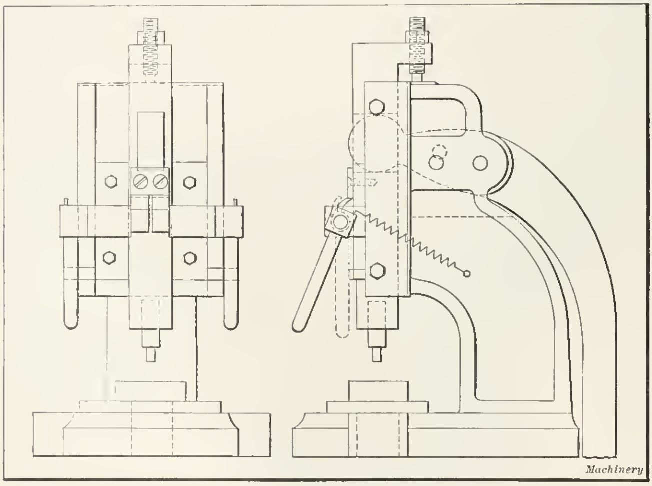


Fig. 2. Machine set up for grinding Face Milling Cutter 30 1-2 inches in Diameter

LA SALLE SAFETY DEVICE FOR FOOT PRESSES

The safety device for foot presses shown in the accompanying illustration is a recent product of the La Salle Machine & Tool Co., La Salle, Ill. The use of this device on a foot press makes it practically impossible for the operator to be injured through getting his hands or fingers caught under the slide.

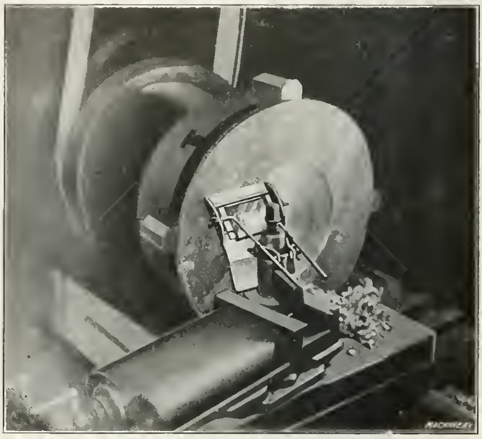
The slide is locked through the medium of two latches, and in order to release it, it is necessary for the operator to use both hands. To do this he pushes forward the two small hand-levers at each side of the head of the press. These levers swing on spindles which are journaled in castings bolted to the press, and carry the latches which lock the slide. When it is desired to trip the press, both of these levers are pushed forward to disengage the latches from the steel block screwed to the slide. The machine can then be tripped in the regular way, and upon the return of the slide to its highest position, the latches are brought back into engagement with the steel plate on the slide by the tension of two springs. The construction is both simple and efficient and its details will be readily understood by referring to the accompanying line engraving.



Foot Press Safety Device released by Two Hand Levers

BARCY-NICHOLSON LATHE CHIP GUARD

The universal chip guard shown herewith was made for use in the plant of the American Steel & Wire Co. by the Barcy-Nicholson Co., Detroit, Mich., to prevent injury to operators from flying chips. This guard is especially designed for use on the heavier classes of lathe work, and has been found to give satisfaction in this service. The guard is 4 inches wide by 5½ inches high, and has a heavy glass window 2 inches high by 2½ inches wide which is slipped in from the top and held in place by a 3-16-inch rod. The frame of the guard is 3-32 inch thick, and has a slit ⅞ inch by 1½ inch, which allows the guard to slip over the tool-holder and drop down flush with the toolpost ring; the guard is held to the toolpost with a clamp and two rods. The clamp is adjustable to fit different sized toolposts and the guard may be adjusted for different classes of work.



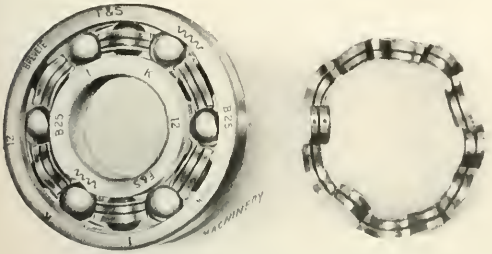
Chip Guard especially adapted for the Heavier Classes of Lathe Work

F. & S. RIBBON TYPE BALL SEPARATOR

The illustration shows a new form of ball separator which is being generally used in the F. & S. ball bearings where the die-cast aluminum separator was formerly applied. The new separator is known as the ribbon type and is formed from a single steel stamping drawn and formed without joints, welds or rivets in its construction. The separator is heavily ribbed on one side to give added stiffness, and is finished in gun-metal blue. It is light in weight and causes practically no friction. The new separator permits raceways with deeper grooves to be used than is possible with other types of separators, and this adds considerably to the lateral wall strength of the inner and outer race-ways.

The illustration shows the construction of the separator and also an assembled bearing in which the separator can be seen. Several advantages are claimed, among which the following may be mentioned: It permits the bearing to be operated at high speed, and it is not affected by ordinary vibrations. Larger balls may be used, and in many sizes of bearings a larger number of balls can also be used. This statement, however, does not apply to all sizes of bearings, since the ribbon type of separator requires the use of an even number of balls, and consequently, in sizes where an odd number of balls was formerly used, it is necessary to reduce the number by one instead of increasing it. But as the load capacity of a bearing varies as the square of the ball diameter and as the first power of the number of balls, a slight increase in diameter of the balls compensates for decreasing their number by one, and in many sizes of bearings the load-carrying capacity has been increased thirty per cent.

Another advantage of the ribbon type of separator is that it permits a freer circulation of lubricant and also lessens the probability of foreign particles being retained in the separator.



F. & S. Ribbon Type of Ball Separator

Although this separator has been but recently placed on the market, it has been subjected to careful tests during the period of about a year; it is stated that bearings equipped with it run even more smoothly and quietly than those in which the aluminum type of separator is used. The J. S. Bretz Co., 250 W. 54th St., New York City, is agent for the F. & S. ball bearing in America.

GARDNER GRINDING AND POLISHING MACHINES WITH BALL BEARINGS

That ball bearings can be used advantageously in disk grinding and polishing machines has been proved by the Gardner Machine Co., Beloit, Wis. This company has recently equipped a number of its grinding and polishing machines with ball bearings, and tests which have been made with the view of comparing the efficiency of ball bearings and plain bearings in this class of service show that with ball bearings considerably less power is required to operate the machine. This saving of power is particularly noticeable in the motor-driven machines and in all types of polishing machines.

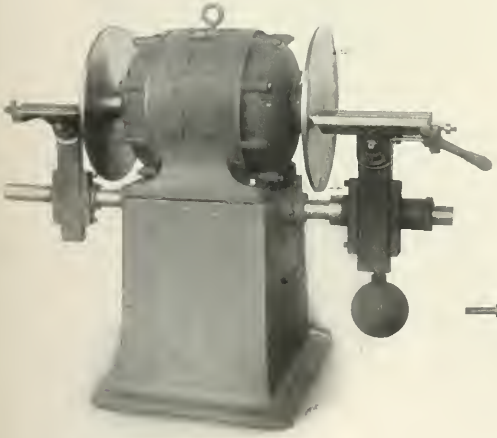


Fig. 1. No. 4 Gardner Disk Grinder equipped with Fully Enclosed Motor and Ball Bearings

Fig. 1 shows a No. 4 Gardner disk grinder equipped with a fully enclosed 5-horsepower alternating-current motor. The motor is equipped with special end yokes and radial and thrust ball bearings. It will be noticed that the machine shown in the illustration has a universal lever feed table for the right-hand disk and a plain table with a squaring gage for the left-hand disk; the wheels used on this machine are 23 inches in diameter. Fig. 2 shows a No. 18 Gardner patternmaker's disk grinder fitted with radial and thrust ball bearings. This machine is equipped with two disk wheels, 30 inches in diameter, which are faced with special garnet paper. Fig. 3 shows the bench type of polishing lathe equipped with ball bearings. It will be noticed that this machine is arranged for under-belt drive. Other features of the Gardner polishing lathes are the ample dimensions of the spindles and the rigid construction of the machine. This polishing machine is also built in the floor type, and both the floor and bench types are made in four different sizes.

Ball bearing countershafts are also being furnished by this company for use in connection with any of the machines, and practically all of the disk grinders can be equipped with ball bearing motor drives. It may be of interest to state that after the power has been shut off from a ball-bearing disk grinder, the spindle and disk wheels will continue to revolve for eight or ten minutes. In actual practice, this momentum of the wheel is naturally overcome by the reaction between the work and the face of the wheel, but the ability of an idle wheel to run for such a length of time shows the efficiency of ball bearings in this class of service.

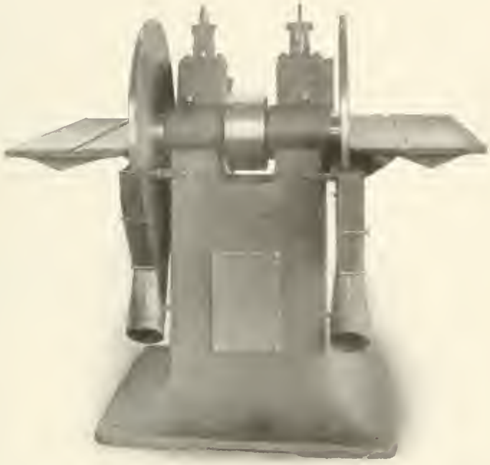


Fig. 2. No. 18 Gardner Patternmaker's Disk Grinder equipped with Ball Bearings

BRAMWELL PRECISION DRAWING INSTRUMENT

The precision drawing instrument shown in the accompanying illustrations was recently placed on the market by Joseph W. Bramwell, 4931 Rubicam Ave., Philadelphia, Pa. This instrument embodies features conducive to the production of accurate and rapid work, and provides for drawing horizontal and vertical lines, and inclined lines at any angle; provision is also made for accurate section lining. Means have also been provided for locking the instrument so that both of the operator's hands are left free. The blade extends right across

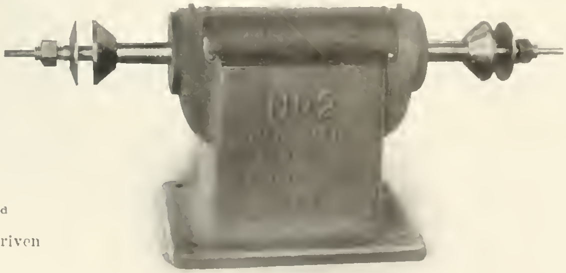


Fig. 3 Bench Type of Polishing Lathe equipped with Ball Bearings

the board so that practically the entire surface may be used; in addition to the angular settings provided by the scale on the carriage, the blade can be set at any angle with the edge of the board, which is a useful adjustment when perspective drawings are being made.

Referring to Fig. 1, it will be seen that the instrument comprises a carriage *A* which runs on a straight steel bar *B*, attached to the left-hand end of the drawing-board. This carriage is provided with a clutch which receives the male portion of the clutch attached to the blade; this clutch provides for locking the carriage in any required position. The blade and carriage constitute a unit which travels along the bar and somewhat resembles the ordinary swivel T-square, except that the carriage is automatically held to the bar, leaving the operator's hands free. The bar can be adjusted for height by means of the thumb-screws shown at *C* and moved parallel to the end of the board. The blade *D* has a metal strip *E* fixed to its face which forms a track for the scale carriage to run on from end to end of the blade. The scale carriage *F* is held automatically in any position upon this track in the same manner as the carriage which carries the blade. The scale carriage is arranged with holes for locking the scale at the common angles 30, 45, 60 and 90 degrees, and the scale can easily be set for special angles that are required in drawing the heads of screws, etc. Where such angles are commonly used, it is an easy matter to drill special holes in the carriage for locking the scale for drawing them. A finely graduated arc is also provided, which, in conjunction with a detachable vernier arm *G*, enables angles to be drawn to an accuracy of three minutes. The scale *H* revolves on a pivot and the arm carrying the locking-pin extends out at the opposite side of this pivot in the manner shown; this arm and pin provide a means for locking the scale securely at the required angle. It will be seen that the scale can be swung to any angle between the vertical and horizontal positions. An auxiliary scale *I* is also provided for horizontal work so that the time required to swing the scale *H* down is saved in most cases where horizontal lines are being drawn.

The attachment for section lining is shown at *J*. This attachment consists of a screw carried by a support clamped to the scale carriage track *E*, and a nut secured to the scale carriage. When the knurled knob at the end of the screw is turned, it advances the carriage, and a ratchet and pawl provide means for spacing so that the section lines are accurately located. This attachment can be mounted in position for section lining or removed from the instrument in a few moments. A device on the arm supporting the scale makes the latter suitable for use on both ink and pencil work, and as the attachment is securely held, the operator has both hands free for holding his pen and manipulating the section liner.

This instrument is at present being made in sizes suitable for moderate sized drawings, but it is intended to increase its scope to the field of the large drawings used in civil and mining engineering work. These instruments will be arranged for attachment to the edge of the drafting table used in engineers' offices.

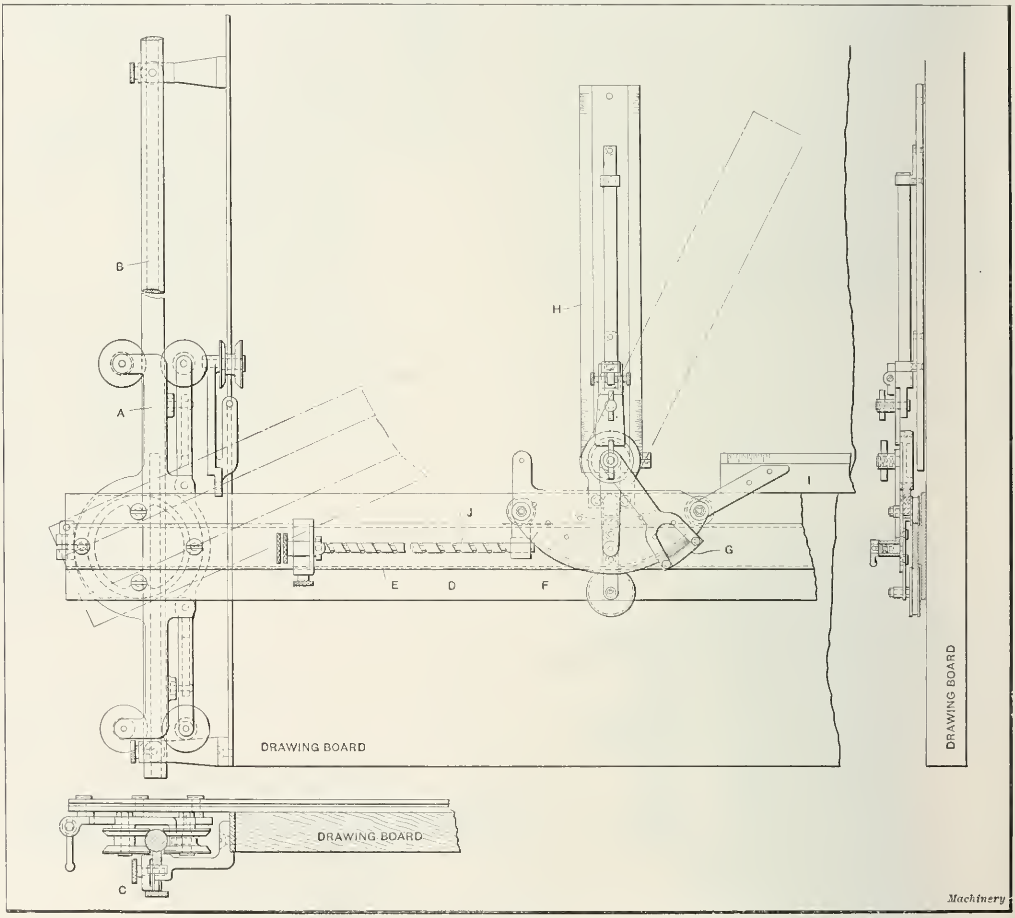


Fig. 1. Design and Construction of Bramwell Precision Drawing Instrument

NEW MACHINERY AND TOOLS NOTES

Inclinable Foot Press: Rockford Iron Works, Rockford, Ill. An inclinable open-back, foot press which is made in several different sizes.

Shaft Centering Machine: Rockford Drilling Machine Co., Rockford, Ill. A shaft centering machine which can also be used for rounding ends of cold-rolled shafting.

Vertical Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. Vertical milling machine similar to the established design of this company, but comprising a number of improvements.

Helical Gear Cutter: Gleason Works, Rochester, N. Y. A helical gear cutter of the planer type for planing double helical gears of coarse pitch. The machine is particularly adapted for cutting helical mill pinions.

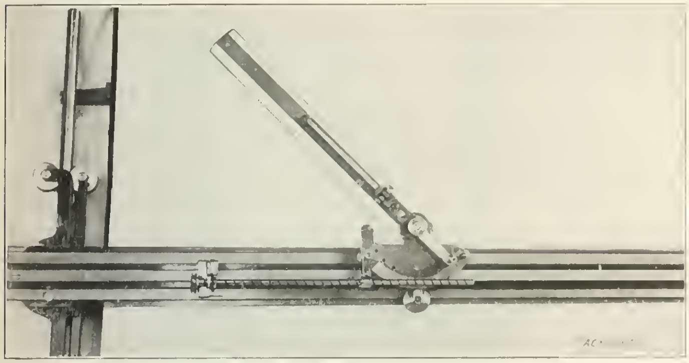


Fig. 2. Bramwell Drawing Instrument with Section Lining Attachment in Use

Portable Shear: Danville Foundry & Machine Co., Danville, Pa. A portable shear similar in design to the machine formerly manufactured by this company but modified to reduce the high fulcrum formerly used.

Lathe for Turning Projectiles: Niles-Bement-Pond Co., 111 Broadway, New York City. A special lathe for turning projectiles, having a wide speed range and high spindle speed, which is necessary when finishing the points of projectiles.

Adjustable Spring Tool-holder: Imperial Tools Mfg. Co., Brooklyn, N. Y. An adjustable spring or goose-neck tool which is so designed that it may be swung around to finish fillets and similar work without changing the toolpost setting.

Marking Machine: Hjorth Lathe & Tool Co., Boston, Mass. This machine is designed to mark straight and flat work in metal with imprints of trademarks, patent dates or other designations. It has a capacity for sizes up to $3\frac{1}{2}$ by $10\frac{1}{2}$ inches.

Buffing and Polishing Machine: Webster & Perks Tool Co., Springfield, Ohio. The machine is equipped with S. K. F. double-row, self-aligning ball bearings; it has tight and loose pulleys on the spindle and may be belted from either above or below.

Lincoln Milling Machine: Becker Milling Machine Co., Hyde Park, Mass. A new machine known as the No. 7H Lincoln miller, which has an over-arm and auxiliary arbor support to provide for increased rigidity, and an adjustable tailstock of special design.

Portable Electric Drill: Standard Electric Tool Co., Cincinnati, Ohio. This drill is made in four sizes having capacities for drills of 1/4, 5/16, 1/2 and 3/4 inch diameter. The motor is so designed that the drill can be connected to a lamp socket on either alternating or direct current.

Multiple-spindle Drilling Machine: Henry & Wright Mfg. Co., Hartford, Conn. This machine is made with from one to eight spindles, with 16 inches between centers. The design comprises a number of valuable improvements which add to the efficiency of the machine.

Emery Wheel Guard: Challenge Machine Co., Inc., Philadelphia, Pa. A floor type of emery wheel guard made of steel channel stock. The guard has adjustment both vertically and horizontally and is equipped with a leather brush which serves the purpose of an eye guard.

Multiple-spindle Drilling Head: W. E. Scallan & Co., Cincinnati, Ohio. This multiple-spindle drilling head consists of a driving shaft and housing with brackets which carry the auxiliary drill spindles. The spindles can be set to drill at any point between two circles of $4\frac{1}{4}$ and 11 inches in diameter. The closest center distance between spindles is 2 inches.

Geared Pump: Matson Machine & Tool Co., Bethel, Vt. A geared pump adapted for pumping oil or water to cutting tools of automatic and other machinery. The pump has a relief valve which regulates the pressure on the feed pipes and nozzles. The overflow from the relief valve returns to the tank.

Hacksaw: North Wales Machine Co., North Wales, Pa. Hacksaw machine equipped with gravity feed, automatic speeds and a swivel vise provided for cutting angles to 45 degrees. The machine operates at from 70 to 90 strokes per minute and will cut through a $1\frac{1}{2}$-inch steel bar in two minutes.

Quartz Lamp: Cooper-Hewitt Electric Co., 165 Broadway, New York City. Lamp in which provision has been made for a vapor pressure of nearly one atmosphere. This increased vapor pressure means a corresponding increase in the luminosity of the vapor, with corresponding improvement in the efficiency of the lamp.

Sixteen-inch Engine Lathe: Cincinnati Iron & Steel Co., Cincinnati, Ohio. A new 16-inch engine lathe, which is characterized by the strength and simplicity of its design. Only two levers are required in making all changes in feeds and threads and these changes are made without the necessity of changing the gears.

Locomotive Link Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A machine for milling locomotive links, which consists of this company's No. 2 vertical milling machine, in which the lower cutter arbor support is hinged on one side of the machine to permit swinging it out of the way when not in use.

Hydro-pneumatic Accumulator: Watson-Stillman Co., 192 Fulton St., New York City. A hydro-pneumatic accumulator designed for equalizing the demand made by hydraulic presses when operating in severe service. The claim is made that this accumulator operates without shock, occupies little space and works with great regularity.

Combination Dry and Wet Grinder: Springfield Mfg. Co., Bridgeport, Conn. The wheel at the right-hand end of the spindle of this machine is equipped with a pump, tank, drain pan and special hood to adapt this wheel for wet grinding. The wheel at the left-hand end of the spindle is used for dry grinding and is arranged in accordance with the established design of this company.

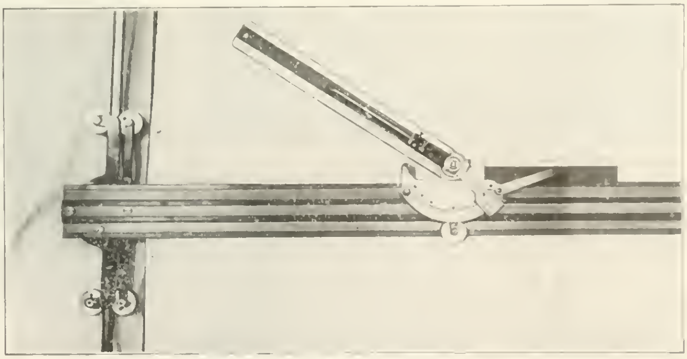


Fig. 3. The Instrument arranged with Auxiliary Horizontal Scale and Vernier Angle Gage

Shaft Straightening Machine: Rockford Drilling Machine Co., Rockford, Ill. A shaft straightening machine designed for handling shafting up to $2\frac{1}{4}$ inches in diameter by 8 feet in length. The headstock spindle runs at a slow speed, while the machine is in use, and carries a center and a spring chuck with a leather friction face for rotating the shafting when it is picked up between the centers.

Cylindrical Grinder: Queen City Machine Tool Co., Cincinnati, Ohio. A line of plain cylindrical grinders which are built in two swings of 10 and 12 inches and in lengths of 36, 48, 60 and 72 inches for each swing. The design provides for a stationary work-table and a traversing wheel base. Massive construction and simplicity of design may be said to constitute the characteristic features of the machine.

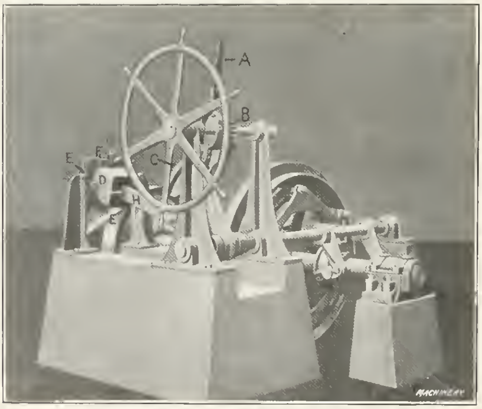
Frog and Switch Planer: Woodward & Powell Planer Co., Worcester, Mass. Two types of frog and switch planer for motor and belt drive, respectively. With the belt drive, the housings are carried up to the full dimensions of a 36- by 36-inch machine to provide sufficient belt length. With the motor drive, the housings are low with only sufficient height above the table to provide for the 17 inches required under the cross-rail.

Vertical Turret Lathe: Bullard Machine Tool Co., Bridgeport, Conn. A 36-inch vertical turret lathe, similar in design to the preceding types of machines built by this company, but comprising a number of important improvements. All of the driving and feed gears are of alloy steel. Lubrication is provided from a continuous flow system. The interlocking machine control is centralized. A rigid support is provided for the cutting tools and work-table.

* * *

DODGE SAFETY DEVICE FOR RUBBER GRINDING MACHINE

In the process of preparing crude rubber for commercial purposes, large rolls are used for grinding and mixing operations. The material is fed to these rolls by hand with more or less danger to the employe. Trouble had been experienced by the Mishawaka Woolen Mfg. Co. from injuries sustained by its employes while operating these machines. With the view of avoiding such difficulties, the problem of developing a safeguard was turned over to the Dodge Mfg. Co., Mishawaka, Ind., and the device finally hit upon is shown in the accompanying illustration. The lineshaft from which power is taken to drive the machine was equipped with a 60-inch iron-center, wood-rim pulley and a Dodge split clutch. This clutch is engaged by the handwheel which turns the pinion *B* and segment gear *C*, which, in turn, engages the clutch. The lever *A* disconnects the wheel from the mechanism by sliding pinion *B* out of mesh with the segment. It is evident that such a method is too slow to enable the machine to be stopped in time if an operator gets caught. To avoid this difficulty, a cord is attached to the loop *G*; this cord runs over two pulleys which brings its other end back to the operating position in front of the machine. The operator has his foot in a loop in the end of the cord, and by pulling it he is able to disengage the clutch instantly. The method by which the device operates is as follows: When the loop is pulled the lever *F* disengages the hook lever *E* from weight *D*. This allows the weight to fall and bring the lever *H* into contact with a dog which throws the clutch out of engagement. This safety device has been so successful in the works of the Mishawaka Woolen Mfg. Co. that it has recently been adopted by the Rubber Regenerating Co. of the same city.

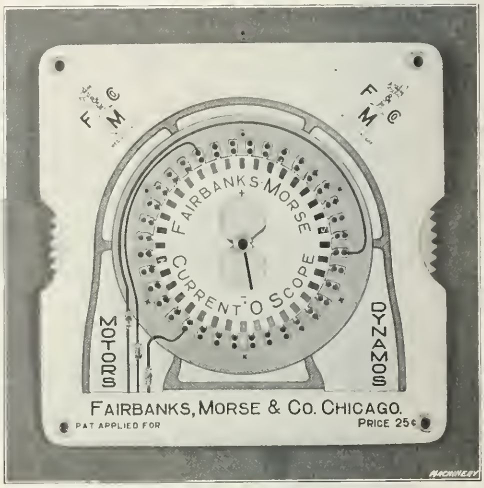


Safety Device used on Rubber Grinding Machine

FAIRBANKS-MORSE CURRENT-O-SCOPE

The Fairbanks-Morse "Current-O-Scope," shown herewith, is a simple device for illustrating the principles of the revolving magnetic field in three-phase bi-polar induction motors. It shows the direction of the phase currents and the location of the magnetic fields, the relation of the instantaneous current values and how the phases combine in the windings to produce the revolving field.

The "Current-O-Scope" is made of two sheets of celluloid, the motor diagram being laid out on the face of the front sheet. A notched disk, which may be rotated with the fingers, is mounted on a central pivot between the two sheets of celluloid, and has the vector diagram laid out on it. This device, which affords simple and effective means of explaining the principles of the revolving magnetic field in induction motors, is being distributed by Fairbanks, Morse & Co., Wabash Ave. & Eldredge Pl., Chicago, Ill.



Fairbanks-Morse Current-o-scope for determining Instantaneous Current Values in a Three-phase Circuit

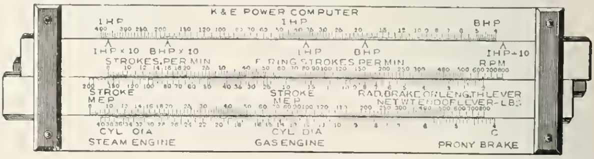
* * *

KEUFFEL & ESSER POWER COMPUTING SLIDE-RULE

The Keuffel & Esser Co., Adams and 3d Sts., Hoboken, N. J., has placed upon the market a slide-rule especially laid out for making power computations from the fundamental power formula:

$$\text{H. P.} = \frac{PLAN}{33{,}000}$$

This rule is applicable for making calculations on all types of reciprocating engines, whether driven by steam, gas or oil. In addition to its use in making power calculations, it can be applied in determining dimensions, etc., of engines where the power developed is known. There are five series of graduations which are used for determining the brake horsepower, indicated horsepower and also the principal dimensions of steam, gas or oil engines.



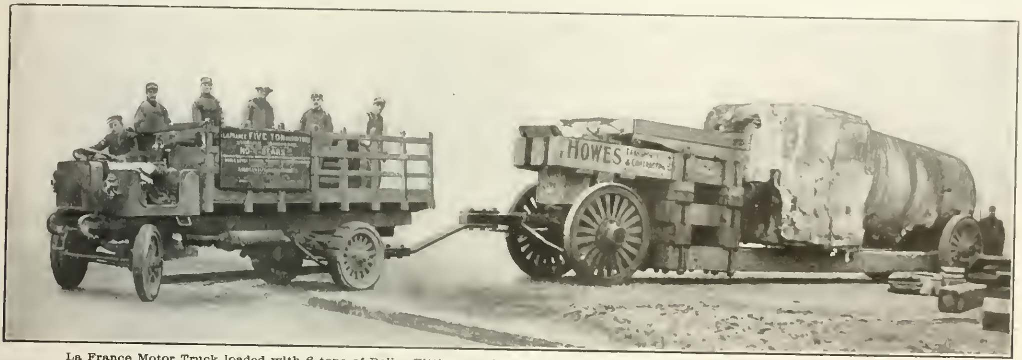
Keuffel & Esser Power Computing Slide-rule

The frame of the rule is made of mahogany, faced with white celluloid on which the graduations are printed. It is designed with the regular K. & E. adjustment for the slide so that the latter can be regulated for expansion and contraction due to atmospheric conditions. The reverse side of the rule is laid out with the regular logarithmic scales used on the Mannheim slide-rules so that it can be used for ordinary calculations, in addition to the power computations made with the scales on the opposite side.

* * *

HAULING A FORTY-FIVE-TON LOAD WITH A MOTOR TRUCK

A load of forty-five tons was recently hauled by a La France hydraulic truck from the Municipal Bldg. to 67th St. and the East River, New York City, going up Broadway to 59th St. The truck itself, weighing 4½ tons, was loaded with 6 tons of boiler fittings; and a wagon weighing 12½ tons and carrying a boiler weighing 22 tons was attached behind it. At least twenty horses would have been required to haul this load. These twenty horses would have occupied at least 250 feet on the streets of the city and would have effectively blocked all traffic while they were passing. The truck is only 20 feet long, so that there was over 230 feet of street space saved. Furthermore, the run was made with the truck in half the time that horses would have taken and that means that the streets were in use only half as long. The hydraulic transmission gear of the La France truck made it possible to start and stop with such a heavy load without straining any part of the truck mechanism.



La France Motor Truck loaded with 6 tons of Boiler Fittings, and pulling a 12 1-2 ton Wagon loaded with a Boiler weighing 22 Tons

* * *

THE NATIONAL AUTOMOBILE SHOW

The growth of the automobile and motor truck industries in America is reflected in the annual shows held in New York and other large cities, which have become larger and larger each year. The National Automobile Show, which was held in New York in January, occupied two large buildings, Madison Square Garden and the Grand Central Palace. The show was divided into two parts. Part I was exclusively for pleasure vehicles, motorcycles, accessories, supplies, etc., and Part II for motor trucks, commercial vehicles, machine tools accessories, supplies, etc.

The growth in favor of motor vehicles for commercial purposes was indicated by the large representation at the Part II show. Over seventy makes, ranging from the lightest delivery wagons to ten-ton trucks, suitable for almost every line of business, were on exhibition. Among the novelties were tractors for converting horse-drawn trucks into motor trucks. An advantage of the tractor is that its weight is well within six tons which is considered to be the limit for solid rubber tired trucks, whereas the trailer may have steel tires.

A machine tool exhibit is a new feature of the automobile show, and the first showing did not adequately represent this important industry. The decision to invite machine tool builders to exhibit machine tools used largely in the manufacture of motor vehicles, was made by the show management too late to permit many of the builders to make a creditable exhibit ready. It is hoped by the management that next year the machine tool exhibit will be one of the big attractive features.

The machine tools were shown in the basement of Madison Square Garden, although the first published announcement stated that it would be made in Grand Central Palace. The following concerns were represented: Baush Machine Tool Co., Springfield, Mass.; Bullard Machine Tool Co., Bridgeport, Conn.; Eveland Engineering & Mfg. Co., Philadelphia, Pa.; Fox Machine Co., Grand Rapids, Mich.; Fairbanks Co., New York; Garvin Machine Co., New York; Hisey-Wolf Co., Cincinnati, Ohio; Lees-Bradner Co., Cleveland, Ohio; Potter & Johnston Machine Co., Pawtucket, R. I.; Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

* * *

AMERICAN MUSEUM OF SAFETY AWARD

The annual exercises and award of four gold medals of the American Museum of Safety, were held in the United Engineering Societies building, New York, January 23. The *Scientific American* medal, which is awarded to the most efficient safety device invented during the last three years, was given to the Draeger Oxygen Apparatus Co. for the pulmotor, an apparatus for inducing respiration in cases of drowning, asphyxiation, etc. The Travelers' Insurance Co.'s medal, which is awarded to the American employer who has accomplished the most for the protection of the lives and limbs of the workman, was awarded to the New York Edison Co. The Louis Livingston Seaman medal, which is awarded for progress and achievement in the promotion of hygiene and sanitation and the mitigation of occupational diseases, was given to the National Cash Register Co. The Rathenau gold medal, which was placed at the disposal of the museum by the Allgemeine Elektricitäts Gesellschaft of Berlin, Germany, to be awarded for the best device or process in the electrical industry for safeguarding industrial life and health, was given to Thomas A. Edison.

Arthur Williams, president of the museum, delivered an address in which he reviewed the progress made in promoting safety of life and limb in our industrial undertakings. He mentioned the fact that as regards museums of safety, America makes a poor showing compared with foreign countries. There are twenty-two museums of safety in the world, and only one in the United States. The museum is in great need of larger quarters, many models and specimens having never been unpacked because of lack of room to show them. Andrew Carnegie spoke, following Mr. Williams, and expressed great interest in the museum's work and amazement at what had already been accomplished. Other speakers of the evening were T. C. Martin, Dr. George F. Kunz, Dr. Norman E. Ditman, A. A. Anderson and Dr. F. R. Hutton. Dr. Hutton presented the medals to representatives of the recipients.

Announcement was made of a fifth gold medal which had been placed at the disposal of the museum by Mrs. Mary W. Harriman, widow of the late E. H. Harriman. The medal will be known as the E. H. Harriman memorial medal, and will be given each year to the American steam railway making the best record in accident prevention and industrial hygiene.

Dr. W. H. Tolman showed a series of lantern slides illustrating museums of safety, guards for dangerous machinery, the conditions of dangerous industries, etc.

AUTOMATIC PROFILING DEVICE

An automatic feeding mechanism applicable to profiling and other machines in which the cutter must describe an irregular path, has been patented by C. R. North of Hartford, Conn. By means of this mechanism a profiling machine may be made semi-automatic in its operation, the only attention necessary being the locating and removing of the work. Profiling machines, generally speaking, are provided with a cutter spindle and a former pin located at a fixed distance from each other at the head of the machine. The former pin is guided around a steel master plate by hand, feeding the head of the machine in a lateral direction and the work-table in a longitudinal direction. On hand profiling machines the operator's attention is required all of the time. By employing this automatic feeding device one man can run two or more machines, depending upon the speed with which the cutter is fed.

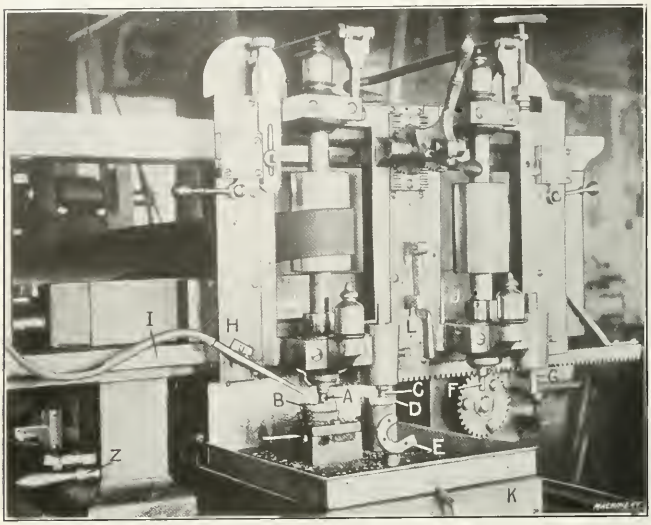


Fig. 1. Profiling Machine with Automatic Feeding Device

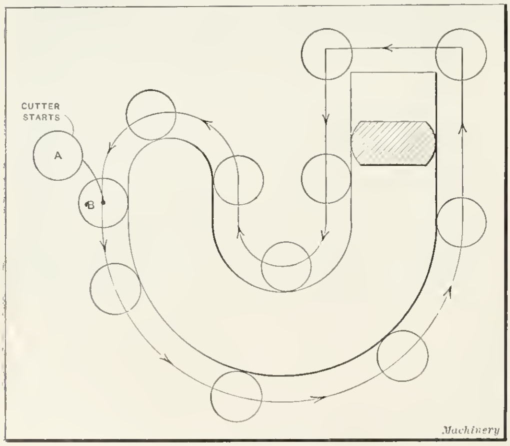


Fig. 2. A Typical Job of Profiling showing Path automatically traversed by Cutter

The automatic feeding is accomplished by means of two cams at the rear of the machine, one of which operates the transverse movement of the cutter and cutter-slide, while the other cam moves the work-table in a longitudinal direction. By a combination of these cam movements any desired curve or outline may be readily followed. For the purpose of demonstration, the piece shown in Fig. 2 was selected as the outline to be automatically profiled. The reason for selecting this particular shape was that it incorporates a large outside curve, a small outside curve, an inside curve, and two right-angle corners. Taking for the starting point of the cutter the small circle indicated by *A*, the path followed is around the large outside curve, as indicated by the arrows, thence around the two sharp corners to the small inside curve, then to the small outside curve and around as far as point *B*. At this point the cutter is caused to reverse its direction, receding from the work to the position *A*.

In Fig. 1 is shown the head of an ordinary profiling machine. This machine is of the usual type, employing a cutter *A* which operates on the piece *B*. A former pin *C* is automatically kept in contact with the master plate *D*. At *E* is shown a specimen of the work which is profiled. There is also a cutter *F* and a former pin *G* which may be employed when a subsequent profiling operation is to be performed upon the piece. The head of this machine *H*, from which are supported the cutters and former pins, slides laterally upon the frame *I*. This machine was transformed into an automatic profiling machine by adding rail *J*, which was mounted in the outer housings of frame *I*. By means of pin *L*, which can be removed by a hand lever, the head of the machine is made fast to rail *J* so that any movement of rail *J* will carry the head and, consequently, the cutter and former pin with it.

In Fig. 3 is shown a close-range view of the work, the cutter, the master plate and former pin. For doing work of a shape other than the one described, it would be necessary to have a base-plate with provision for holding the piece as well as for mounting the master plate. This, in conjunction with a set of cams, would constitute the requirements for any particular profiling job.

The actual operating mechanism can best be understood by referring to Fig. 4. In this illustration, which shows a plan and elevation of the operating parts of the machine, the head of the machine is indicated as *H* and, as before stated, slides on frame *I*. Here also may be seen the pin *L* which unites head *H* with rail *J*. The work is mounted upon the movable table of the machine indicated as *K* in Fig. 1 as well as in Fig. 4. As table *K* may be moved in a longitudinal direction and head *H*, in conjunction with rail *J*, may be moved in a lateral direction, it will be seen that it only remains to secure the proper combination of these two movements to follow any desired outline.

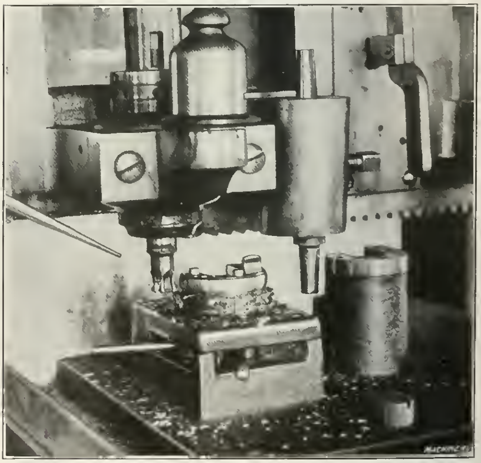


Fig. 3. Close-range View of Cutter, Work, Former and Former-pin

The required combination of movements is secured by means of barrel cams *M* and *N*, mounted upon a cam-shaft *O* which is given rotation by means of worm *P* and worm-wheel *Q*, worm *P* being driven through driving pulley *R*. In the groove in cam *M* runs the cam roll *S*. Connecting this roll with work-table *K* is the link *T*. Thus, as cam *M* is slowly rotated, work-table *K*, through link *T*, is caused to advance or recede in agreement with the path of the cam groove. Similarly, a cam-groove is cut in *N*, in which cam roll *U* operates, and by means of bell-crank *V*, fulcrumed on pin *W* on the frame of the machine, the lateral motion of rail *J*, and consequently cutter-head *H*, is effected. It is obvious, therefore, that by securing the proper combination of these two movements the cutter may be caused to follow any desired outline.

The illustration Fig. 5 shows the cams and mechanism employed for profiling the work shown in Fig. 3. The cams shown are about eight inches in diameter, and this size is ample for profiling pieces whose total perimeter does not exceed eight inches. If longer outlines must be traversed, the pitch of the cam groove on an 8-inch diameter cam would be excessive and the feeding of the work-table and cutter-head would not be satisfactorily performed. Therefore on large work it is advisable to use large cam rolls. When employing this principle every distinct job of profiling requires two cams for its accomplishment.

The necessity for having a master plate and former pin in addition to the cams which are used to guide the cutter around any desired outline might be questioned, but by using a master plate and former pin, the action of the machine is made far more steady and, moreover, any slight inaccuracies caused by imperfect cam cutting or wear of the cam groove are corrected by the use of the master plate and former pin, which are indicated as *D* and *C* in Fig. 1. The former pin is always kept in close contact with the master plate without regard to the direction of travel. This is accomplished through "elastic connections" on connecting link *T* and the shaft which passes through rail *J*, which may be seen projecting at the ends of the plan view Fig. 4. The elastic connection on link *T* is indicated as *X* in Fig. 4 and, briefly, it, as well as the one on the shaft which passes through rail *J*, consists of a pair of spiral springs located on each side of a collar, serving to connect the two otherwise separate sections of the shaft. Thus if excessive pressure should be placed upon link *T* through inaccuracy of cam *M*, it would be taken up by this elastic connection and the former pin still kept in normal tension against the side of the master plate. The same results are obtained from a similar construction employed on the shaft passing through rail *J*.

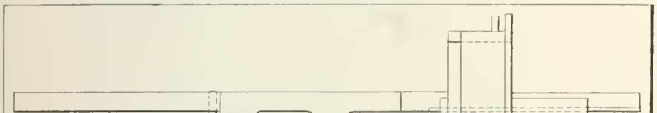


Fig. 4. Plan and Elevation of Cam Mechanism

In operation, the piece, which may be seen at *E* in Fig. 1, is held on the milling fixture as indicated at *B*. The piece is held by an ordinary clamping method. By throwing handle *Z* the machine is started and follows the path indicated in Fig. 2, around the large curve in the direction of the arrows. In Fig. 1 it is shown midway of the inside curve. After rounding the small external curve and on reaching position *B*, in Fig. 2, an abrupt change in the cam groove—which, by the way, may be noticed by referring to the right-hand cam in Fig. 5—reverses the direction of cutter travel, bringing the cutter back to the starting position *A*, when an automatic trip throws out the feed and leaves the cutter stationary. In this position it is away from the work, so that the piece may be removed and a new piece of work inserted. After once locating the piece and throwing the starting lever *Z*, no attention from the operator is required until the insertion of a new piece is necessary.

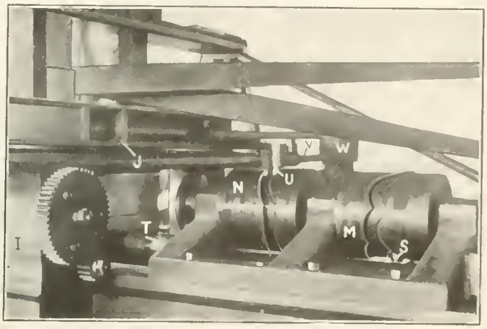


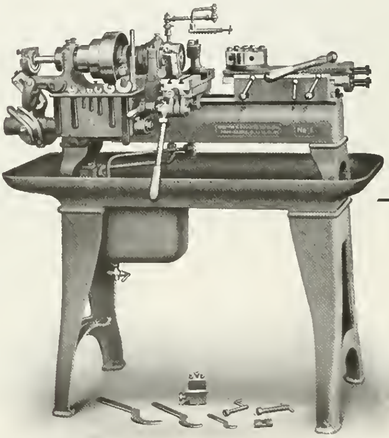
Fig. 5. The Operating Cams

The operation of the machine is smooth and free from "jumpy" action. On the job in question, the cutter moves at the rate of three inches per minute, and as the perimeter of this piece measures practically six inches, the profiling time was two minutes. The device was built by the Spafford Tool Works, Hartford, Conn., and is controlled by Henry G. Newton, 818 Chapel St., New Haven, Conn. C. L. L.

* * *

The U. S. Bureau of Standards has made an investigation with relation to the testing of the hardness of metals, the results of which are reported by Mr. R. P. Devries in a recent report. Five of the most well-known instruments for hardness testing were investigated. The static tests studied were that of Brinell and the cone test. The dynamic test apparatuses used in the investigation were the Shore scleroscope and the Ballantine device. The Bauer drill test for measuring the workability of metals was also included. The tests were made on a series of metals ranging from very hard carbon steel to comparatively soft alloys. The conclusions that may be drawn from the results of this investigation are: (1) That it is possible to obtain rational hardness numerals from static tests, and (2) that static and dynamic tests for hardness do not, in general, agree, except when tests are made on classes of metal having the same texture and general properties. The report of the investigation will be welcomed by users of various means for testing the hardness of metals.

BROWN & SHARPE



Economy in producing pieces where the expense does not warrant setting up automatic screw machines.

In every shop many lots of a hundred or so of screws, studs, pins, washers, or other pieces are wanted from time to time and the problem is one of producing them most economically. Such jobs do not warrant the time and expense of setting up an automatic screw machine. Neither do they if there are considerably larger quantities, unless lots come along at regular intervals.

For this reason it is advantageous to supplement the automatic screw machines in a shop with

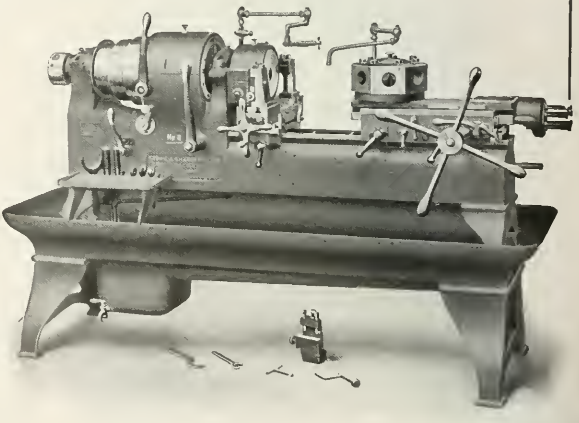
Wire Feed Screw Machines

which are especially adapted for producing this class of work economically.

These machines can be quickly and easily set up and are so arranged that the workmen can operate them rapidly. The chuck and feed for stock are automatic and rapid in operation. All levers and pilot wheels are conveniently located so that the operator does not have to change his position.

Irregular Pieces made from Forgings and Castings

can also be produced to good advantage on these machines by using an ordinary chuck.



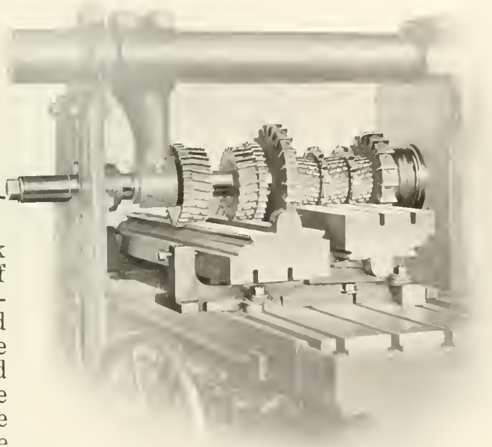
WHAT SIZE MACHINE ARE YOU INTERESTED IN?

BROWN & SHARPE MFG. COMPANY,

See Advertisement on page 75

MACHINE TOOLS

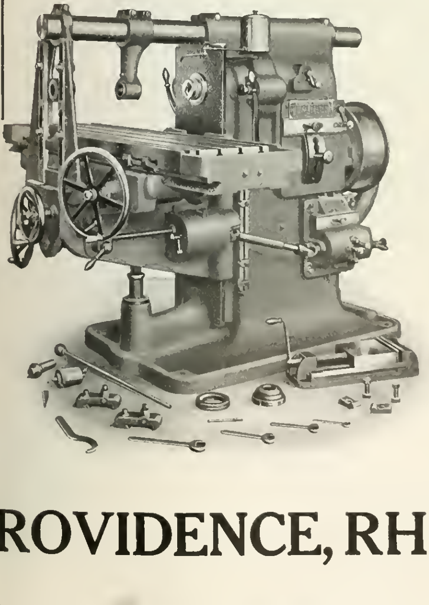
Are there not jobs in your shop that can be milled just as economically as this one?



It is worth while to look your work over, for the pronounced advantages of milling pieces as shown above are unquestionable. On this job a finished milled piece is produced at every traverse of the table. Two pieces are fastened in place and at one cut the top of one piece and bottom of the other piece are finished. The table is then run back, the outer piece removed and the inner piece put in its place. A new piece is substituted for the inner one and the machine is ready for another cut. This job is shown set up on one of our

Heavy Plain Milling Machines

like that illustrated below. These machines are adapted to just such classes of work because of their powerful design. The constant speed type of drive furnishes a constant and maximum amount of power at the spindle at all times, regardless of the spindle speed. The table feeds and spindle speeds are entirely independent of one another, enabling a combination in every case to be selected, that will give a satisfactory finish and production rate.



Write for further information about these machines—they may be the means of saving many dollars in manufacturing similar pieces.

OUR 1913 CATALOG IS READY.
DO YOU WANT A COPY?

PROVIDENCE, RHODE ISLAND, U.S.A.

See Advertisement on page 75

NEW TYPE OF WAREHOUSE

A new type of warehouse for storing iron and steel castings has just been completed for the Crocker-Wheeler Co. of Ampere, N. J. It is known as a marine warehouse because its roof construction embraces the principle of the hatchways on a ship. The new building, the only one of its kind, is 85 feet long, 38 feet wide and 13 feet high to the rafters, the capacity being over 40,000 cubic feet. The peak of the slightly sloping roof is fifteen feet high. In each side of the roof there are six big hatch covers 12 feet 10 inches by 10 feet 4 inches, resting on strongly built coamings protected by metal sheathing. A ten-ton traveling crane, running on tracks high enough to give sufficient clearance for the largest castings, is provided to lower the castings into place through the hatchways. This method of handling the castings not only saves the cost of putting in an industrial railway, but also the space necessary to move around small hand cars inside of the building. The hatches are so large that the castings can be put down anywhere, and, thus all of the space can be utilized. The hatch covers themselves are lifted and lowered by the crane. The structure is of wood resting on concrete foundations. The floor consists of solid earth and clay soil smoothed off with cinders to absorb the moisture. The sides are of sheathing and clapboards, and the roof is covered with boards and slag roofing. It is supported by five uprights in the center of the building. The slope of the roof is easy and a handrail along the top prevents the workingmen from falling. Access to it is gained by a stairway at one end. The building is well lighted with twelve windows on each side. The main entrance 10 by 14 feet is closed by two sliding doors, and there is also a small opening at the rear. The building took about six weeks to complete, and cost less than fifty cents a square foot.

* * *

One of the most important requirements for rapid production of machine parts ground from the rough on cylindrical grinding machines, is rigid support for the work, and it is one of those most difficult to meet, especially on long work—chiefly because of the prejudice of grinding machine operators. The Norton Grinding Co., Worcester, Mass., insists that the steadyrests beneath the work shall be brought up firmly against the work while in the rough, whether it be out of round or not. The general run of grinding operators hesitate to do this because they see the shaft sprung out of line and wabbling back and forth. But the irregularity of contour which causes vertical displacement of the work, does not appreciably affect the final accuracy of the ground portion; the reason is that as the roughness is removed the lateral displacement becomes less and less and finally disappears altogether when the work is true. Then the steadyrests supporting the work sideways may be adjusted for the finish grinding. Simple as this procedure is, and as sure to produce good work rapidly, it is still one of the difficult matters for operators to properly understand and apply.

* * *

"FLANGED HEADS"—CORRECTION

The reference letters E and F on the engraving accompanying the article "Flanged Heads," by R. H. Crevoisie in the January number, were transposed. By changing E to F and F to E the apparent errors in the formulas will be corrected.

* * *

PERSONALS

L. F. Hussey has resigned from the position of advertising manager for the Standard Tool Co., Cleveland, O. Mr. Hussey has not yet announced his plans for the future.

Franklin D. Jones, associate editor of Machinery, sailed January 8 on the *Laurentic* for a four weeks' cruise to the West Indies, touching at Havana, Cuba; Colon, Panama; and other ports.

William T. Elzinga, for the past four years instructor in the industrial arts at the Stout Institute, Menomonie, Wis., has been appointed instructor of machine construction and forge practice at the State Manual Training Normal School, Pittsburg, Kans.

C. L. Campbell, who was for some years with the Standard Tool Co., Cleveland, Ohio, and later was works manager of the National Twist Drill Co. of Detroit, and during the last year supervisor of tools of the Studebaker Corporation, has resigned to become treasurer and general manager of the Toledo Drill & Tool Co., Toledo, Ohio.

C. E. Allen was recently appointed assistant manager of the detail and supply department of the Westinghouse Electric & Mfg. Co. at East Pittsburg, Pa. Mr. Allen entered the employ of the company in 1909, having formerly been employed by the General Electric Co., where he was in charge of transformer development designs. When in charge of this work, Mr. Allen invented the "distributed core type transformer."

Robert Wuest, for several years commissioner of the National Metal Trades Association, has resigned because of ill-health, and will take a trip abroad to recuperate. Mr. Wuest is succeeded by John D. Hibbard of Chicago, formerly president of the John Davis Co., and for years president of the (former) Chicago Metal Trades Association. Mr. Wuest's resignation takes effect in April following the annual convention, but Mr. Hibbard has already taken up the work of the association in order to familiarize himself with its many details.

* * *

OBITUARIES

M. B. Stauffer, foreman of the toolroom of the Crescent Mfg. Co., Scottdale, Pa., and an occasional contributor to Machinery, died of typhoid fever November 30, aged twenty-nine years.

Edward O'Connell, formerly chief constructor of the U. S. Navy, under whom the famous armored turret vessel the *Monitor*, designed by Captain John Ericsson, was built, died January 20, aged eighty-five years. The *Monitor* was the progenitor of the modern battleship.

Samuel F. Hall, chief engineer with the Norton Co., Worcester, Mass., died from injuries received in an elevator January 8. Mr. Hall was a graduate of the Worcester Polytechnic Institute, class of 1900, and since then, until within a few weeks, had been in the employ of the Norton Co. at its Niagara Falls and Chippewa plants.

F. E. Maxon, who for the past three years was connected with the New York sales department of the Independent Pneumatic Tool Co. of Chicago, as assistant to R. S. Cooper, manager, died January 8 from an attack of appendicitis. Mr. Maxon was formerly employed by the Rutland R. R. and was later chief clerk to the inspector of tools and machinery N. Y. C. & H. R. R. R.

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SOCIETIES, SCHOOLS AND COLLEGES

Stevens Institute of Technology, Hoboken, N. J., announces a special engineering lecture course for Stevens students, comprising six lectures on shop management, by John Calder of the Cadillac Motor Car Co.; four lectures on contract law, by H. E. White; four lectures on patent law, by W. R. Baird; two lectures on boilers and power plants, by Dr. J. S. Jacobus of the Babcock & Wilcox Co.; two lectures on heating and ventilating, by Mr. Henry C. Meyer, etc.

American Institute of Electrical Engineers, 33 W. 39th St., New York, through its board of directors, has adopted a set of resolutions urging Congress to provide for a commission made up of unbiased, independent, non-partisan men, chosen from different walks of life and serving without pay, to hold public hearings and make a careful and thorough study of the American patent situation, and to prepare and submit a comprehensive report and recommendations to Congress for such changes as in their judgment are required in the patent office, in the method of court procedure, or in the organic patent law and for legislation that should be enacted.

COMING EVENTS

February 25-27.—Convention and exhibit of the New England Hardware Dealers' Association in the new municipal auditorium, Springfield, Mass.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York.

May 26-29.—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York.

June 10.—Departure from New York of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

NEW BOOKS AND PAMPHLETS

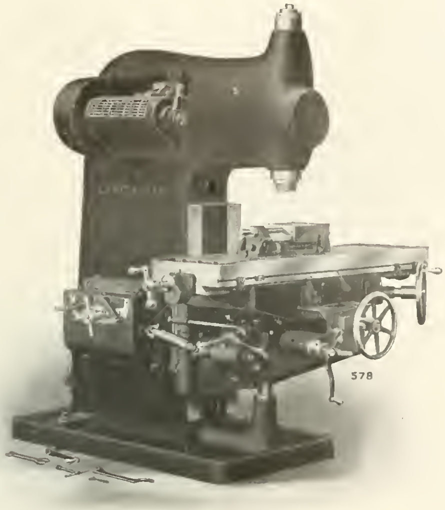
The Proposed Patent Law Revision. By Gilbert H. Montague, 40 Wall St., New York. 18 pages, 6¾ by 10 inches. Reprinted from the *Harvard Law Review*.

Mission Furniture, How to Make It. 120 pages, 4½ by 7 inches, numerous illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price 50 cents.

Steam Boilers. By H. DeB. Parsons. Second Edition. 377 pages, 9¼ by 6¼ inches. 156 illustrations. Published by Longmans, Green & Co., New York. Price, $4, net.

Specifications for and Measurement of Standard Sieves. 14 pages, 9⅞ by 7 inches. Prepared by the Bureau of Standards of the Department of Commerce and Labor, Washington, D. C.

Wireless Telegraphy and Telephony Simply Explained. By Alfred P. Morgan. 154 pages, 7½ by 5¼ inches. 156 illustrations. Published by Norman W. Henley & Son, New York. Price, $1.



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Winding Engines and Winding Appliances. By George McCulloch and T. Campbell Futers. 452 pages, 9½ by 6⅜ inches. 174 illustrations. Published by Longmans, Green & Co., New York. Price, $6, net.

The Sherman Anti-Trust Act and the Patent Law—The Supreme Court on Patents (The Dick Patent Case). By Gilbert H. Montague, 40 Wall St., New York. 55 pages, 6½ by 10 inches. Reprinted from the *Yale Law Journal.*

The Gist of the Supreme Court Decision in the Dick Patent Case and of the Proposed Patent Law Amendments. By Gilbert H. Montague, 40 Wall St., New York. 21 pages, 7 by 10 inches. Reprinted from the *Engineering Magazine.*

Popular Mechanics Year Book for 1913. 214 pages, 9½ by 6½ inches. Illustrated. Published by *Popular Mechanics,* Chicago, Ill. Price, 50 cents, net.

The present issue, which is Vol. IX. of the Popular Mechanics Year Book, contains illustrated descriptions of 595 ways of doing various mechanical operations in the shop, home and office.

The Coking of Coal at Low Temperatures. By S. W. Parr and H. L. Olin. 46 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill.

This bulletin, which is No. 60 of the Engineering Experiment Station of the University of Illinois, reports the results of experiments on various types of Illinois coal with reference to the principles which govern their use in the production of coke. Reference is also made to the by-products obtained.

Saw Filing and Management of Saws. By Robert Grimshaw. 133 pages, 4 by 6 inches, 106 illustrations. Published by Norman W. Henley & Son, New York. Price $1.

This is the third edition of a book designed as a practical aid to those who use saws for any purpose. While it treats principally of saw filing, it also deals with such questions as gumming, spring-setting, and swaging. The third edition has been revised and considerable new material added in order to bring the book up-to-date.

Henley's Twentieth Century Book of Recipes, Formulas and Processes. Third Edition. Edited by Gardner D. Hiscox. 787 pages, 9¼ by 6½ inches. Published by Norman W. Henley & Son, New York. Price, $3.

The information in this book is arranged alphabetically and covers a wide range of recipes and formulas of value to the mechanic and manufacturer. The data is not based on actual experiments, but, as far as possible, the accuracy of the methods outlined has been verified by the editors.

Practical Mathematics. By Claude Irwin Palmer. 176 pages, 7 by 4¾ inches. 31 illustrations. Published by McGraw-Hill Book Co., New York. Price, 75 cents, net.

Parts I and II of this series dealing with the subjects of arithmetic and geometry were reviewed in the December issue of Machinery. The present volume, which is Part III, covers the subject of algebra, the object of the author having been to present the subject in a way which will make it particularly suited for the requirements of practical men who are "brushing up" their knowledge of mathematics.

Best's Key Ratings of Fire Insurance Companies. 108 pages, 4¼ by 8¼ inches. Published by Alfred M. Best Co. Inc., 100 William St., N. Y. Price, $5.

This compilation of ratings includes all licensed joint-stock fire insurance companies except re-insurance companies, and all of the "surplus line" fire insurance companies and associations operating in the United States. Comparative underwriting and financial exhibits for five years are also included. The value of insurance company ratings is obvious to all who have the responsibility of placing fire insurance.

Industrial Diseases. 417 pages, 6 by 9 inches. Published by the American Association for Labor Legislation, 131 E. 23d St., New York City. Price $1.

This book, which is No. 2 of the second volume of publications of the American Labor Legislation Review, contains a symposium on diseases of occupation, an investigation of industrial diseases and of health problems in modern industries, and a review of the progress of state promotion of industrial hygiene. A list of books published on industrial diseases and their prevention, is also included, this list being quite complete in its scope.

Book of Standards. 600 pages, 4 by 6¼ inches. Published by the National Tube Co., Frick Bldg., Pittsburg, Pa. Price, $2.

This handbook is for engineering use in connection with tubular material, pipe and pipe fittings, and contains information on manufacture, sizes, weights, dimensions, test pressures, sections of joints, physical and chemical properties, bursting, collapsing and column strength of all pipe and tubular goods manufactured by the National Tube Co. Other sections of the book are devoted to information on air, gas, water and steam. In addition, there is a glossary defining a large number of terms used in the pipe and fitting trade.

The "Mechanical World" Electrical Pocket Book for 1913. 240 pages, 4 by 6 inches, 98 illustrations. Published by Emmott & Co. Ltd., 65 King St., Manchester, England. Price sixpence.

In the 1913 edition of this popular little handbook, 16 pages of useful information for the electrician have been added and some sections have been rewritten and expanded. This is especially the case with the sections dealing with dynamos, motors and electrical measuring instruments. A new section on magnetic circuits and magnetic materials has been introduced, and space has also been devoted to electric motor applications, motor control by switches, depreciation, etc.

Calculations on the Entropy-Temperature Chart. 74 pages, 5 by 7½ inches, 52 illustrations. Published by J. B. Lippincott Co., Philadelphia, Pa.

The author of this book, who is a lecturer in mechanical engineering at the Municipal and Technical Institute, Belfast, Ireland, has endeavored in this book to show students who are not well versed in the theory of thermo-dynamics, how to make use of the entropy-temperature chart. For this reason, the matter has been treated as simply as possible and a complete knowledge of the principles underlying entropy is not necessary. The purpose of the book is thus a thoroughly practical one and it should be useful to students who want to be able to use entropy-temperature charts without going into complete details as regards their theory.

The Gas Turbine. By Hans Holzwarth. Translated by A. P. Chalkley. 138 pages, 6 by 9 inches. 142 illustrations and several folding tables. Published by J. B. Lippincott Co., Philadelphia, Pa. Price $2.50.

This book deals with the theory, construction, and records of results obtained from two actual gas turbines, and contains information concerning systematic investigation work with regard to machines of this kind which has now been proceeding for more than three years. The book is divided into four general parts of which the first part comprises about one-half of the book and deals with the theory of the gas turbine. The second part deals with the construction of the particular gas turbines tested. In the third part, general comparison is made between the gas turbine and reciprocating gas engines, and in the fourth part are given the results of the tests made on the gas turbines described.

An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries. By L. P. Breckenridge and G. A. Goodenough. 117 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill. Price, 50 cents.

The filing and classification of engineering data have become matters of much importance, and this bulletin was prepared for use as a guide in carrying out such work. The original edition of Bulletin No. 9 was gratuitously distributed and it met a general want. A second edition was printed and altogether 20,000 copies were sent out free. The demand having continued, it was decided by Dr. Goss, director of the engineering experimenting station, to revise and print a limited edition which will not be distributed free, but which will be sent postpaid on receipt of 50 cents. The revised bulletin is much extended as compared with the original edition. It presents subdivisions of subjects in such detail as to constitute a complete classification for most engineering industries, even though they are highly specialized. The revision was made in accordance with the 1911 edition of the "Decimal Classification" by Melvil Dewey.

The Elements of Machine Design. II. By W. Cawthorne Unwin and A. L. Mellanby. 426 pages, 5¼ by 8½ inches. 311 illustrations. Published by Longmans, Green & Co., New York. Price $2.50.

Machine designers generally, and engine designers in particular, will welcome the revised edition of Part II of Prof. Unwin's well-known work, which is devoted chiefly to engine details. The revised editions of both Part I and Part II are enlarged in size of page, number of pages and illustrations and scope. The revision was made with the aid of Prof. Mellanby who used the work for years as a text-book in the Royal Technical College of Glasgow. While Unwin's work, in common with others on machine design, is largely a collection of rules and data derived from precedent, the effort throughout is to give reasons for arrangements or proportions and thus establish rational methods of design. The contents by chapter heads are as follows: On Pipes and Cylinders; Arrangement and Proportions of Steam Engine Cylinders; Indicator Diagrams; On the Kinematical and Dynamical Problems in Engine Designing; Balancing; Cranks, Levers and Eccentrics; Pistons and Piston-Rods; Connecting-Rods; Cross-heads and Slides; Stuffing-boxes; Flywheels; The Steam Engine Governor; Valves, Cocks and Sliding Valves; Condensers; Steam Engine Valves; Valve Diagrams; Expansion Valves; Link Motion and Reversing Gears; Lubricators. The book is one that we heartily commend for designers, draftsmen and progressive mechanics generally who are interested in the theory and practice of machine design.

NEW CATALOGUES AND CIRCULARS

Whitman & Barnes Mfg. Co., Akron, Ohio. Folder on "W. & B.", "Diamond" and "Hercules" twist drills.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin on Type G controllers for direct-current motors.

New Jersey Foundry & Machine Co., 90 West St., New York. Circular of cranes, tracks, trolleys and hoists for indoor and outdoor service.

Ohio Valley Pulley Works, Maysville, Ky. Discount card of "Limestone" wood split pulleys in celluloid case, arranged for convenient use.

Emerson Electric Mfg. Co., St Louis, Mo. Bulletin No. 3313 on electric forge blowers, direct-connected, for direct and alternating currents.

Doehler Die-Casting Co., Court & Ninth Sts., Brooklyn, N. Y. Circular of babbitt-lined bronze bearings which are formed by rolling and pressure, instead of being melted and cast in molds.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin U-7 on the "Standard" high-power universal portable electric drills, made to operate on alternating and direct current, 110 to 220 volts.

William F. Wolff Co., 32 Union Square, New York. Circular on "Any Wheare" lamp brackets for use in offices, drafting rooms and all places where an adjustable bracket electric light is advantageous.

Carroll-Jamieson Machine Tool Co., Batavia, Ohio. Circulars of 14-inch single back-gear quick change gear lathe (15¼ inches swing) and 14-inch double back-gear quick change gear lathe (15¼ inches swing.)

Lea-Courtenay Co., Inc., 90 West St., New York. Catalogue of Lea-Courtenay turbine pumping machinery illustrating the construction of the turbine pump and showing examples of various sizes and combinations.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular of Westinghouse commutator cement for repairing pitted commutators, filling grooves in undercut commutators and for insulating inaccessible places.

General Electric Co., Schenectady, N. Y. Bulletin A 4069 on portable and stationary air compressor sets; 4994 on subway transformers; A 4065 on electric hardening furnaces type RHF; and A 4065 on electric fans for 1913.

Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill. Circular of "Thor" close-quarter piston air drills, made in two sizes, Nos. 8 and 9, the first operating within 1 5/32 inch from corner, and the second 1 9/32 inch from corner.

Meisselbach-Catucci Mfg. Co., 29 Congress St., Newark, N. J. Bulletin No. 3, illustrating and describing the company's No. 1 M-C turret head which is designed to be readily adapted to any bench lathe, thus converting it into a screw machine.

Betts Machine Co., Wilmington, Del. Booklet illustrating Betts machine tools in use by prominent railroads, comprising boring and turning mills, tire turning mills, car-wheel boring mills, horizontal boring and drilling machines, slotting machines and planing machines.

Keuffel & Esser Co., 127 Fulton St., New York. Circular of the K & E power computing slide-rule for computing power and dimensions of steam, gas and oil engines, solving the equation $H.\,P. = \frac{PLAN}{33{,}000}$

Hydraulic Truck Sales Co., 1777 Broadway, New York. Circular on the La France gasoline-hydraulic truck, illustrating the principle of the hydraulic variable speed mechanism, by which the velocity ratio of the engine to the drive wheels can be changed by minute increments.

Lumen Bearing Co., Buffalo, N. Y. Booklet on casting alloys and babbitt metals, comprising bronze, brass and aluminum alloys and different grades of babbitt metals. The physical characteristics of the various alloys are given, and the services for which they are particularly suited.

M. A. Haskell & Co., 12 Summer St., South Braintree, Mass. Leaflet illustrating the Haskell universal three-jaw clamp, for the use of patternmakers, cabinet makers, picture framers, carpenters and machinists. The tool may be used over a three-jaw clamp or two-jaw clamp, as required.

Thos. H. Dallett Co., York & 23d Sts., Philadelphia, Pa. Bulletin No. 303 on the Dallett "quick action" hose coupling which provides

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to manipulate two or more levers when one will accomplish the desired end, or to manipulate anything by hand when power will do the work. It is worse than *waste labor* when a man engages the wrong feed, or engages another feed when one is already engaged and smashes something in consequence. You will find none of these or other disadvantages on the

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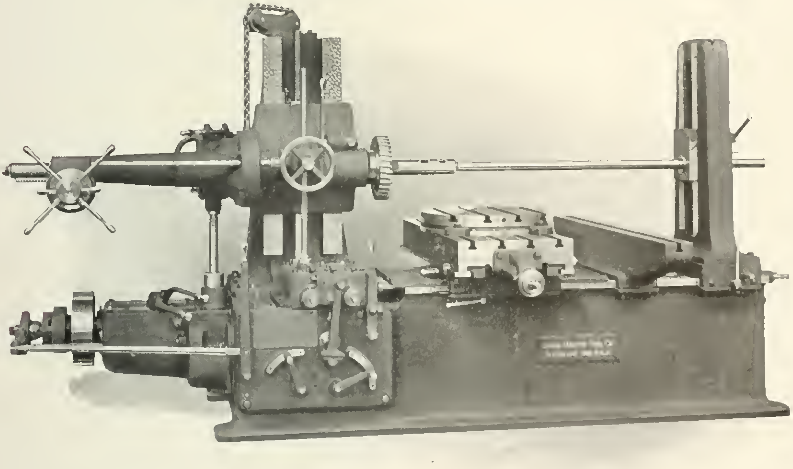

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means for quickly connecting or disconnecting hose and which is particularly adapted to compressed air equipment in shops, foundries, mines, quarries, etc.

Sawyer Tool Mfg. Co., Ashburnham, Mass., is publishing a house organ called the *Sawyer Bulletin* which will be sent free to machinists, toolmakers and others interested in fine machinists' tools. The bulletin illustrates new Sawyer tools and contains funny stories, jokes and road experiences.

Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalogue of the Beaudry power hammers, comprising Beaudry "Champion" 50- to 500-pound rams and the Beaudry "Peerless" 25- to 200-pound rams. The two styles are illustrated in detail, and sizes and dimensions of both styles are tabulated.

W. S. Rockwell Co., 50 Church St., New York. Circular of the Rockwell tilting crucible melting furnaces for aluminum, bronze, brass, copper, gold, silver and other non-ferrous metals. The furnaces are designed to use either oil or gas fuel, and are made in four sizes having working capacities of 200 to 1600 pounds.

Cleveland Twist Drill Co., Cleveland, Ohio., is distributing a handsome wall calendar for 1913. A feature of general interest and value to machinists is tables of tap drill sizes for U. S. standard threads, pipe threads, A. L. A. M. standard threads, and machine screw threads.

Duplex Gasoline Motor Co., 42d St. & Broadway, New York. Circular of "Twostrok" four-cylinder gasoline motor, having only seventeen moving parts. It is claimed that the "Twostrok" motor is economical of gasoline, comparing favorably with any four-cycle or two-cycle motor of the same size. The motor has no rotary valves nor poppet valves.

Keuffel & Esser Co., 127 Fulton St., New York. Catalogue of drawing materials, surveying instruments and tapes, comprising a large variety of materials, supplies, instruments and apparatus used in drafting-rooms, engineers' offices, by surveyors, mathematicians, etc. Colored inserts show drawing instruments and equipment of a drawing-room and a transit.

Lindhe Shim Co., 210-212 Canal St., New York. Circular of the Lindhe shim for machinery bearings, etc., which is composed of laminated brass sheets 0.002 inch thick, held together by a metallic binder. These shims have all the solidity of the ordinary all-metal shim and the advantage that the thickness can be reduced by simply peeling off one or more layers as required.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletins E-22, on heavy-duty electric drills for alternating current; E-26, on "Universal" electric drills operating on direct or alternating current; E-27, on heavy-duty electric drills; 34-G, on air receivers, after-coolers, air line drain traps, reheaters and economizers; and 34-F on the design and construction of class G "Chicago-Pneumatic" air compressors.

Sprague Electric Works of the General Electric Co., New York. Bulletin No. 117 on electrical equipment for buildings, comprising generators, gasoline-electric generating sets, motor generators, switchboards, conduit boxes and fittings, wire and cable, wiring devices, panel boards, direct- and alternating-current motors, controllers, electric hoists, electric fans, lamps, ozonators, theatrical devices, etc.

Doehler Die-Casting Co., Court & Ninth Sts., Brooklyn, N. Y. Circular on molded brass parts made from brass heated to a semi-fluid or plastic state and subjected in molds to a high pressure. The alloy used is golden yellow in color, and is easily machined. It has a tensile strength of 55,000 pounds per square inch, an elastic limit of about 22,000 pounds and an elongation in six inches of about 20 per cent.

Motch & Merryweather Machinery Co., 707-715 Lakeside Ave., Cleveland, Ohio. Catalogue of machine tools and other accessories made by sixty well-known concerns for whom the company is the representative. The catalogue contains 445 pages, 9 by 11 inches, and is fully illustrated throughout. The value of this catalogue to purchasing agents and others concerned with the purchase of machine tool equipment, is obvious.

Superior Machine Tool Co., Kokomo, Ind., Bulletins 160 and 250-C on Kokomo "Hi-Speed" roller bearing sensitive drilling machines, and "Hi-Speed" vertical drilling machines. The sensitive drilling machines are made in 16-inch and 20-inch swing and in single spindle and multiple spindle combinations. The vertical drilling machine is 25-inch swing exclusively, and is furnished with friction back-gears, friction quick-return, positive gear feed, tapping attachment, etc.

Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa. Circular of electric riveters with which rivets are heated and headed by electric current and pressure without welding. Advantages claimed for electric riveting are: any shape of rivet head can be produced, the most fragile articles can be riveted without danger of breakage, and rivets of high carbon steel, nickel-chrome steel, etc., can be headed as readily as rivets of soft steel.

W. P. Davis Machine Co., Rochester, N. Y. Circulars of 12- to 16-inch swing engine lathe with motor drive, quick change gear box; 18- to 32-inch swing engine lathe with motor drive, quick change gear box; 14-inch Davis tool-room lathe with quick change feed gear box, oil-pan and draw-in attachment; 16-inch Davis lathe with turret on carriage, quick change gear and taper attachment; 20-inch Davis back-gear and power feed drilling machine, with square table; and 6-inch Davis cut-off machine.

Bath Grinder Co., Fitchburg, Mass. Booklet of useful information on Bath universal grinding machines, comprising description of the machine and attachments with illustrations showing construction of machine and the attachments set up for use. The illustrations of attachments are partial phantom views, the machine proper being in phantom and the attachments in full. Directions for grinding cutters and reamers are included and other useful information on grinding wheels, work and traverse speeds, wheel grades, etc.

Hendey Machine Co., Torrington, Conn. Catalogue of screw cutting engine lathes, comprising 12-inch to 32-inch swing inclusive, with regular belt-cone driven heads; 12-inch to 24-inch swing inclusive, with all-geared drive heads; and a modified geared drive head for 32-inch swing, designed for variable speed motor drive. The catalogue contains 147 pages, 6 by 9 inches, and is fully illustrated. It shows a large number of attachments and accessories of general interest to mechanics, especially those concerned with the equipment of toolrooms. Data is included on calculating change gears for thread cutting, etc.

Doehler Die-Casting Co., Court & Ninth Sts., Brooklyn, N. Y. Pamphlet entitled "Successful Die-Casting" illustrating the new Doehler factory and many examples of die-cast parts which illustrate the remarkable possibilities of the die-casting process. Manufacturers generally, and those particularly making small machinery and apparatus such as magnetos, motor starting devices, electric horns, electrical apparatus generally, automatic vending machines, cash registers, coin counting devices, force-feed oil pumps, carbureters, etc., will find the pamphlet of much suggestive value.

National Machine Tool Builders Association. James H. Herron, Cleveland, Ohio, secretary. Official report of the eleventh annual convention held in New York City at the Hotel Astor October 16, 17 and 18. The report includes the interesting papers: "Export Trade" by W. A. Viall; "The Use of an Association Catalogue in the Development of Foreign Markets" by S. H. Bullard; "How United States Patents Might be Made of Greater Value to Patentees" by S. W. Banning; and "How Could the Association be Benefited by the Formation of a Mechanical Section?" by E. J. Kearney.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill. Bulletins illustrating several styles and sizes of Q-M-S cold metal-sawing machinery, comprising style 1M saw with capacity for 6-inch rounds and squares and 10-inch I-beams; B cut-off and universal type, motor-driven through belting from motor to machine; A or B type universal machines which may be used either as metal-sawing machines or milling machines, the saw being replaced with a milling cutter, thus combining two machines in one; A. cut-off and universal type machine, arbor-driven, using inserted-tooth saw blades and having feed of the variable adjustable friction type; foundry type of cold metal cut-off machines, being the B cut-off type machine arranged especially for foundry use. The bulletins are profusely illustrated and of general interest to users of metal-sawing machines such as bridge works, structural steel works, machine shops, foundries, etc.

TRADE NOTES

St. Louis Machine Tool Co., formerly of 1209-1211 Gratiot St., St. Louis, Mo., has moved to 2607-2609 South Broadway, St. Louis.

Barcy-Nicholson Co., Detroit, Mich., has taken over the business of the Universal Stamping Co., Buffalo, N. Y., and is manufacturing the "Universal" safety devices.

Cleveland Worm & Gear Works, 66th St. and St. Clair Ave., Cleveland, Ohio, is a concern recently organized for the manufacture of worm-gears for automobiles and trucks.

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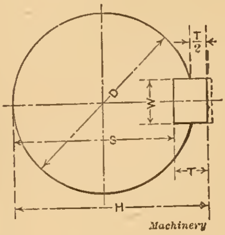
DIMENSIONS OF TAPER KEYS AND KEYWAYS—I



Approximate Formulas

$W = \frac{1}{4} D$

$T = \frac{3}{4} W$

T is measured at the thin end of key.

Taper of key equals 1/8 inch in 12 inches.

Keys 1 inch wide and wider are made thinner than the formula calls for.

Diameter of Shaft, Inches D	Width of Key, Inches W	Thickness of Key, Inches T	Hub Dimension for Keyway at Thin End, Inches H	Shaft Dimension for Keyway, Inches S
3/4	3/16	9/64	13/16	43/64
13/16	3/16	9/64	7/8	47/64
7/8	3/16	9/64	15/16	51/64
15/16	1/4	3/16	1 1/64	53/64
1	1/4	3/16	1 5/64	57/64
1 1/16	1/4	3/16	1 9/64	61/64
1 1/8	1/4	3/16	1 13/64	1 1/64
1 3/16	5/16	15/64	1 9/32	1 3/64
1 1/4	5/16	15/64	1 11/32	1 7/64
1 5/16	5/16	15/64	1 13/32	1 11/64
1 3/8	5/16	15/64	1 15/32	1 15/64
1 7/16	3/8	9/32	1 9/16	1 9/32
1 1/2	3/8	9/32	1 5/8	1 11/32
1 9/16	3/8	9/32	1 11/16	1 13/32
1 5/8	3/8	9/32	1 3/4	1 15/32
1 11/16	7/16	21/64	1 53/64	1 1/2
1 3/4	7/16	21/64	1 57/64	1 9/16
1 13/16	7/16	21/64	1 61/64	1 5/8
1 7/8	7/16	21/64	2 1/64	1 11/16
1 15/16	1/2	3/8	2 3/32	1 23/32
2	1/2	3/8	2 5/32	1 25/32
2 1/16	1/2	3/8	2 7/32	1 27/32
2 1/8	1/2	3/8	2 9/32	1 29/32
2 3/16	9/16	27/64	2 23/64	1 15/16
2 1/4	9/16	27/64	2 27/64	2

Contributed by G. G. Dana

DIMENSIONS OF TAPER KEYS AND KEYWAYS—II

Diameter of Shaft, Inches D	Width of Key, Inches W	Thickness of Key, Inches T	Hub Dimension for Keyway at Thin End, Inches H	Shaft Dimension for Keyway, Inches S	Diameter of Shaft, Inches D	Width of Key, Inches W	Thickness of Key, Inches T	Hub Dimension for Keyway at Thin End, Inches H	Shaft Dimension for Keyway, Inches S
2 5/16	9/16	27/64	2 31/64	2 1/16	3 5/16	3/4	9/16	3 35/64	2 63/64
2 3/8	9/16	27/64	2 35/64	2 1/8	3 3/8	7/8	21/32	3 21/32	3
2 7/16	5/8	15/32	2 5/8	2 5/32	3 7/16	7/8	21/32	3 23/32	3 1/16
2 1/2	5/8	15/32	2 11/16	2 7/32	3 1/2	7/8	21/32	3 25/32	3 1/8
2 9/16	5/8	15/32	2 3/4	2 9/32	3 9/16	7/8	21/32	3 27/32	3 3/16
2 5/8	5/8	15/32	2 13/16	2 11/32	3 5/8	7/8	21/32	3 29/32	3 1/4
2 11/16	11/16	33/64	2 59/64	2 13/32	3 9/16	7/8	21/32	3 31/32	3 5/16
2 3/4	11/16	33/64	2 63/64	2 15/32	3 3/4	7/8	21/32	4 1/32	3 3/8
2 13/16	11/16	33/64	3 3/64	2 17/32	3 13/16	7/8	21/32	4 3/32	3 7/16
2 7/8	11/16	33/64	3 7/64	2 19/32	3 7/8	1	11/16	4 5/32	3 15/32
2 15/16	3/4	9/16	3 11/64	2 39/64	3 15/16	1	11/16	4 7/32	3 17/32
3	3/4	9/16	3 15/64	2 43/64	4	1	11/16	4 9/32	3 19/32
3 1/16	3/4	9/16	3 19/64	2 47/64	4 1/16	1	11/16	4 11/32	3 21/32
3 1/8	3/4	9/16	3 23/64	2 51/64	4 1/8	1	11/16	4 13/32	3 23/32
3 3/16	3/4	9/16	3 27/64	2 55/64	4 3/16	1	11/16	4 15/32	3 25/32
3 1/4	3/4	9/16	3 31/64	2 59/64	4 1/4	1	11/16	4 17/32	3 27/32

Contributed by G. G. Dana

DIMENSIONS OF TAPER KEYS AND KEYWAYS—III

Diameter of Shaft, Inches D	Width of Key, Inches W	Thickness of Key, Inches T	Hub Dimension for Keyway at Thin End, Inches H	Shaft Dimension for Keyway, Inches S	Diameter of Shaft, Inches D	Width of Key, Inches W	Thickness of Key, Inches T	Hub Dimension for Keyway at Thin End, Inches H	Shaft Dimension for Keyway, Inches S
4 5/16	1	11/16	4 19/32	3 29/32	5 1/2	1 1/4	13/16	5 7/8	5 1/16
4 3/8	1 1/8	3/4	4 11/16	3 15/16	5 5/8	1 1/4	13/16	6	5 3/16
4 7/16	1 1/8	3/4	4 3/4	4	5 11/16	1 1/4	13/16	6 1/16	5 1/4
4 1/2	1 1/8	3/4	4 13/16	4 1/16	5 3/4	1 1/4	13/16	6 1/8	5 5/16
4 9/16	1 1/8	3/4	4 7/8	4 1/8	5 7/8	1 1/2	7/8	6 1/4	5 3/8
4 5/8	1 1/8	3/4	4 15/16	4 3/16	6	1 1/2	7/8	6 3/8	5 1/2
4 11/16	1 1/8	3/4	5	4 1/4	6 1/8	1 1/2	7/8	6 1/2	5 5/8
4 3/4	1 1/8	3/4	5 1/16	4 5/16	6 1/4	1 1/2	7/8	6 5/8	5 3/4
4 7/8	1 1/4	13/16	5 1/4	4 7/16	6 3/8	1 1/2	7/8	6 3/4	5 7/8
4 15/16	1 1/4	13/16	5 5/16	4 1/2	6 1/2	1 1/2	7/8	6 7/8	6
5	1 1/4	13/16	5 3/8	4 9/16	6 5/8	1 1/2	7/8	7	6 1/8
5 1/8	1 1/4	13/16	5 1/2	4 11/16	6 7/8	1 3/4	1	7 1/4	6 1/4
5 3/16	1 1/4	13/16	5 9/16	4 3/4	7 1/8	1 3/4	1	7 1/2	6 1/2
5 1/4	1 1/4	13/16	5 5/8	4 13/16	7 3/8	1 3/4	1	7 3/4	6 3/4
5 3/8	1 1/4	13/16	5 3/4	4 15/16	7 5/8	1 3/4	1	8	7
5 7/16	1 1/4	13/16	5 13/16	5	7 7/8	2	1 3/16	8 3/8	7 3/16

Contributed by G. G. Dana

No. 163, Data Sheet, MACHINERY, February, 1913

SELECTING CUTTER FOR MILLING SPIRAL GEARS

HOW TO USE THE TABLE

Multiply the actual number of teeth in the spiral gear to be cut by the factor K as given in the table opposite the angle of spiral. ($K = 1 \div \cos^3 a$). The product gives the number of teeth for which to select the cutter.

Example: Angle of spiral = 30°; number of teeth in spiral gear = 18. Then: $18 \times 1.540 = 28$, approximately. Hence, use spur gear cutter for 28 teeth, or spur gear cutter No. 4.

Angle of Spiral, a	K	Angle of Spiral, a	K	Angle of Spiral, a	K	Angle of Spiral, a	K	Angle of Spiral, a	K
0° 0'	1.000	17 0'	1.145	34 0'	1.755	51 0'	4.012	68 0'	18.98
0 30'	1.000	17 30'	1.154	34 30'	1.787	51 30'	4.144	68 30'	20.33
1 0'	1.001	18 0'	1.163	35° 0'	1.819	52 0'	4.284	69 0'	21.72
1 30'	1.001	18 30'	1.172	35° 30'	1.853	52 30'	4.433	69 30'	23.33
2 0'	1.002	19 0'	1.182	36 0'	1.889	53 0'	4.586	70 0'	25.00
2 30'	1.003	19 30'	1.193	36 30'	1.926	53 30'	4.752	70 30'	26.97
3 0'	1.004	20 0'	1.204	37 0'	1.963	54 0'	4.925	71 0'	28.97
3 30'	1.005	20° 30'	1.216	37 30'	2.003	54 30'	5.101	71 30'	31.40
4 0'	1.007	21° 0'	1.228	38 0'	2.044	55 0'	5.295	72 0'	33.88
4 30'	1.009	21 30'	1.241	38 30'	2.086	55 30'	5.497	72 30'	36.92
5 0'	1.011	22 0'	1.254	39 0'	2.130	56 0'	5.710	73 0'	40.00
5 30'	1.013	22 30'	1.268	39 30'	2.176	56 30'	5.940	73 30'	43.88
6 0'	1.016	23 0'	1.282	40 0'	2.225	57 0'	6.190	74 0'	47.79
6 30'	1.019	23 30'	1.297	40 30'	2.275	57 30'	6.435	74 30'	54.72
7 0'	1.022	24 0'	1.312	41 0'	2.326	58 0'	6.720	75 0'	57.68
7 30'	1.026	24 30'	1.328	41 30'	2.380	58 30'	7.010	75 30'	64.15
8 0'	1.030	25 0'	1.344	42 0'	2.436	59 0'	7.321	76 0'	70.65
8 30'	1.034	25 30'	1.360	42 30'	2.495	59 30'	7.650	76 30'	79.20
9 0'	1.038	26 0'	1.377	43 0'	2.557	60 0'	8.000	77 0'	87.78
9 30'	1.042	26 30'	1.395	43 30'	2.621	60 30'	8.380	77 30'	99.50
10 0'	1.047	27 0'	1.414	44 0'	2.687	61 0	8.780	78 0'	111.3
10 30'	1.052	27 30'	1.434	44 30'	2.756	61 30'	9.209	79 0'	144.0
11 0'	1.057	28 0'	1.454	45 0'	2.828	62 0'	9.658	80 0'	191.2
11 30'	1.062	28 30'	1.474	45 30'	2.902	62 30'	10.16	81 0'	261.4
12 0'	1.068	29 0'	1.495	46 0'	2.983	63 0'	10.69	82 0'	370.6
12 30'	1.074	29 30'	1.517	46 30'	3.066	63 30'	11.27	83 0'	552.1
13 0'	1.080	30 0'	1.540	47 0'	3.152	64 0'	11.87	84 0'	876.4
13 30'	1.087	30 30'	1.563	47 30'	3.242	64 30'	12.55	85 0'	1509.0
14 0'	1.094	31 0'	1.588	48 0'	3.336	65 0'	13.25	86 0'	2940.0
14 30'	1.102	31 30'	1.613	48 30'	3.436	65 30'	14.03	87 0'	6990.0
15 0'	1.110	32 0'	1.640	49 0'	3.540	66 0'	14.86	......	......
15 30'	1.118	32 30'	1.667	49 30'	3.650	66 30'	15.80	......	......
16 0'	1.127	33 0'	1.695	50 0'	3.767	67 0'	16.76	......	......
16 30'	1.136	33 30'	1.724	50 30'	3.887	67 30	17.85	......	......

Contributed by George W. Burley

No. 163, Data Sheet, MACHINERY, February, 1913

MACHINERY

MARCH, 1913

SHOP PRACTICE OF THE WILLYS-OVERLAND CO.*

EVOLUTION OF A FOUR-THROW CRANKSHAFT—MACHINING FLYWHEELS, CAM-SHAFTS, ETC.

BY DOUGLAS T. HAMILTON†

THE Willys-Overland Co., Toledo, Ohio, employs many interesting shop methods and tools in the manufacture of the Overland automobile. A description of the forging and machining of the crankshaft and other parts is given in the following.

Drop-forging Crankshafts

The crankshaft used in the four-cylinder engines built by the Willys-Overland Co. is made by drop-forging a high carbon manganese steel bar, 38¼ inches long by 2⅜ inches in diameter, to the desired shape under powerful steam hammers. The long bars of stock are first sheared to the correct length in a power shear, after which they are taken to a furnace beside the drop-hammer where they are heated to a bright red. When the bars attain the desired temperature they are quickly removed by the "heater" one at a time, and passed to the steam hammer operator. This man first places the rod over the breaking down impression on the die shown in Fig. 2, and then operates the hammer; as the top die descends, it forces the heated rod into the impressions in the breaking-down die. The operator now, by holding the heated bar in a pair of large tongs, quickly shifts the bent bar to the roughing impression (shown to the right of the die in Fig. 2), where it is given another blow. The bar is moved back and forth from the breaking-down to the roughing impression until it has been formed roughly to the desired shape, two blows in each impression generally being sufficient for the purpose. While forcing the heated bar into the impression in the die, a certain amount of scale is formed, which is removed by directing a blast of compressed air onto the face of the die.

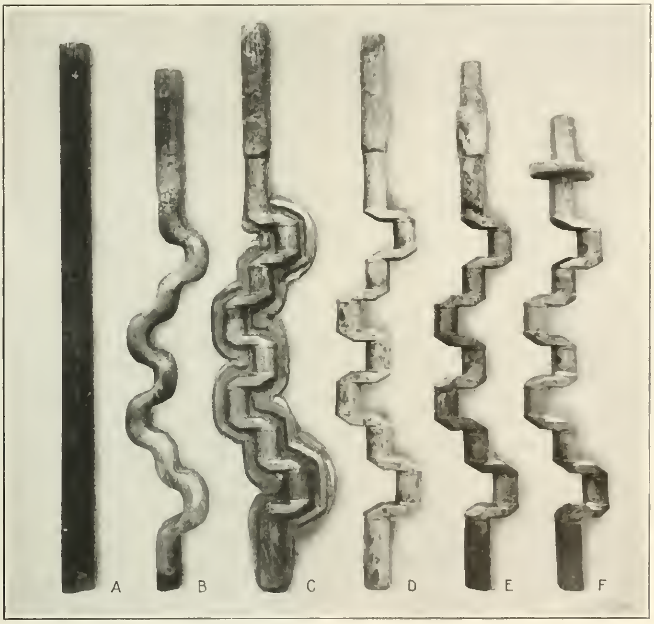


Fig. 1. Evolution of a Four-throw Crankshaft from the Straight Bar to the Final Shape—Illustrating Sequence of Drop-forging and Upsetting Operations

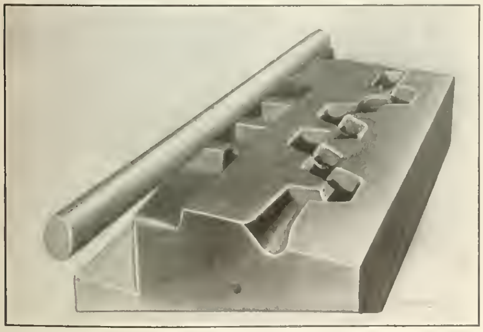


Fig. 2. Breaking-down and Rough-shaping Drop-forging Die

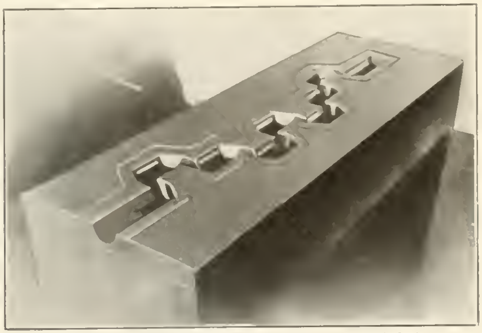


Fig. 3. The Finish Drop-forging Die for the Crankshaft

The shape of the crankshaft, after passing through the roughing dies, is shown at *B* in Fig. 1. After rough-forming, the crankshaft is placed on the finishing die shown set up in a Chambersburg steam hammer in Fig. 4, a closer view of the lower die appearing in Fig. 3. The steam hammer is now operated, and the top die forces the already roughly formed bar into the finishing impression. As the bar is not heated, but is taken directly from the roughing to the finishing dies, it usually requires from two to three blows to bring it to the final shape. The appearance of the crankshaft after the final drop-forging operation is indicated at *C* in Fig. 1, where it can be seen that the excess metal has been flashed out. Grooves cut around the impression in the finishing die are provided to take care of this excess metal. The crankshaft is now taken to a power press in which are held a trimming punch and die for removing the flash formed in the final drop-forging operation. The crankshaft, as it appears after the flash is removed, is shown at *D* in Fig. 1.

After the flash has been removed, the crankshaft is again taken to the furnace, and the opposite end (flange end by which it was gripped when being drop-forged), is heated to the correct temperature. The heated bar is then taken to a power hammer, where the long end is reduced in diameter, see *E*, Fig. 1, to fit the hole in the plunger of a 4-inch Ajax upsetting and forging machine, where the flange upon which the flywheel is subsequently attached, is formed. After reducing the diameter of the long end, the crankshaft is again taken to the furnace and this end heated. The next and final forging operation is illustrated diagrammatically in Fig. 5. In this illustration, only one of the gripping dies is shown, the views being sectional elevations to show the operations more clearly.

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*For information on automobile shop practice previously published in MACHINERY, see "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and other articles there referred to.

† Associate Editor of MACHINERY.

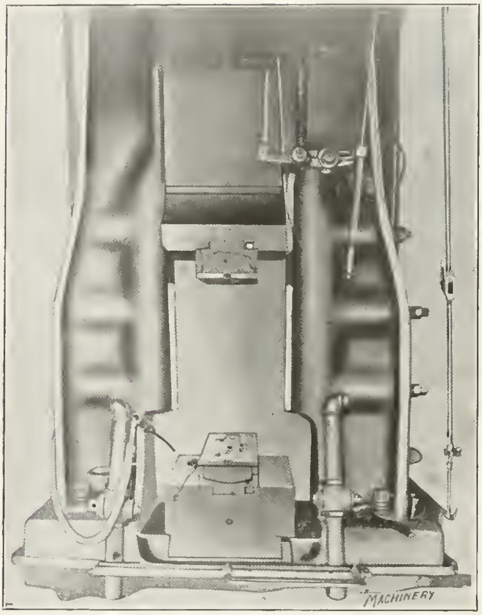

Fig. 4. Chambersburg Steam Hammer with the Finish Drop-forging Dies in Place

The gripping dies which hold the crankshaft while the flange is being formed by the upsetting plungers *b* and *c*, are known as "double-deck" gripping dies, as they are provided with two impressions enabling the flange to be rough- and finish-formed without removing the crankshaft from the machine. The diagram at *A* shows the crankshaft located in the lower impression in the gripping die *a*, and also in place in the lower upsetting plunger *b*. When in this position, the machine is operated, and as the ram advances, the lower plunger upsets the flange to the shape shown at *B*. The ram now retreats and the operator removes the crankshaft from the lower impression in the gripping dies, placing it in the upper impression as shown at *C*. The machine is again operated, and as the ram advances, plunger *c* forces the roughly formed flange into the large impression in the gripping dies, forming it to the correct shape as illustrated at *D*. As a rule only two blows are required to completely form the flange to a diameter over two and three-quarters greater than the bearing portions.

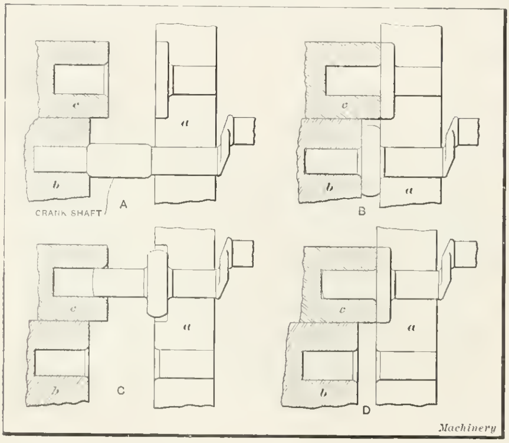

Fig. 5. Diagram illustrating the Evolution of the Flange on the Crankshaft which is produced in a Four-inch Ajax Upsetting and Forging Machine in Two Blows

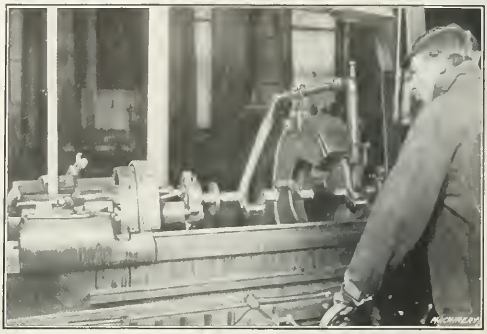

Fig. 6. Rough-grinding the Crank-pins in a Norton Grinder

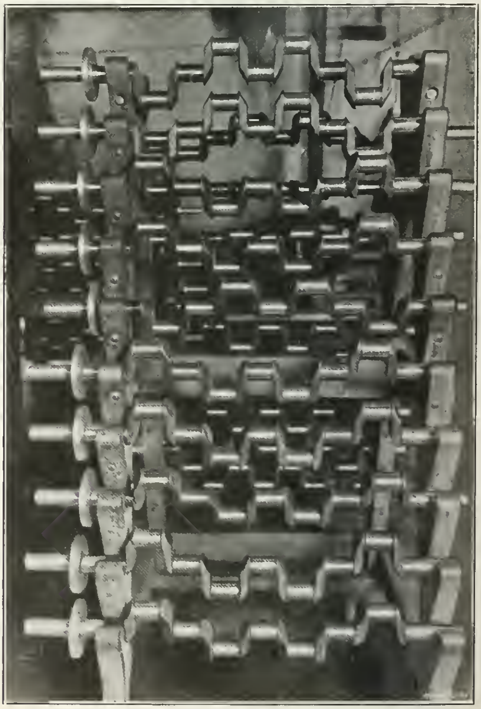

Fig. 7. Rack used for holding Crankshafts when transporting them from One Operation to another

One of these gripping dies is stationary, whereas the other is movable, enabling the bar to be inserted and removed easily—the dies automatically stay open when not in operation.

The condition of the crankshaft after it leaves the forging machine is shown at *F* in Fig. 1. This is the final forging operation, and when cool, the crankshafts are transferred to the heat-treating department. The forging operation sets up internal strains in the bar, which can only be removed by annealing. The crankshafts are next straightened and heat-treated. After heat-treating they are centered on each end, and in this condition pass to the lathe department. Here the main end bearings are rough-turned and the flange roughed out; then the crankshaft is cut to the proper length, centered, and the flange faced. The crankshaft is now placed in an American crankshaft lathe where the faces of the throws are machined to the proper width to admit the rough grinding wheel. Two tools are used in this operation so that the space between the "arms" of the throw is machined to the correct width in one setting.

From the lathe department the crankshafts are taken to the grinding department where all portions are ground to size, except the flange and the end on which the clutch cone is mounted. The first grinding operation consists in roughing down the crank-pins in a Norton grinder to within 0.025 inch of the finish size. This operation is illustrated in Fig. 6, where it can be seen that a wheel the exact width of the space between the arms of the throws is used; this is fed directly into the work until the proper diameter is reached. When grinding the crank-pins the crankshaft is held by both ends in fixtures attached to the headstock and tailstock of the grinder, which are offset sufficiently to give the desired amount of eccentricity.

The crankshafts are now taken to another grinder of the same type as that illustrated in Fig. 6, where the crank-pins are ground to the desired diameter, 1.500 inch. The bearings are then finish-ground, and upon the completion of this operation the crankshafts are returned to the lathe department for a few minor operations. For conveying from one machining department to another, a special type of rack is used as shown in Fig. 7. This is built on the pyramid plan and holds twenty crankshafts. It is mounted on small wheels enabling it to be moved about easily. After leaving the lathe department the crankshafts pass through a few minor operations and then receive the final inspection, after which they are ready for assembling in the engines.

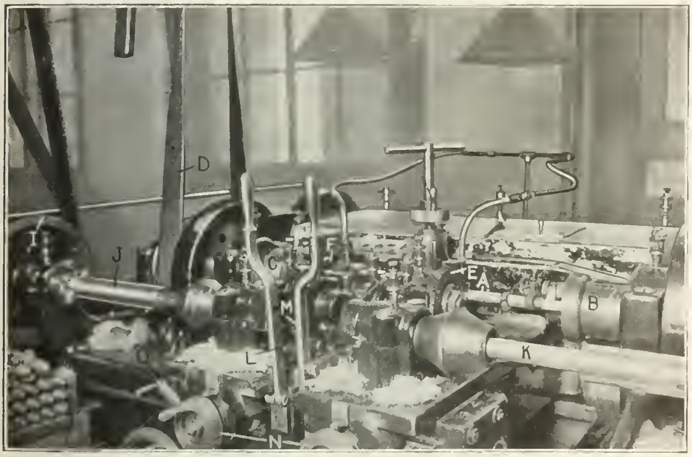

Fig. 8. Machine used for milling Cams. Two Cams being machined at one Setting of the Cutters

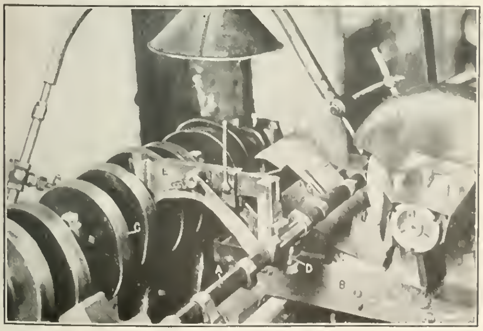

Fig 9. Le Blond 16-inch Engine Lathe rigged up with Special Fixtures for grinding Cams

Machining and Gaging Cam-shafts

The cam-shaft, which is also made from a bar of high-carbon manganese steel, is drop-forged to shape under a steam hammer, three die impressions being used, two for roughing and one for finishing. After drop-forging and trimming, it is taken to the heat-treating department and annealed; then cut to the required length and centered in each end. It is now ready to be turned between the cams, which operation is performed in a "Lo-Swing" lathe. From the lathe, the cam-shafts are taken to the special cam milling machine shown in Fig. 8, which was designed and built by the Willys-Overland Co. especially for this work. The cam-shaft *A*, which has been provided with a locating flat on each end, is retained by swinging clamps in two special holders *B* and *C*; these holders are held on spindles in heads which are driven by belts *D* (only one of which is shown) from the countershaft. The spindle carrying the master cams is located immediately behind the heads driving the cam-shaft *A* and is connected to these heads by spur gears of an equal ratio, so that both work and master cams rotate at the same speed. These master cams are similar in shape to those shown in Fig. 9.

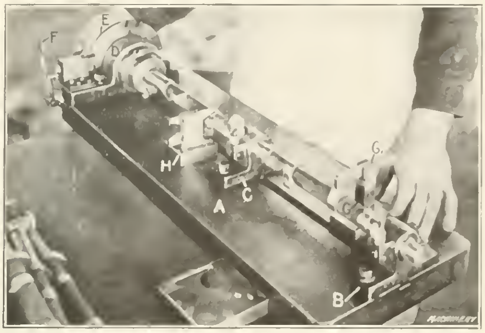

Fig. 10. Fixture used in Testing Shape, Lift and Angularity of Cam-shafts

The two milling cutters *E* and *F*, which do the machining, are mounted on spindles located in heads which are fastened to the cross-slides shown. The milling cutters are driven by two pulleys *I*, which are belted to the countershaft and transmit power through knuckle-jointed shafts *J* and *K* and gears to the cutter-spindles. The cross-slides are operated to withdraw the milling cutters from the work by two handles *L* and *M*, which pull the slides back to a stop by a link connection. The slides are fed forward by a screw, which is provided with micrometer collars *N* and is engaged with the half-nut by operating the levers *O*, one of which is provided for each slide.

In operation, after the cam-shaft has been properly located in the chucks, and the slides moved over to bring the helical milling cutters in line with the two innermost cams, the operator pushes the handles *L* and *M* forward, then engages the half-nuts with the screws and the machine operates automatically, the half-nuts disengaging from the screws when the desired depth is reached. At the same time that the milling cutters are at work, the slides on which they are held are being oscillated back and forth by the master cams, connection being made to rollers in contact with the latter. When the two cams have been completed, the operator withdraws the slides, and moves them apart until the milling cutters are in line with the next set of cams, then forces the slides in and engages the half-nuts, as previously described. This procedure is followed until the four sets—eight cams—have been milled. The cam-shaft is well supported against the thrust of the milling cutters, so that two cams are completed for every revolution of the shaft.

After milling, the cam-shafts are taken back to the hardening department where they receive the final heat-treatment. The next operation consists in straightening those cam-shafts which have become slightly distorted during the final heat-treating process. Then they are taken to the grinders, where the bearings are ground to the required size. The next operation consists in grinding the eight cams to the desired shape and size in the special machine shown in Fig. 9, which is a 16-inch LeBlond engine lathe that has been fitted up with a special slide holding an emery wheel in place of the ordinary tool-post slide. Brackets fastened to the back of the machine carry a shaft on which the eight master cams *C* are held. A hardened and ground roll held on the wheel-slide *B* is kept in contact with the master cams by a suspended weight.

In operation, the cam-shaft *A* is held as shown in Fig. 8, and one cam is ground to size at a time—0.020 inch being removed from the "diameter." The cam-shaft is supported on the center bearing by a special leather-faced shoe *D*, which is retained in a bracket adjustably mounted on the arm *E*. When one cam is ground to size, the slide carrying the wheel is moved along until the roll comes in contact with the next master cam, when the operation is repeated, the wheel being fed in directly against the work. Water is used on the wheel and work to make the wheel free-cutting and prevent the work from heating.

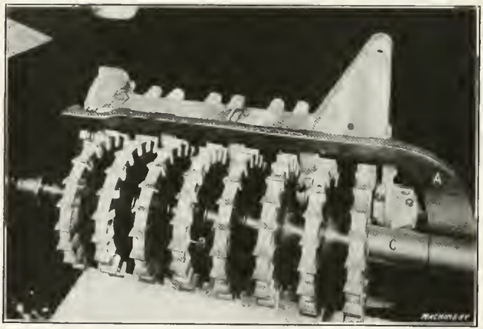

Fig. 11. Facing the Five Bearings in the Crank-case in One Setting on a Lucas Boring, Drilling and Milling Machine

This completes the manufacturing operations on the cam-shafts, and they are now turned over to the inspection department, where the cams are tested for shape, lift and angularity. The testing fixture used for this purpose is shown in Fig. 10. It comprises a bedplate *A* on which three brackets *B*, *C* and *D* are held. Brackets *B* and *C* are used as supports only, and are provided with hinged caps held by thumb-screws, to facilitate the insertion and removal of the cam-shaft. The bracket *D* carries a special chuck for gripping the work, and is furnished with an indexing disk *E* which has eight notches to correspond with the number and position of the cams on the shaft. This disk is located in the various positions by a tapered plunger, which is held in contact with the disk by a spring and is removed by the handle *F*, to index the disk.

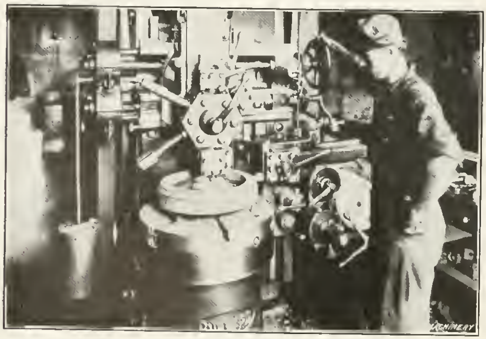

Fig. 12. Machining Flywheel in One Setting on a Bullard Vertical Turret Lathe

The highest point of the cam is tested by the T-gage *G* which is provided with "go" and "not go" points on the bar G_1. The angularity and shape of the cams are tested by the V-gage *H*; this is provided with knife-edge gaging points, and is used in connection with the indexing disk to test the angularity and position of the cams on the shaft. It is also provided with "go" and "not go" V-grooves, which are made to the exact shape desired. All three brackets are located from a groove in the bed, so that they are in perfect alignment.

Fig. 13. Threading Speed Rods in Geometric Threading Machines at the Rate of 90 Rods per Hour

Facing Crank-case Bearings

Fig. 11 shows the method used in facing the five main bearings in the aluminum crank-case. For this operation, the crank-case is held on trunnions in the fixture *A* which is fastened to the table of a Lucas boring, drilling and milling machine. The facing is accomplished with eight inserted-tooth milling cutters *B*, which are held on the cutter-arbor *C*, being separated by washers as shown. These cutters are fed directly in toward the bottom of the case and face the five bearings in one operation. The caps are fastened on before the crank-case is placed in the fixture.

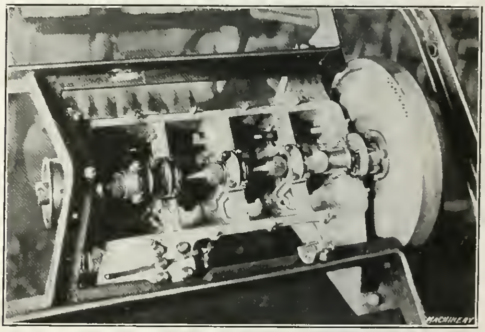

Fig. 14. Rotating Trunnion Stand used in Assembling Engine Parts

Machining Flywheels

The flywheels used on the Overland engines are machined complete in one setting, with the exception of facing the lower hub, on Bullard vertical turret lathes. Fig. 12 shows one of these machines at work on a flywheel, which is held by the hub in the chuck of the machine. The tools held in the side head are used for rough- and finish-turning the rim and bevel face, whereas the other three tool-heads held in the turret carry turning tools for rough- and finish-facing the top of the flange, inside face of the flange, and hub. The boring-tool is used for roughing out the bore, which is finished to the exact size by the reamer, also held in the turret. As the side head and cross-rail head are operated independently of each other, it is possible in this machine to be working on the circumference and face of the work at the same time, which naturally increases the production to a marked extent over that of a machine which is adapted for performing only one operation at a time.

Threading Speed Rods

The threads on speed rods are cut in a Geometric threading machine as shown in Fig. 13. These rods are 7/16 inch in diameter and are threaded for 1⅜ inch, with a 14 pitch thread. No previous machining operations are accomplished on these rods, the thread being cut on the rough bar. In action, the rod is placed in the vise by the operator and set to the desired length by the swinging stop shown. The machine, which has been set to trip at the proper moment—when the thread has been cut for the proper distance—then works automatically, the chaser dies opening to allow the rod to be removed without backing out. The operator then draws the carriage back, removes the work from the vise, and repeats the order of operations on the succeeding rods. The thread produced is clean and accurate in every respect, and what is more interesting, is produced at the rate of ninety threads per hour.

Engine Assembling Stand

A stand built on the trunnion principle as shown in Fig. 14, is used for holding the engine while assembling the various members. The engine is held to this stand in the same manner as when in place in the car, being fastened to the frame by three-point support holes. The top portion of the frame to which the engine is attached can be swung around to any desired position, enabling the assembler to get at any part of the engine easily. The rapidity with which an engine can be assembled when held in this manner is really remarkable.

* * *

MACHINING GASOLINE ENGINE GOVERNOR VALVES

BY JOHN F. WINCHESTER

One of the interesting pastimes of a machinist or toolmaker is to figure out the best and most economical method of doing a certain piece of work. In many instances the mechanic receives instructions from the foreman as to how the necessary operations are to be performed, or he is governed by the jigs which have been designed for the work. But whether he is under the direction of a superior or allowed to use his own judgment in regard to the work, his object is to do an economical job. After the "cut" is started, the mechanic will recall former experiences with different equipment and wonder if he would not have been able to do the job more economically if part of the old equipment were at his disposal.

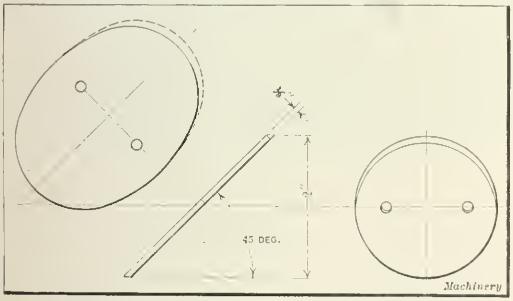

Fig. 1. Oval Butterfly Governor Valve for Gasoline Engine

We often see two shops doing the same work in totally different ways, although both may possess practically the same equipment. This is due to the reasoning done by the executive heads, each of whom would swear by his own particular method. The writer's attention was recently attracted by such a case where the job in question consisted of machining gasoline engine governor valves in small quantities. Entirely different methods were employed by the two firms.

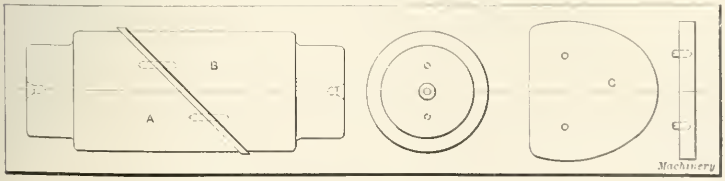

Fig. 2. Split Arbor for turning Valves in Lathe and Templet for filing

Fig. 1 shows the work to be machined, which was accomplished by the first firm as follows: The valve was first cut to a rough outline from ¼-inch sheet brass, and two screw holes were drilled. The work was then placed upon the arbor illustrated in Fig. 2 and turned to size, after which the corner indicated by dotted lines in Fig. 1 was hand filed to the templet *C*. The arbor was made of tool steel, split at an angle of 45 degrees. The two guide pins pass through the screw holes in the valve. These pins are a driving fit in *A* and a slip fit in *B*, the valve being held in position by them. It can be seen that placing this arbor between the centers of the lathe causes it and the work to be held together.

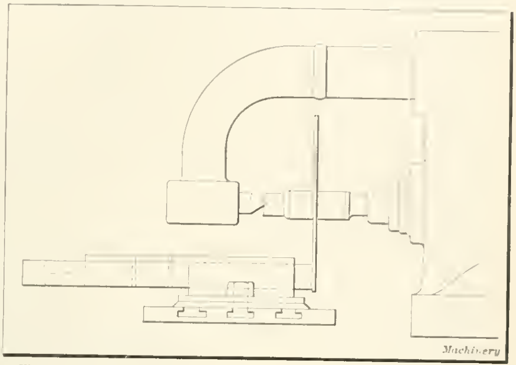

Fig. 3. Method of cutting Valves from Bar Stock in a Milling Machine

The second firm solved the problem in the following manner: A bar of brass stock of the proper diameter was sent to the milling department, where a machine was set up with a 1/16-inch saw and a universal vise turned to an angle of 45 degrees with the cutter. The bar was then clamped in place with the end projecting sufficiently to allow a number of pieces to be cut off before it was moved. With the aid of the dial index, it is obvious that these pieces could be cut off accurately and quite rapidly. After this operation they were drilled, then filed to the templet shown in Fig. 2. Fig. 3 shows the operation being performed.

An analysis of these two methods shows that the first one required a great deal of hand labor, a waste of sheet metal such as always takes place in a job of this kind, and a specially made arbor suitable only for this particular job. The time required for turning was no small item, as it is readily seen that the tool was "cutting wind" to a great extent to accomplish the desired result. In contrast, we find that the second method required no hand labor except to file the valve down to the templet and remove the burrs caused by the milling cutter; a very small amount of waste resulted, as compared with the first method and no investment was needed for special tools, as the saw used to cut blanks from the bar could be used for any similar work on the milling machine.

* * *

An interesting use of polarized light to locate stresses in machine members was described in *Nature*, December 5. A pair of cut gear wheels, made of a nitro-cellulose compound similar to celluloid, were run together under load, while polarized light was transmitted through the rims and teeth in engagement. The condition of internal stress was marked by color fringes which appeared as black bands when photographed. The possibilities of this method of analyzing the stresses in models of machine members, building frames, bridges, etc., are apparently great. Many puzzling questions may be easily settled and new facts of much importance discovered regarding the distribution of internal stresses.

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PLANING OR MILLING—WHICH?

In the manufacture of special machinery, large numbers of cast-iron rails, each from twelve to sixteen feet long, were required to be milled on two faces at right angles to each other. One of these pieces is shown in detail in Fig. 1, and the machining of the two faces comprises the machine work on the piece. As these pieces are finished in large numbers, the question arose as to the most economical method of doing the work—by planing or milling. In either case the purchase of a machine was necessary, and if a milling machine was used the outlay for cutters would be considerable. After some consideration it was decided to plane the pieces, and a Cincinnati planer was installed, as shown in Fig. 2. This illustration also shows some of the pieces to be finished and gives a general idea of the way the work was handled. By referring to Fig. 3 in connection with Fig. 2, it will be seen that seven sets of special dogs were used with provision for holding eight of the rails. The cross-rail of the planer was provided with eight tool-holding heads, four of which were equipped with roughing tools and four with finishing tools. By mounting four rough rails at one side of the planer table and four rough-planed rails on the opposite side, it was possible to perform eight cutting operations, four of which were roughing and four finishing. After roughing four rails, they are moved over to the finishing side of the planer table and four castings are rough-planed again while the previous four rails are being finished. By using the type of dog shown, it is insured that the cuts will be at right angles to each other. Each of the tools is adjustable independently of the others on the cross-rail, and any tool may be removed for sharpening and replaced easily. With this equipment it is believed by the users that planing is more economical than milling for this particular job.

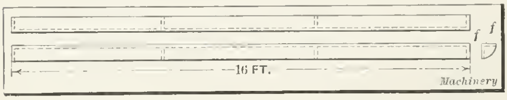


Fig. 1. One of the Pieces to be machined

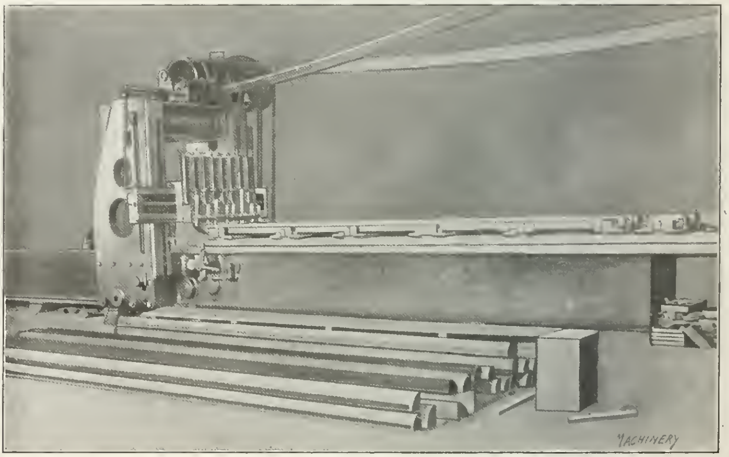


Fig. 2. The Planer and the Work

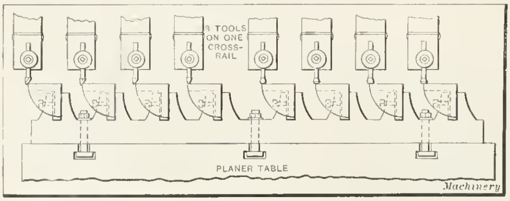


Fig. 3. How the Work was held and machined

C. L. L.

* * *

"GENERAL ELECTRIC REVERSING MOTOR DRIVE"—CORRECTION

The table of comparative tests of planers equipped with belt drive and direct-connected reversing motor drive which accompanied the description of the "General Electric Reversing Motor Drive" in the January number contained two errors, *viz:* The return speed in feet per minute in the twelfth column, fifth line from top, should be 59.3 instead of 599.3; and the cut in inches, sixth column last line should be 1/2 by 1/16 and 1 by 1/16 for the 72- by 22-inch reversing motor planer, the same as for the belt planer, same size just above.

AT THE AUTO SHOW—BOOSTING THE GAME

"No," said the oil salesman. "I never knock a competitor's goods—it isn't good policy. I believe in boosting the game even if the other fellow does make a sale right under my nose once in a while. I'd rather he made the sale than to have neither of us make one.

"Yes, I know you don't want any oil now, but I've been coming to the auto show ever since it started and I've seen a bunch of people. I remember a lot of them that come up here to see me every year. Last year perhaps they had no car, but now they have and they're interested in what I've got to sell 'em, but that's not what I was going to tell you about boosting the game.

"At one show several years ago, a fine-looking old gentleman came up to me and began to talk about oil. He had made up his mind to buy a certain make of car—the Squedunk we'll say—and wanted to use the best oil—that's my Slick oil. Well I told him what my oil is and why it would give him satisfaction. He said that he would want a barrel just as soon as he got the car.

"The next day he came again, but he wasn't looking happy. 'Bought the car yet?' I asked.

"'No,' he said, 'and I'm not going to buy one now.'

"'Why, I thought the sale was as good as clinched.' said I.

"'So it was, but it's all off now, and I'm thoroughly disgusted with auto salesmen, or rather one in particular.'

"Then he told me what the trouble was. He had made up his mind to buy a car of the same make as the one owned by a friend, and had seen the agent. The agent had invited him to come to the show and see the latest model. But the old gent got mixed on the name or location and went to see another car. The salesman got hold of him and finding out that he was going to buy the Squedunk car began to knock it for fair. The Squedunk car was the worst ever. Why you were likely to lose a wheel, break a spring or blow up the engine every time you took it out. Many unfortunate owners had been brought back to their sorrowing friends crushed and mangled beyond recognition just because they had insisted on buying Squedunk cars.

"Well, the old gent let the agent pump it into him until he concluded he didn't want any car and wouldn't take one as a gift. The result is that he has never bought one, although he's able to have a half-dozen and probably would have two or three now if that fool agent had boosted the game. My motto is, get trade and let the other fellow get some too, but that gink didn't see that he was spoiling business for everyone when he spun out that line of talk.

"So long! Have a circular, and remember Slick oil when you get the car. She sure will run some if you use that dope. Take it from me."

HARDENING SMALL NOVO STEEL MILLING CUTTERS

When it is impossible to grind a small milling cutter after hardening because of its irregular shape, "Novo" steel as a rule cannot be used. This is due to the high heat to which this steel must be brought before it will harden correctly; and as the sharp edges of the tool are generally burnt before the proper heat is obtained, it is evident that irregular shaped cutters cannot be successfully made from this brand of steel, when hardened by ordinary methods. This no doubt has been the experience of many mechanics who, knowing the good cutting qualities of this steel, have endeavored to make as many cutters as possible from it.

After having made numerous experiments in an endeavor to satisfactorily harden small form cutters made from "Novo Superior" steel, Mr. J. E. Lehman of the Universal Machine Tool Co., Canton, Ohio, has adopted a method which gives remarkably good results. After the cutters are finished and ready for hardening, they are packed in powdered charcoal in a wrought-iron pipe. The cutters are separated from each other and also from the wall of the pipe with a one-half inch layer of charcoal, and the same amount is placed upon the top of the work after it has been packed.

The pipe with the work packed in it is now placed in an ordinary forge fire and is heated slowly. When the pipe commences to show signs of fusing on the outside, it is removed from the fire and placed directly in fish or kerosene oil. The dipping must be done quickly to prevent the oil from catching fire. When cool, the pipe and its contents are removed from the bath and the work is taken out. If the heating has been carried on slowly and in the manner described, it will be found that the work is glass-hard, free from scale and just as sharp as it was before being put in the fire.

A similar experiment was tried with Stubs steel. First, a piece of steel was cut off the bar and hardened carefully in an open fire. It was then dipped in oil, and when cool was gripped between the jaws of a bench vise and given a blow with a hammer. As was expected, it broke without bending. Another piece of steel from the same rod was packed in charcoal in the manner previously described, then heated slowly and quenched in oil. The heat, however, in this case was not as high as that used for "Novo" steel, the pipe only being brought to a "bright yellow heat." The piece of steel thus hardened was gripped between the jaws of the bench vise and an attempt made to break it with an ordinary machinist's hammer. Several sharp blows were required to break this piece, and it bent considerably before fracturing. This experiment proved that the steel hardened in this manner was not only harder, but was also much tougher than when heated carefully in an open fire.

Packing the work in powdered charcoal not only provides a more even heat, but it prevents the heated parts from coming in contact with the air when in the highly heated state. Scale on the work is thus prevented and furthermore it saves heating small pieces to a considerably higher heat, as the temperature is not reduced in transferring the parts from the fire to the cooling bath. D. T. H.

* * *

STANDARDS FOR HOSE COUPLINGS

Hose couplings for 2½, 3, 3½ and 4½-inch sizes have been standardized and adopted by the American Waterworks Association, The New England Waterworks Association, the National Firemen's Association, the National Fire Protection Association, etc., and up to January 1, 1910, more than two hundred towns and cities in the United States had also adopted this standard, details of which have been published in MACHINERY'S Data Sheet Book No. 1, "Screw Threads." For sizes under 2½ inches, however, there is no universal standard; there are at least six different so-called "standards" used, known as follows:

Eastern gage hose thread (used in the New England States); Pacific Coast hose thread, known also as the California standard hose thread (used on the Pacific Coast); Chicago hose thread (used in the Middle West); Pittsburg hose thread; Boston hose thread; and the iron pipe thread, which is the general standard for pipe threads.

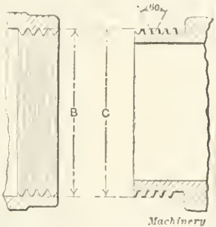
Table I, prepared by the aid of a table furnished by the Elkhart Brass Mfg. Co., Elkhart, Ind., gives a comparison of the dimensions of the outside diameter and the number of threads in the various sizes. Tables II and III give complete dimensions for the California standard hose and Chicago hose thread, as furnished by the Crane Co. of Chicago. In addition to these "standards," there is a great diversity of 2½-inch threads used by the fire departments of various cities. As regards the standards, there is no absolute agreement as to the dimensions, so that it is possible that some manufacturers deviate slightly from those given in the tables. It will be seen, for example, that the number of threads per inch as given in Table I for 1-inch Pacific Coast or California hose thread differs from the number given for the same thread in Table II. The only actual standard is that of the iron pipe thread, which, of course, is extensively used in all parts of the country.

TABLE I. COMPARISON OF HOSE COUPLING THREADS

Nominal Size	Eastern Hose Thread		Pacific Coast Hose Thread		Pittsburg Hose Thread		Boston Hose Thread		National Std. Hose Thread		Iron Pipe Thread	
	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch	Outside Diam.	No. of Threads per Inch
¾	1 1/16	11	1 1/16	11	1 3/16	11	1 1/16	11	....	....	1.050	14
1	1 5/16	11½	1 5/16	11	....	....	1 15/32	11	....	....	1.315	11½
1¼	1 23/32	11½	1 55/64	11	....	....	....	....	....	....	1.660	11½
1½	1 31/32	11	2 9/64	11	....	....	....	....	....	....	1.900	11½
2	2 35/64	8	2 17/32	10	....	....	....	....	....	....	2.375	11½
2½	3 1/32	7	3	7	....	....	....	....	3 1/16	7½	2.875	8
3	....	....	....	....	....	....	....	....	3 5/8	6	3.500	8
3½	....	....	....	....	....	....	....	....	4¼	6	4.000	8
4½	....	....	....	....	....	....	....	....	5¾	4	5.000	8

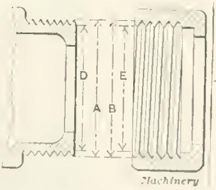
Machinery

TABLE II. CALIFORNIA STANDARD HOSE COUPLING THREAD



Nominal Size	B	C	No. of Threads per Inch	Clearance between Male and Female Thread
¾	1.080	1.070	11	0.010
1	1.320	1.310	11	0.010
1¼	1.860	1.850	11	0.010
1½	2.120	2.110	11	0.010
2	2.560	2.550	10	0.010
2½	3.050	3.040	7½	0.010

TABLE III. CHICAGO STANDARD HOSE COUPLING THREAD



Nominal Size	A	B	D	E	No. of Threads per Inch
¾	1.081	1.099	0.931	0.949	11½
1	1.295	1.315	1.145	1.165	11½
1¼	1.705	1.723	1.580	1.598	11½
1½	1.946	1.964	1.796	1.814	11½
2	2.522	2.542	2.306	2.326	8
2½	3.043	3.047	2.812	2.816	7

* * *

The 800,000-pound capacity Riehle testing machine of the Fritz engineering laboratory, Lehigh University, is being utilized for the testing of rails by the rail committee of the American Railway Engineering Association. These tests are expected to aid materially in the effort to reduce the number of defective rails. M. H. Wickhorst of Chicago, engineer of tests of the association's rail committee, is in charge of the work and is being assisted by members of the several engineering departments of the university. The present phase of the research is that of investigating the rate of reduction of the cross-section of rails in rolling from the ingot to the finished rail. One hundred pieces of 100-pound American Railway Association section, each two feet long, are being used.

DANGERS OF CONCRETE CONSTRUCTION

The falling of a concrete stairway at the Nostrand Avenue station of the Long Island R. R. in Brooklyn which caused the death of a man, has called wide-spread attention to the danger of imperfect concrete construction. The general and growing use of concrete in the construction of factories, warehouses, office buildings, bridges, tunnels, culverts and a thousand other structures, makes the possible hidden defects of concrete a serious menace to the safety of life and property. It is a great pity that so useful a building material—one that can be readily molded to any form—should be so dependent on the honesty of contractors for its integrity. The opportunities for saving a large percentage of the cost of a job by the use of poor cement and little of it and the chances of detection are so small, unless the work is rigidly watched and inspected at every step, that the conscience of the many builders succumbs to the temptation. But the use of inferior materials and improper proportions is only one of the ways of scamping concrete construction. The time element is important also, and in any cases not sufficient time is given for the concrete to set before the forms are struck. Another serious defect found in some examples of reinforced concrete is the improper placing of the reinforcing rods. A steel reinforcement not properly placed may be worse than useless. It is too much to expect that ignorant laborers will place the reinforcement where it will act to the best advantage unless directed by competent overseers. Static loads are most favorable; vibratory loads test the quality of concrete as perhaps nothing else. Structures affected by the action of printing presses or other reciprocating machinery are likely to speedily deteriorate unless designed by experts and built of the best materials, properly mixed, skilfully placed, and firmly set before the forms are removed.

* * *

The habit of care is the best accident policy.

WELFARE WORK AT THE UTICA DROP-FORGE & TOOL CO.'S SHOP

The officials of the Utica Drop Forge & Tool Co., Utica, N. Y., have taken much pride in equipping their factory to make the working conditions the best possible for the employes. In many factories, grinding and polishing is a disagreeable and unhealthy operation, but by means of a complete and effective exhaust system in this plant, the polishing room has been put on a par with the other departments, as regards freedom from dust. The work is grinding and polishing pliers of all kinds, and a great deal of belt polishing is therefore necessary. As the illustration Fig. 1 shows, the belts and wheels are all enclosed and large size exhaust pipes draw away the dirt and dust from each wheel. Air required for the exhaust system is moved by a 30 H. P. Buffalo blower. The effect of the equipment is to make the polishing department a comparatively clean and sanitary part of the shop, and the workmen, far from being continually grimy, are, as a class, a remarkably clean and healthy looking lot of men.

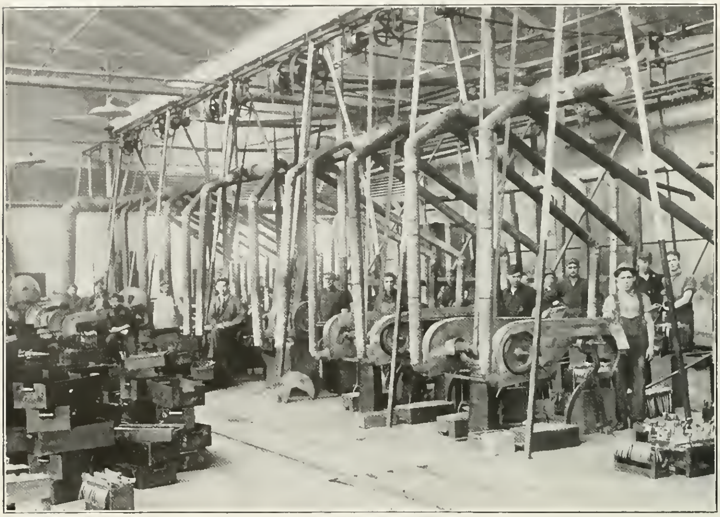


Fig. 1. A Dustless Grinding Room

For the convenience of the men in the drop-forging department, shower baths have been installed, each man being provided with an individual wash tray and shower bath. At the end of a hard day's work the men can clean up thoroughly before leaving the factory, being thus provided with conveniences which some perhaps do not have at home. In addition to the shower baths, a large wash-room is provided in which the 150 factory employes are provided with individual porcelain wash trays. Hot as well as cold water is available.

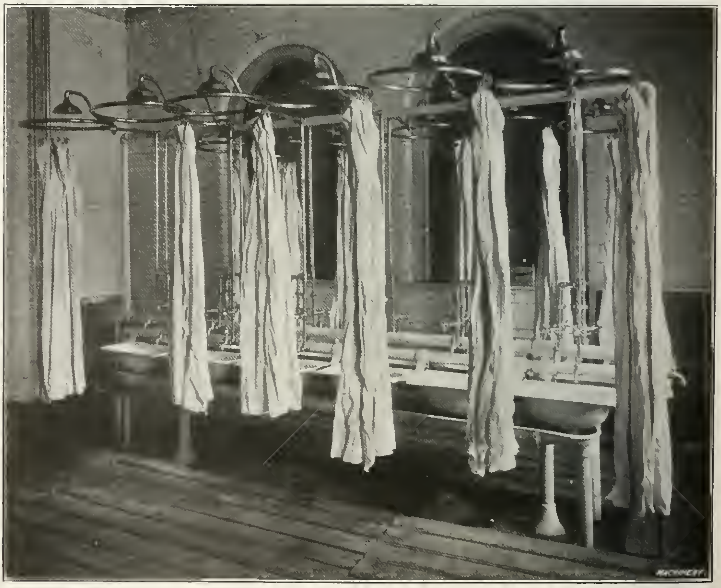


Fig. 2. Shower Baths for Employes in Drop-forging Department

Perhaps the most noteworthy example of welfare work is the special clubhouse building which was erected through the efforts of H. F. Kelleman, general manager. This two-story building is fitted with a bowling alley, rifle range, and game rooms on the first floor, and on the second floor, shown in

Fig. 3, a combined hall and gymnasium has been fitted up. In one corner of the hall is a pool table of standard make, and at the opposite end is a stage and piano. Entertainments given by the Mutual Benefit Association of the company are held in the hall from time to time, and at frequent intervals through the winter dances and gymnastic exhibitions are given. At all times outside of working hours, the building is open for the exclusive use of the employes, and they avail themselves of the opportunity every evening.

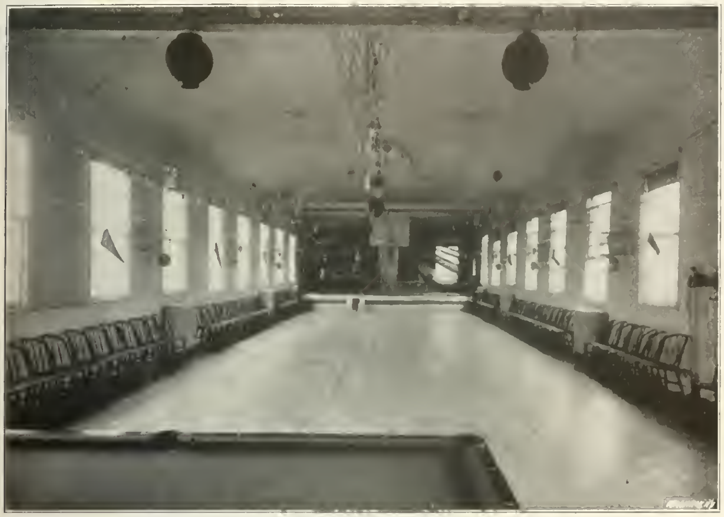


Fig. 3. The Recreation Hall in the Club-house

By means of welfare work of this kind, a spirit of factory pride is inculcated in the employes, which, coupled with the good working conditions afforded, enables the shop to attract and retain good workmen. C. L. L.

* * *

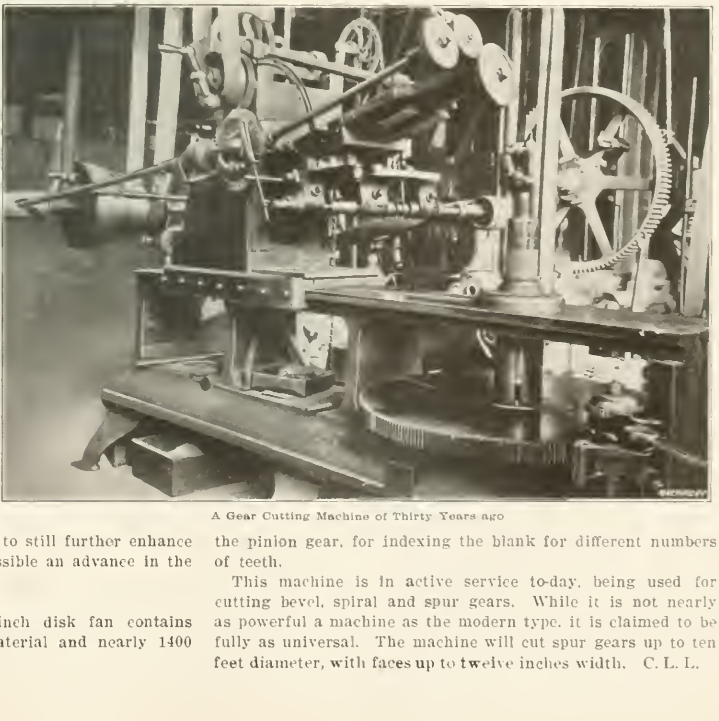
The file manufacturers of Sheffield, England, have displayed marked activity and enterprise in producing files of high efficiency, tested by means of recently developed methods for file testing. To an increasing extent users of files are now buying these tools on the basis of the amount of work they will do under given mechanical tests, instead of merely accepting the lowest tender. It is reported that at tests made by the Sheffield Testing Works, Ltd., a new type of fourteen-inch high-speed file, recently placed on the market by Messrs. Lockwood Bros., Ltd., of Sheffield, tested on both sides, made 120,000 strokes and in 39 hours removed 78.8 cubic inches of metal, weighing 22 pounds from a bar 1 inch square. At the conclusion of this severe test, the tool is reported to have been "slightly worn." The British Admiralty requires that files bought for naval use should make 20,000 strokes when tested and remove 6 cubic inches of material from a test bar 1 inch square. Recent improvements proposed both in Germany and England on file testing machines will be likely to still further enhance the value of these tests, and make possible an advance in the development of better files.

* * *

It is stated that an ordinary 16-inch disk fan contains more than 750 separate pieces of material and nearly 1400 feet of wire.

AN OLD GEAR CUTTING MACHINE

At the shops of the Rice, Barton & Fales Co., Worcester, Mass., there is an old gear-cutting machine which serves as a reminder of the progress which has been made in modern gear-cutting machinery. This machine was built by Lucius W. Pond of Worcester in 1872 and, as the illustration shows, was provided with a central work-spindle which held the gear blank in a horizontal plane. In referring to the illustration, the more modern gear-cutting machine in the background should not be confused with the old machine in the foreground. The machine is shown in position for cutting a bevel gear, the cutter spindle being mounted upon a hinged bracket so that angular cuts may be taken. When working on spur gears, the hinged bracket is elevated, of course, to an upright position, in contact with the head of the machine. The cutter-slide feed is operated by means of bevel gearing from the driving shaft, which may be seen toward the left of the illustration. By this means, motion is transmitted to the train of gears upon the end of the bracket on which the cutter-slide acts, which provides means for varying the rate of traverse of the cutter. Rotation of the cutter is effected by means of a pulley on the right-hand end of the cutter-spindle. While the machine is automatic in its cutting action, the gear blank must be indexed by hand. The indexing mechanism is shown in the lower right-hand corner of the illustration and consists of a large index gear having 240 teeth, and a pinion having 20 teeth which meshes with it. Thus it requires twelve revolutions of the pinion to carry the index wheel once around. The machine is supplied with several ratchets having different numbers of teeth which may be put onto the same stud as the pinion gear, for indexing the blank for different numbers of teeth.



A Gear Cutting Machine of Thirty Years ago

This machine is in active service to-day, being used for cutting bevel, spiral and spur gears. While it is not nearly as powerful a machine as the modern type, it is claimed to be fully as universal. The machine will cut spur gears up to ten feet diameter, with faces up to twelve inches width. C. L. L.

GETTING A RAISE

BY ROUNDERS

It has been estimated that there are twenty-seven million people in this great and glorious United States who hope to have their rates of pay raised during the coming year. It has been further estimated that they will not all get it. For years the magazines have been printing advice as to how to accomplish this very desirable result, and the great majority of it is good advice. It seems that a little supplementary advice about "what not to do in order to get a raise" might not come amiss. It is funny what a difference your position makes on how you look at things. For many years I worked zealously for raises and was of the opinion that a liberal policy of rewarding young men was very profitable. Then I got a job that depended on my keeping a payroll as small as possible and I at once decided that there was nothing in this raise idea anyhow. You see I was taken from the ranks and made a sort of straw boss, and the men that wanted a raise were told that this was up to me. Privately, I was told that no raises would be considered unless a corresponding saving could be made somewhere else, and that it was up to me to keep the force contented on what they were getting. Later on this policy was amended, and it was allowed that there might be occasions where a raise could slip through but that they would be mighty few and far between. In effect, I found that I had to either stand off my men or else go in to the big boss and beg for the raise. In place of simply working for my own raises, as I had done in other years, I was now obliged to be scheming all the time to get a little increase for such of the force as deserved it. I had no sooner gotten settled in my new job than I found that all my former associates were looking to me to get for them that increase that they felt they so richly deserved. One after another they buttonholed me, and I got so that I could tell for weeks ahead when some fellow or girl was working up courage to strike me. Some of them got what they were looking for and some did not. What I started to tell about was the time John Zeigler opened up his negotiation.

John was an old German draftsman and quite an "institution." He had been with the concern for many years, most of this time being taken up with asking his boss for an increase in salary. There had been several dozen bosses in this time, and none of them having John's experience some were bound to fall, so that the old fellow was getting the top notch figure that the concern would allow for the grade of position that he occupied. Being new to the job I was not fully posted as to salaries, although I knew in a general way that the old man was getting pretty close to the limit. Therefore, when he came to me with his tale of woe, I did not at once recollect what he was getting and I asked him casually, "What is your rate now, John?" He looked at me for a bit and then said, "Certainly you ought to know that."

He was right and I knew it. I should have known but I did not and in place of saying so and looking it up I said, "You are getting 'steen dollars a week are you not?" naming the highest figure that I thought was paid in the room. Now I missed it by five dollars a week, the old man getting that much more than I thought. In place of putting me straight, the old rascal assented and at once began to beg me to put through an increase card for five dollars more. Liars are never able to control their eyes, and there was something about the old fellow's manner that made me suspicious, so that I told him that I thought that perhaps I could get him a little increase but that I would have to see what the big boss thought about it. He thanked me and as soon as he had left I made a bee-line for the treasurer's office to see his rate and experience card myself. I found that he had deceived me, and after waiting a few days, I called him over and told him that I had gotten him a five dollar increase and that thereafter he would get 'steen dollars a week, naming the exact rate that he was then getting but five dollars more than he had led me to suppose. The old rapscallion thought that I had probably put through one of our regular cards authorizing the treasurer to jump him up five dollars more, that I would probably not discover that he had fooled me for some time and that I would then grin and bear the increase, the joke being on me.

I am satisfied that he fully expected to get five dollars more in his pay envelope and I watched him carefully as he opened it. He took it over to his table and ruminated on it a little. Finally he came over and asked me if he would get that raise the next week. I pretended great surprise. "Why, John," I said, "how much did you get? Let's see your envelope." The amount being written on the outside of the envelopes, it was an easy matter for me to check it up. He rather shamefacedly handed me the envelope and after I read the amount I handed it back to him with the remark. "That's right. That is the sum I told you you would get." The old fellow looked at me for awhile and then went back to his table and thought it over for a long time. This getting a five-dollar raise and still having no more in his pay envelope was a hard nut for him to crack, and I could see him wrestling with it. He finally gave it up as a bad job and I had no more trouble with him for some months. Neither of us ever admitted that we knew all about the reasons that lay back of this strange fact, and I do not know whether the old fellow ever appreciated the whole incident or not.

The funny part of the whole deal was that soon after I left the job he worked a very similar trick on my successor who after a long time confided it to me. I have often wondered since at the very opposite views taken of the incident by different people. The average employe thinks that his boss is wronging him by not promptly increasing his wages while, as a matter of fact, the chances are that this same boss is in a position where he cannot give such an increase and hold down his own job. I think those companies are happiest where the raise question is worked out logically, and a good man can count on a small yearly increase for a term of years. I also think that this increase should come naturally, and not depend on the solicitation of the man. Some fellows have a faculty of getting such increases while others, fully as valuable, are not good salesmen and go for long periods without getting what is coming to them.

* * *

WANTED, A HYDRAULIC ENGINEER

BY A. P. PRESS

One day we were sitting in the office after the rush of the day's work was over, when in came a long, gawky country boy, whose arms had a tendency to extend out of his sleeves, and whose pants did not grow as fast as his legs did.

"Say, Mister, is this where they fix things?"

"Why, yes, sometimes."

"Well, I've got something outside, and it wants fixing."

"What is it?"

"It's a water motor, but it don't mote."

Stepping outside the door, sure enough, there he had a good sized water motor, of a well known make and apparently new. It was about a two or three horsepower, with the usual pulley on one side, and the regular openings for the inlet and discharge of the water.

"Well, what's the trouble?"

"Why, I don't know. I sent and got that off the S. R. Co. and paid $36 for it, but when I took it home and put it down in the well it wouldn't go any."

"Put it down in the well! What in the world did you put it down there for?"

"Well, the circular says it should be at least twenty feet of water back of it, and the well is over thirty feet deep. I thought that ought to work pretty good."

"Yes, but don't you understand there is no power in still water?"

"Yes, Mister; but the book says I get a pound of pressure for every twenty-eight inches, only I don't just understand what that means."

To make a long story short we labored with the lad for an hour, and finally succeeded in demonstrating to him that the motor must be placed under a head of running water in order to develop any power, and then finally helped him out by giving him a small steam engine and boiler, and allowing him a fair price for his motor.

We have often seen a lack of mechanical knowledge, but never to a greater extent than in the case described.

PUNCH AND DIE MADE IN SECTIONS

BY A. L. MONRAD*

Among the interesting problems of tool design which the writer has dealt with, was a punch and die for producing the type bar plates for linotype machines, illustrated in Fig. 1. These plates have one hundred rectangular holes 0.060 by 0.360 inch in size; the bar is 0.03 inch thick. One of these plates is attached to the under side of each linotype machine for holding the end springs which return the type bars after the keys are struck by the operator. It is necessary to have these type bar plates made with considerable accuracy; the holes must be of the size specified, there must be the proper space between them, and their sides must be parallel and perpendicular, respectively, with the edges of the plate. Evidently these conditions would make it very difficult, if not impossible, to produce plates of this type with a single punch and die and some suitable form of spacing mechanism.

Several attempts were made to produce a punch and die for this purpose before a successful device was hit upon. In the first case, the punch and die appeared to be satisfactory after it was finished, but had only run a few days when one of the bridges caved in to such an extent that attempts to repair it were unsuccessful. The second punch and die was of similar design to the first, except that special means were taken to strengthen its construction. When this die was inspected after hardening, however, it was found that two of the bridges were cracked in the corners. It was then decided to make a sectional form of punch and die which would enable individual parts to be replaced when broken or worn in service, without necessitating the construction of an entirely new tool. The die section adopted for this purpose is indicated at *B* in Fig. 3. It will be seen that two 5/16-inch holes are drilled and reamed through these sections, pieces of drill rod being used to hold the sections together in a 30-degree bolster; the sections were wedged in this bolster by means of a suitable gib and set-screws. This die also proved a failure because no provision had been made for guide posts or pilots. The result of this omission caused the die to shift while in service, so that the punches were stripped to such an extent that they became absolutely useless. The difficulties met with in early forms of dies for producing these type bar plates are mentioned in order that the same trouble may be avoided by other shops that are called upon to produce punches and dies of this type for similar classes of work.

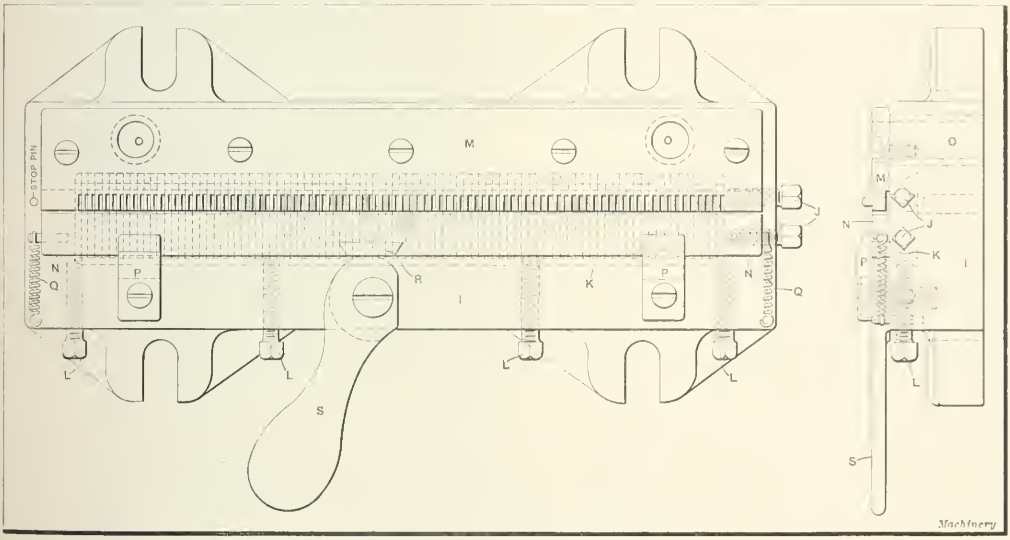


Fig. 1. Plan and End Elevation of Die made made in Sections

Fig. 1 represents the form of sectional die which was finally developed for this operation. All parts of this device which are likely to be worn or damaged in operation are made interchangeable, duplicate parts being kept in stock so that they can be placed in service when required. The die pieces are machined to the required dimensions, allowing 0.005 inch for grinding and lapping. One of the die sections *C* is shown in Fig. 3, and in machining these parts, in order that the slot will be the same distance from the inclined sides of the bolster, the milling fixture—also illustrated in Fig. 3—was designed for producing them. The cast-iron block of this fixture is held in an ordinary milling machine vise and the pins *E* and *F* are so placed that the blank for the die sections will be held at an angle of 60 degrees. The strap *G* holds the work in position while milling; all of the pieces are first milled at one end to an angle of 30 degrees, after which they are turned over in the fixture to have their opposite ends milled in a similar manner. Before starting the section milling operation, the machine is set to produce pieces of the required length, and it will be evident that this method of production insures having all the die sections of exactly the same size. The same fixture is used for milling the slot in the die section; for this purpose the fixture is swung around 30 degrees and a cutter 0.360 inch wide is used, the slot being cut 0.060 inch deep. The three sides of the slot are now relieved with a file and after being hardened and drawn at a light straw color, the sections are ground on both sides so that the section through the slot will just enter the 0.060 inch space in the gage *H*, and the thicker section will enter the 0.120 inch space. The bottom and angles are not ground, but the top of all the sections are ground when they are assembled in the cast-iron bolster *I*, Fig. 1. Two set-screws *J* are provided to take care of the end thrust on the die sections. The length of the die is 9 inches, but if it is found that this dimension is slightly exceeded, it is an easy matter to lap the sections off on the sides to reduce it the required amount.

The cast-iron bolster is held securely to the press bed by means of four ⅝-inch hexagon screws. The gib *K* runs through the entire length of the die bolster and is held against the die sections by four set-screws *L*. On top of the bolster, there are two soft iron plates *M* and *N*. The plate *M* is held in position by five fillister screws and acts as a stop wall for the work to rest against in the die. This plate has slots milled along its edge which correspond with the die section, only they are a few thousandths larger than the punches; the plate *M* acts as the stripper for the punch. The plate *N* slides back and forth on the bolster under the strap *P*, its movement being controlled by the cam and lever *S*. The hardened wedge *R* is driven into the middle of the plate for the cam *S* to rest against and when the cam is swung around to bring the flat section into engagement, the springs *Q* at each end of the die pull the plate *N* back so that sufficient space is made to lift the finished work out of the die.

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* Address: Rockfall, Conn.

There are two ¾-inch holes *O* provided in the bolster to receive the pilots *B* of the punch-holder, Fig. 2; these holes have hardened bushings driven into them which can be replaced when they become worn to an objectionable extent. The punch sections are held in a machinery steel holder *A* shown in Fig. 2. This holder is finished all over, great care being taken to secure the necessary alignment. The guide pins *B* are hardened, ground and lapped to exact dimensions and the same gage *H* that was used for measuring the die sections is also used in determining the accuracy of the punch sections. These punch sections are secured to the holder by fillister screws *E*, a single screw being used between two sections in the manner shown in the illustration. The clamp *F* runs the entire length of the holder and is held in position by the fillister screws *G;* this clamp member holds the clamp securely in position. Two set-screws *H* are provided to take up any end thrust in the punch sections.

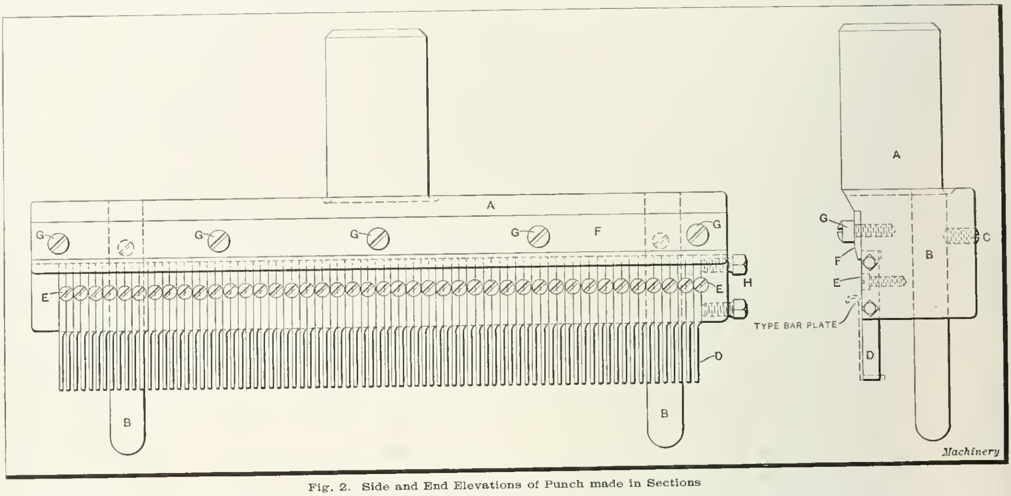

Fig. 2. Side and End Elevations of Punch made in Sections

It may appear that this punch and die is rather elaborate, but this design seemed to be the only means of producing a device that could be maintained in working condition, and as a matter of fact, the working parts are relatively simple, and were not as expensive to make as it might appear. The forming of the type bar plates *A* is done in two operations. The stock is rolled on a spool and held in the proper position to be received by a powerful trimming press. In the first operation, the stock is cut off and formed to the right angle; the downward stroke of a roller at the back of the die then curves the other edge of the plate upward to form a quarter segment. The second operation is made separately in a clamping die and forms the plate to the required shape.

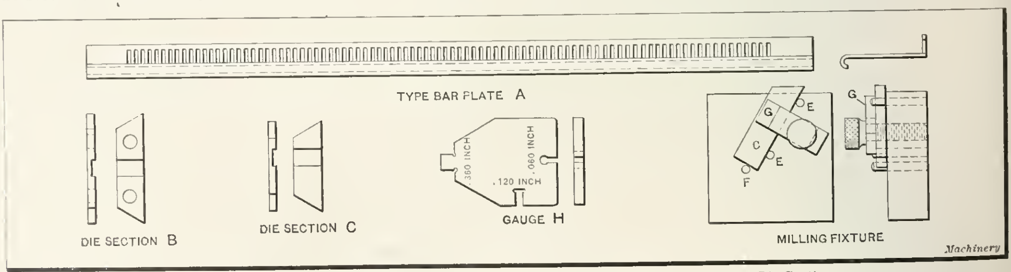

Fig. 3. Type Bar Plate A, Die Sections B and C, Gage H, and Milling Fixture for making Die Sections

* * *

The shipbuilding tonnage during 1912 for the United Kingdom is the greatest on record, the total output being more than 2,125,000 tons.

WHEELS FOR TRUCKS IN MANUFACTURING PLANTS

Metal tired truck wheels are generally used in manufacturing plants, notwithstanding the increased wear of floors as compared with that incident to the use of soft tire wheels. The president of the Aberthaw Construction Co., Boston, Mass., who has investigated many features of factory management, states that the preference is due particularly to the greater resistance of soft tire wheels as compared with metal tire wheels. There is again, the trouble of keeping soft tire wheels in proper condition as well as the expense. The fact is pointed out that there are wheels made with fiber tires, wheels made with sheets of fiber bolted together, and wooden wheels made in various forms. A wheel of hard wood cut into sectors with the sections breaking joints, makes an entirely satisfactory wheel for heavy loads, and one that is particularly good under wet conditions. Trucks equipped with fiber or wood wheels operate as easily as trucks with metal wheels and are much easier on the floors. This is an important consideration in all manufacturing plants where large amounts of material are moved from station to station on trucks.

* * *

The popularity of the American automobile is evidenced by the fact that the exports of automobiles and parts thereof, including tires, approximates $30,000,000 in 1912, against $22,000,000 in 1911, $15,000,000 in 1910, and $9,000,000 in 1909. A striking fact shown by the automobile figures is the marked decline in the price at which the machines are exported. In 1907 the average export price was nearly $1800 per machine; in 1909, $1470; in 1911 about $1000; and in 1912, a little less than $1000 each, the average export price at the present time being thus but little more than one-half that of 1907. The automobiles exported are sold chiefly in British territory. Of the 21,707 machines exported in the eleven months ending November 6, 864 went to Canada, 4371 to the United Kingdom, and 3112 to British Oceania.

TURNING AND FORMING CLUSTER GEARS

BY HENRY M. WOOD*

The accompanying illustrations show the lathe work in turning and forming cluster gears in the shops of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Fig. 1 shows a 24-inch patent head lathe equipped with multiple stops for length and cross feeds, connected compound and plain rests, pan, pump, and tubing, performing this operation. As the multiple stops and connected compound and plain rests have previously been described in detail in MACHINERY, it is unnecessary to enter into a further description here. The blank stock before being delivered to the lathe is bored and counterbored as indicated in Fig. 2. The broken lines indicate the size of the blank when it is first delivered to the lathe, *i. e.*, a straight bar 5 3/8 inches in diameter by 7 3/16 inches long. The solid lines show the finished dimensions except that the gear teeth, which are cut in a subsequent operation, are not shown, the illustration being prepared merely to indicate the lathe work that is done. Fig. 3 is a plan view showing the tooling for this work.

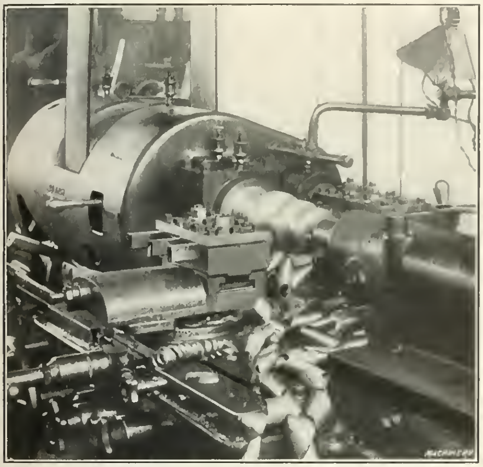

Fig. 1. Lodge & Shipley Patent Head Lathe turning and forming Blanks for Cluster Gears

A special arbor is used for carrying the blank. This arbor has a shoulder at the head end of the lathe to correspond to the counterbored part of the gear blank. There is a key in the arbor to act as the driver. The blank is slipped onto the arbor and forced up against this shoulder. This always insures that each blank placed in the lathe will take the same longitudinal position as all of the others, and therefore the shoulder positions for all gears, as determined by the automatic length feed stops, will come out exactly the same. A portion of the work is done by wide forming tools, and, as seen in Fig. 1, two heavy forming cuts are taken at the same time. This produces more pressure against the work than could safely be supported by the tailstock center. Therefore, the tailstock center is removed, a bronze bushing placed inside the tailstock spindle, and the free end of the arbor made a nice running fit in this bushing. Before turning operations are commenced, the tailstock spindle is run out so that the bushing solidly supports the end of the arbor.

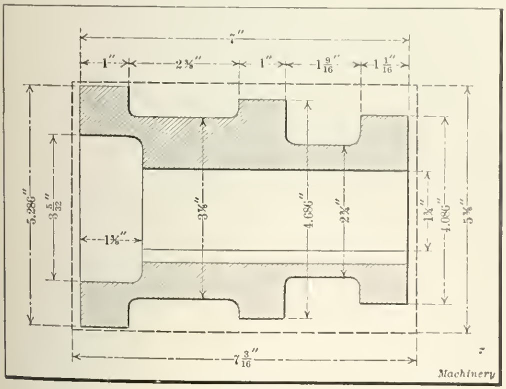

Fig. 2. One of the Blanks bored and counterbored ready for the Lathe Operation

First Operation. The outside diameters of the gears are first roughed by the three turning tools carried in a gang in a special holder held in the compound rest at the front. The cross-feed slide is fed in until the proper point is reached, as determined by the cross-feed stop which has previously been set to give a roughing cut 1/32 inch over size. The power feed is engaged and the three tools continue in action until each has fed across the face of the gear it is turning; at that point the length feed stop trips.

Second Operation. The operator leaves the carriage in the position thus determined by the length feed stop and draws the cross-slide forward, which brings the rear tools into action. The rear tools are also arranged in a gang, and consist of two facing tools for the ends of the blanks and two forming tools for cutting the spaces between the gears. At one operation the forming tools rough out and finish to the proper diameter; they also finish the faces and sides of the gears with the same movement of the cross-slide.

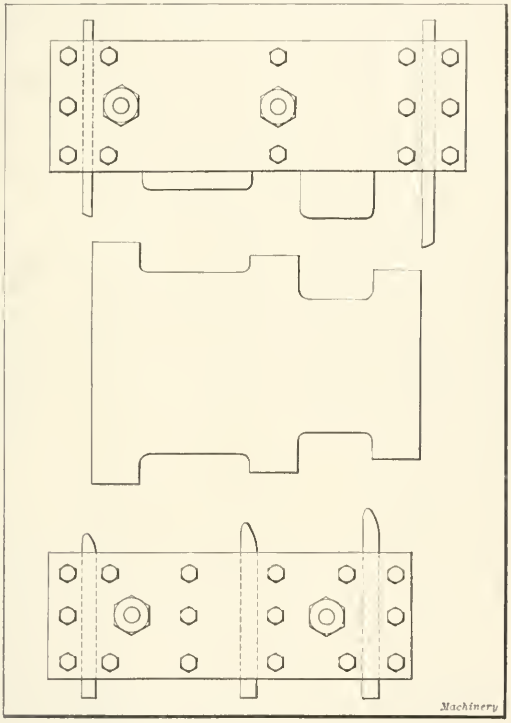

Fig. 3. Diagram showing Tooling for turning and forming Blanks for Cluster Gears

Third Operation. The carriage is returned to its original position. The diameter stop bar is changed to bring another stop into line and the cross-slide is again fed forward to this second stop which locates the three turning tools in the proper position to give the exact finished outside diameters of the three gears. One cut is then taken across the work and the job is done.

The material used for these blanks is chrome-nickel steel with about 0.25 carbon. The blank when delivered to the lathe weighs 38 pounds. The cluster gear after the lathe work is completed weighs 18¼ pounds. The machining time for the lathe work mentioned—including turning, forming and facing—is twelve minutes for one blank, exclusive of the time occupied in setting up or handling. This exceptional output is made possible by a combination of the power of the patent head lathe, the time saving features of the multiple stops and connected rests, and the special tooling for this particular job.

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* Address: Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

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TAP FLUTING CUTTERS

BY CORRESPONDENT

The question of the proper shape of flutes for taps to produce the best form of cutting edges or teeth, mentioned in an editorial in the January number of MACHINERY, has always been a difficult problem to toolmakers and tool manufacturers. Of all small machinists' tools, no one class presents so many interesting points and so many difficulties regarding the rake, chip rooms, etc., as do taps, and the opinions regarding the proper shape of flutes vary to a great extent. It is evident that taps used in different ways and for different purposes should have different forms of cutting edges, and that, in most cases, the same kind of tap should have differently formed cutting edges when cutting materials of different composition. It is, however, necessary for the tap manufacturer to make taps with cutting edges and flutes of such a shape as to satisfactorily tap as many different kinds of materials as possible with the same tool, because tap users, in general, cannot afford, nor can they be induced, to buy taps of the same size with differently shaped flutes for different materials. Hence, it is necessary to determine which form of fluting cutter will produce the best all-around results. In the following will be shown a type of fluting cutter which has been found to be far superior for all-around work to any that have previously been described.

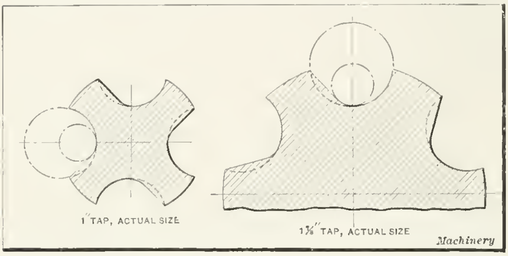


Fig. 1. Cross-section of Taps fluted with Proposed Type Fluting Cutter

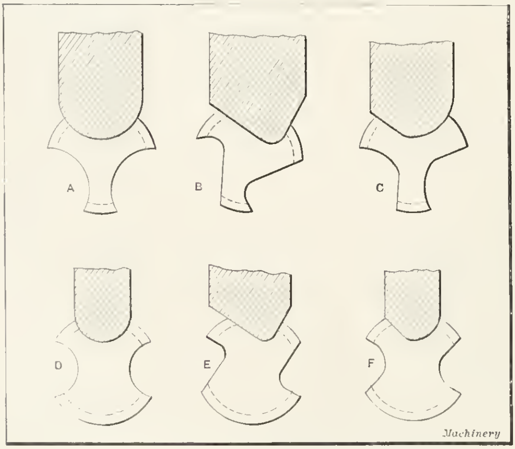


Fig. 2. Three-quarter inch Diameter Tap fluted with Three and Four Flutes using Different Style of Fluting Cutters—Actual Size

The most universally used cutter for fluting taps is undoubtedly the so-called convex fluting cutter, tables for which were given in MACHINERY, October, 1911. It has been generally accepted that when taps have to be backed out of a hole, the convex cutter is the best one to use for fluting them, because, on account of the form of the flute, the chips are not liable to get in between the teeth of the tap and the threads in the nut when backing out. A critical study, however, will lead to the conclusion that while the hook or undercut produced on the cutting edges of the tap by the convex-shaped fluting cutter is an advantage on taps for general all-around use, there is no reason for having this hook or undercut on the back side of the cutting land of the tap. When a tap is fluted by a convex fluting cutter, therefore, instead of by one that would give what might be termed a slight negative rake to the back side of the land, the tap is not only seriously weakened, but whenever it has to be backed out of a hole, as do hand taps, in many cases, and screw machine taps, in all cases, it is liable to cut and scrape the thread in the tapped hole on the return.

Cutters of the shape shown in the illustration in Table I, for taps from 1/16 to 4 inches in diameter, produce the same amount of undercut or hook on the cutting land of the taps as do the convex cutters, but the back of the cutting lands has a slight negative rake, smaller, however, than that produced by the regular old-style fluting cutter with an 85-degree included angle between the straight sides of the teeth, described in MACHINERY, June 1907. The shape of the cutter is such that all danger of chips getting in between the threads of the tap and the threads of the tapped nut, when the former is backed out, is practically eliminated. The strength of the tap has been increased without in any way sacrificing any of the advantages gained by the use of the convex fluting cutter. In the illustration accompanying Table II, two of the flutes have been shown as shaped with a regular convex cutter, while the others are laid out as cut by the proposed cutter. In Fig. 1 are shown 1- and 1-⅜-inch taps drawn accurately to scale—actual size. The dotted lines show the shape of the flute if cut by a regular convex cutter, showing clearly the advantages of the proposed type.

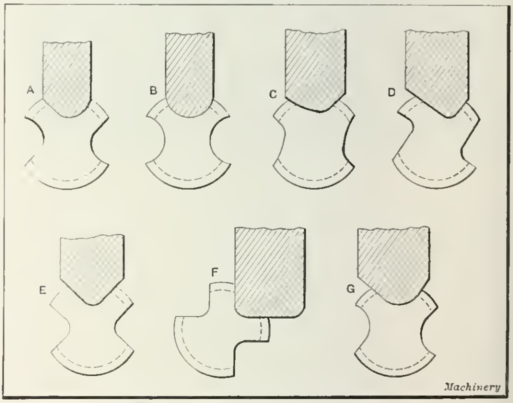


Fig. 3. Comparison of Methods and Cutters for Tap Fluting

The thickness of these cutters, as given in Table I, is the minimum thickness. They should preferably be slightly thicker than the figures given, the additional thickness being added on the angular side. The depth of the flute is governed by the rule that the width of the land at the top of the thread should be as nearly as possible equal to one-half of the width of the space, or, in other words, for four-fluted taps, the width of the land should be one-twelfth of the circumference of the tap, and for six-fluted taps, the width should be one-eighteenth of the circumference. The table of fluting cutters gives the outside diameter and the diameter of the hole in the cutter also, but these dimensions are, of course, optional and are given only as a guidance. In Figs. 2 and 3 are shown a comparison between the flutes produced with different kinds of fluting cutters, cutting three and four flutes in taps. At *A*, *B* and *C*, in Fig. 2, are shown taps with three flutes, and at *D*, *E* and *F*, are shown taps with four flutes. *A* and *D* show a regular convex fluting cutter for cutting the flutes; *B* and *E* show a double angle cutter—85 degrees included angle, 30 degrees on one side and 55 degrees on the other; *C* and *F* show the proposed style of fluting cutter. In Fig. 3 is shown a comparison between methods and types of cutters that are or could be used for fluting taps. At *A* is shown the new style cutter; at *B*, the regular convex cutter; at *C* and *D*, cutters of the shape shown in the Brown & Sharpe Mfg. Co.'s catalogue; at *E*, a double-angle cutter of 90 degrees included angle, 45 degrees on each side; at *F* is shown a regular side milling cutter used for fluting taps; and at *G*, the 85-degree included angle fluting cutter with a very large radius for the arc connecting the two straight sides.

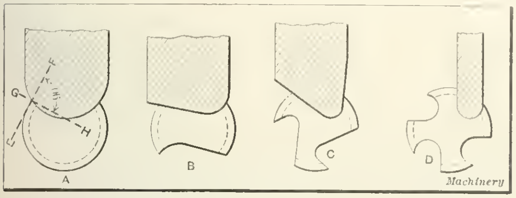
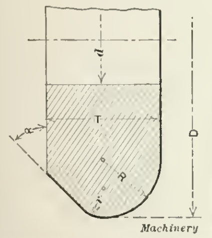


Fig. 4. Method of Fluting Taps for Copper and Similar Materials

In order to compare the differences between the flutes cut with a convex milling cutter and one cut by the new proposed style of fluting cutter, Table II has been made up, giving the thickness of the land *A* measured at the weakest part of the land, when cut with a convex cutter, and the thickness of the land *B* measured at exactly the same point, when the tap is fluted with a new-style cutter. It also gives the difference *C*, which is a measure of the increased strength in the tap produced by the new-style cutter. It is likely that cutters of the type described will eventually be generally used for tap manufacture and adopted by tap makers in general, as there is no doubt that this style of fluting cutter is superior to the cutters now generally employed.

TABLE I. DIMENSIONS OF TAP FLUTING CUTTERS



Number of Flutes, Angles and Diameters of Cutters

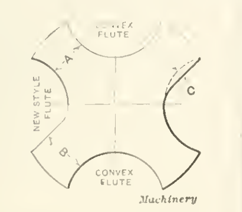
Size of Taps, Inches	No. of Flutes	Angle *a*, Degrees	Diam. of Cutter D	Diam. of Hole d
1/16 to 1/8	3	60	1 3/4	3/4
5/32 to 11/16	4	45	1 3/4	3/4
3/4 to 15/16	4	45	2 1/4	1
1 to 1 3/4	4	45	2 1/2	1
1 7/8 to 4	6	40	2 1/2	1

Diam. of Tap	Large Radius R	Small Radius r	Thickness T	Diam. of Tap	Large Radius R	Small Radius r	Thickness T
1/16	0.023	0.010	0.047	1 7/16	23/64	11/64	23/32
3/32	0.035	0.015	0.070	1 1/2	3/8	3/16	3/4
1/8	0.046	1/64	3/32	1 9/16	25/64	3/16	25/32
5/32	0.039	1/64	5/64	1 5/8	13/32	13/64	13/16
3/16	3/64	1/64	3/32	1 11/16	27/64	13/64	27/32
1/4	1/16	1/32	1/8	1 3/4	7/16	7/32	7/8
5/16	5/64	1/32	5/32	1 7/8	0.322	15/64	0.644
3/8	3/32	3/64	3/16	2	0.344	1/4	0.687
7/16	7/64	3/64	7/32	2 1/8	0.365	17/64	0.730
1/2	1/8	1/16	1/4	2 1/4	0.387	9/32	0.773
9/16	9/64	1/16	9/32	2 3/8	0.408	19/64	0.816
5/8	5/32	5/64	5/16	2 1/2	0.430	5/16	0.879
11/16	11/64	5/64	11/32	2 5/8	0.451	21/64	0.902
3/4	3/16	3/32	3/8	2 3/4	0.473	11/32	0.945
13/16	13/64	3/32	13/32	2 7/8	0.494	23/64	0.988
7/8	7/32	7/64	7/16	3	0.516	3/8	1.031
15/16	15/64	7/64	15/32	3 1/8	0.537	25/64	1.074
1	1/4	1/8	1/2	3 1/4	0.558	13/32	1.117
1 1/16	17/64	1/8	17/32	3 3/8	0.580	27/64	1.160
1 1/8	9/32	9/64	9/16	3 1/2	0.601	7/16	1.203
1 3/16	19/64	9/64	19/32	3 5/8	0.623	29/64	1.246
1 1/4	5/16	5/32	5/8	3 3/4	0.644	15/32	1.289
1 5/16	21/64	5/32	21/32	3 7/8	0.666	31/64	1.332
1 3/8	11/32	11/64	11/16	4	0.687	1/2	1.375

Taps for Materials Other than Steel

Ordinary commercial taps are not suitable for cutting material of a tenacious nature, such as copper, fiber, etc. Taps for cutting copper and materials of a similar composition should have the back face of the lands of the taps at right angles to the thread, as shown by lines *EF* and *GH* in Fig. 4. It will be seen that a cutter made along the lines just outlined will be more suitable for obtaining this condition than the convex fluting cutter. The most generally used cutter for fluting taps for copper is probably that shown at *A*, in Fig. 4, where a convex cutter is used for fluting the tap, the latter having but one flute, so as to leave as much bearing surface as possible between the tap and the threads in the nut, to prevent the tap from tearing the thread during the tapping operation. Taps of this kind should not be relieved in the angle of the thread, especially not by means of a file, which leaves the relieved portion rather rough and increases the liability of the chips sticking and clogging between the threads of the tap. At *B*, *C* and *D*, Fig. 4 are shown other forms of flutes which are quite frequently used for taps intended for tapping copper. All taps for materials of this kind should be reversed frequently during the tapping operation in order to avoid damage to the threads being cut as far as possible

TABLE II. COMPARISON BETWEEN OLD AND PROPOSED STYLE OF FLUTES



Size of Tap	A Inches	B Inches	C Inches
1/16	0.017	0.024	0.007
3/32	0.027	0.037	0.010
1/8	0.035	0.049	0.014
5/32	0.032	0.037	0.005
3/16	0.039	0.045	0.006
1/4	0.052	0.060	0.008
5/16	0.065	0.075	0.010
3/8	0.078	0.090	0.012
7/16	0.090	0.105	0.015
1/2	0.103	0.120	0.017
9/16	0.116	0.135	0.019
5/8	0.129	0.150	0.021
11/16	0.142	0.165	0.023
3/4	0.155	0.180	0.025
13/16	0.168	0.195	0.027
7/8	0.181	0.210	0.029
15/16	0.194	0.225	0.031
1	0.207	0.240	0.033
1 1/16	0.220	0.256	0.036
1 1/8	0.223	0.271	0.038
1 3/16	0.246	0.286	0.040
1 1/4	0.259	0.301	0.042
1 5/16	0.272	0.316	0.044
1 3/8	0.285	0.331	0.046
1 7/16	0.298	0.346	0.048
1 1/2	0.311	0.361	0.050
1 9/16	0.324	0.376	0.052
1 5/8	0.337	0.391	0.054
1 11/16	0.349	0.406	0.057
1 3/4	0.362	0.421	0.059
1 7/8	0.293	0.336	0.043
2	0.312	0.358	0.046
2 1/8	0.332	0.381	0.049
2 1/4	0.352	0.404	0.052
2 3/8	0.371	0.426	0.055
2 1/2	0.391	0.449	0.058
2 5/8	0.410	0.470	0.060
2 3/4	0.430	0.493	0.063
2 7/8	0.449	0.515	0.066
3	0.469	0.538	0.069
3 1/8	0.488	0.560	0.072
3 1/4	0.508	0.583	0.075
3 3/8	0.527	0.605	0.078
3 1/2	0.547	0.628	0.081
3 5/8	0.566	0.649	0.083
3 3/4	0.586	0.672	0.086
3 7/8	0.605	0.694	0.089
4	0.625	0.717	0.092

* * *

A fire protection committee appointed last spring, by the New England Foundrymen's Association, has analyzed the status of the membership of the association with regard to fire hazards, fire-fighting apparatus, and insurance rates. Of course, the latter are made the basis of very sweeping conclusions with regard to their relation to the former. It has been shown, for instance, that in thirty-two properties protected by automatic sprinklers, the insurance rate averages 10.5 cents per $100 at risk, including all types of construction and other hazard. As compared with this, the rate on foundries constructed of brick and concrete but without sprinklers was 96.5 cents, or more than nine times as much. Buildings constructed partly of brick and partly of wood show an average rate of $1.31 per $100 at risk. Similarly, wooden buildings without sprinkler protection have an average rate of $1.87, or almost two per cent. The committee recognizes that the mere question of insurance savings is quite subsidiary. The fact that a single crippling fire might mean loss of business for months, carrying with it the loss of established trade and seriously hampering other departments of a large establishment, must always far overshadow any question of insurance premiums.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

MARCH, 1913

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IS A NEW MACHINE NOMENCLATURE NEEDED?

The National Machine Tool Builders' Association, through some of its active members, is carrying on a propaganda in favor of changing many of the well-worn machine terms to names more definite and not so likely to be misunderstood. Some names undoubtedly need changing. A "drill" for instance, may mean either the machine or the cutting tool used for making a hole. Obviously "drill" should mean the actual cutting tool, and "drilling machine" the machine driving the "drill" and supporting the work.

The indefinite meaning of "machine tools" affected the industry seriously when the Underwood tariff bill was framed, because the term was supposed by the framers to mean the cutting tools only, such as drills, reamers, counterbores, mandrels, arbors, taps, dies, lathe and planer tools, etc., but it is generally understood by those familiar with the equipment of shops, to mean the machines used in the metal-working industry for turning, drilling, planing, milling, boring, slotting, shaping, sawing, profiling, etc.

The National Machine Tool Builders' Association and the journals devoted to the machine tool trade can in time effect a change in the usage of terms that are obviously misleading or erroneous; but we doubt the wisdom of changing the honorable word "lathe" to "turning machine." We believe it would be wiser to limit the changes at first to those names that now cause confusion and mistakes.

* * *

THE TRUE MEASURE OF INCREASED EFFICIENCY

Frequently statements intended to indicate the increased efficiency of a new machine or method are made in the following words: "It used to take us fifteen minutes to make this piece, but with this machine we turn it out in seven minutes." The unsuspecting listener to this outburst of enthusiasm is easily led to believe that the new machine makes it possible to produce at one-half the cost, as compared with the previous method, but this is by no means a foregone conclusion. The new machine may cost a great deal more than the old one, the overhead expense may be greater, repairs may be more frequently required and the cost of repair parts higher. All these items must be taken into account before a true comparison between the efficiency of the two machines can be made.

The only comparison of the efficiency of two machines or methods that has any value should be made as follows: "The cost of producing one piece by the old method, counting all overhead expense—interest, depreciation, cost of repairs, etc.—was 39 cents. Taking into consideration the same items of expense, the cost of producing one piece by the new method is 31 cents." This gives a true comparison of the relative value of the two methods. It is possible that when the piece is made for 31 cents, it requires but one-quarter of the time as compared with a piece made by the method which costs 39 cents, but in the latter case only the very cheapest machinery was employed, whereas the new method makes use of costly appliances. Comparisons of this kind, therefore, to be of any value, must take into account all the factors of expense—not the labor cost alone.

* * *

LOW COSTS FROM HIGH-GRADE METHODS

The idea has by no means been dispelled that high-grade productions are necessarily high-priced. Whether or not high-grade work is costly depends largely on the quantity produced. If the quantity made is small, high-grade work will generally cost more than low-grade work, but if the quantity made is large enough to warrant the installation of first-class machines, tools and methods, the cost of production may be reduced to less than that of a low-grade product made by out-of-date machines and methods.

The manufacturer of a new firearm which probably will be widely sold was asked if he would improve the equipment of his plant in order to increase his output. He replied that his company would use improved machines and methods as much as it could afford, considering the low cost of the product! As a matter of fact he needs better machines and methods more imperatively than if the product were sold at a higher price. He simply cannot afford to use any but the very best methods and machines if he is to get all the profit possible.

Modern methods may sometimes increase the production of parts on which great accuracy or high finish is not required, such as the crankshafts of a certain agricultural machine which ordinarily are long slender malleable iron castings, rather difficult and costly to make, even though left rough as they come from the foundry. When made from steel shafting, bent to the multiple-throw shape, and ground on the bearings by modern grinding machines, the finish and accuracy of the product are greatly improved, and the cost much reduced. Ground bearings are not necessary, but the grinding method produces a superlatively good crankshaft at a lower cost than the old way. Now the fact that ground bearings are unnecessary on a rough agricultural machine is no reason why the progressive manager should refuse to employ the process. It is true he gets better work than is needed, but he gets it at so low a price that other common methods are at a disadvantage. In such cases it is cheaper to do the work well than to do it poorly.

* * *

The ignorance of some public men of the industries in their home cities might be taken as an indication of the superficial knowledge possessed by many supposedly intelligent public men of those things that are the bases of prosperity or the mainsprings of progress. It is claimed that a member of Congress whose home is in a large Eastern city noted for its machine tool industry—a lawyer of considerable ability—confessed that he knew nothing whatever about the machine tool business nor what machine tools were. He did not know that the Underwood bill vitally affected one of the big businesses in his own city. This lawyer member of Congress, of course, was inexcusably ignorant, but are not the machine tool builders themselves somewhat to blame for not pushing themselves into greater prominence? When it is considered that machine tools are the fundamental machines on which the production of all other machines is dependent, there certainly seems to be some ground for claiming a greater share of recognition in a country noted for its mechanical development.

THEORY VS. PRACTICE

The very title of this editorial is a paradox, but how often do we see theory and practice referred to in this manner. The right way would be to say "Theory and Practice"—not "Theory versus Practice." If theory and practice appear to disagree, either the theory or the practice is wrong, for when rightly applied, theory goes hand in hand with practice everywhere. There is no shop operation so simple that it does not in some way involve the application of a theoretical principle. There is no designer or mechanical engineer, no matter how highly educated, who can successfully design the simplest device without taking into account some practical requirement. The man who looks upon theory as an abstract matter, useless in his practical work, merely proclaims his ignorance. The man who prizes theory so highly that he believes he can afford to disregard the practical requirements and leave them to the shop man to decide, thinking that it is below his own dignity to bother with such details, paves the way for inefficiency and confusion. One of the reasons that America has excelled in the art of machine building is that our practical shop men have had more "theory" than the average European working men, and that our engineers and designers have had more practical training than the technical leaders on the other side. Let it be reiterated that practice without theory is almost as useless as theory without practice, and that there is no such thing as "theory versus practice"; it is "theory and practice" that achieves results.

* * *

AUTOMOBILE MANUFACTURING ORGANIZATIONS

The growth of the automobile manufacturing industry in America has been too rapid to permit some of the large concerns to organize on efficient lines, especially as regards the purchasing of equipment and getting the best results from it in the factory. For instance, special machinery for making certain shapes requiring exactness is purchased, and unsatisfactory work is produced. The foreman condemns the machine as worthless, stating that it will not produce the required product, notwithstanding the fact that he has samples of work produced on the machine before shipment which fulfill the requirements in every respect.

Here is a situation difficult to handle. The machine tool builder knows that the foreman of that department is either ignorant or incompetent, but he cannot afford to antagonize him or "show him up" to his superintendent. He must personally investigate the trouble and recommend as delicately as possible that certain changes in method be made to correct it. In a case that came to our attention recently, a machine was condemned because of the fact that certain formers specified to be used on it were not used, but others several inches smaller in diameter were substituted, the result being, of course, that the work was not up to the required standard. The machine tool builder was not to blame for the blunder, but his prestige suffered, nevertheless.

The organization of every manufacturing plant should be headed by men who have common sense as well as expert knowledge. Such men would know that machine tool builders having years of established reputation do not put special machinery on the market that is fundamentally wrong in design. When a complaint comes from a department that satisfactory results cannot be produced on a new machine, the conditions should be carefully examined to discover, if possible, what the trouble is. Weak spots in the organization can be discovered under such circumstances that might remain hidden otherwise. "Look for trouble at home before blaming someone outside" is a good rule for the progressive manager to follow.

* * *

When a foreman wants a certain kind of a machine for his department and gets another, one must remember that he is only human and that it is possible that he will not get all out of the new machine that might be expected. Of course, there are foremen and foremen, and the one that gets the most out of the machine that he does not believe meets his requirements is a mighty good one.

THE DESIGN OF PIT HEAD PULLEYS

BY JOHN S. WATTS*

The pulley used to carry the rope that hoists the cage in a mine shaft, is evidently a very important part of the machinery, as failure of this pulley would probably lead to dropping the cage. In spite of this fact, many engineers do not know how to calculate the safe load for such a pulley, and so far as the writer knows, there are not any formulas given in the engineering hand-books to cover this design. The method presented herewith has been found a satisfactory means of estimating the load that a rope pulley will safely carry.

Fig. 1 shows a common type of pit head pulley with wrought-iron spokes. The method of casting this pulley consists of setting the spokes—which have previously been polished on the ends where they enter the casting—in their proper places in the mold; the rim is then cast onto the spokes. The hub of the pulley is cast the next day, so that all danger of shrinkage strains is avoided. The only difficult feature in the design of this pulley is that of determining the required number of spokes and their diameter. To make the problem capable of mathematical solution, it is assumed that the rope in passing over the sheave is stretched from one spoke to the next in a straight line, as illustrated at the left-hand side of Fig. 2. From this diagram we can lay out the triangle of forces as shown at the right-hand side of the same illustration. The lines *A*, *B*, *C*, etc., representing the pull on the rope are drawn parallel to the lines *A*, *B*, *C* in the left-hand diagram. The lines *X*, *Y*, *Z*, etc., in the triangle of forces are then drawn parallel to the center lines of their respective spokes as shown at the left of the illustration; the lines *X*, *Y*, *Z* represent the thrusts on the spokes. In drawing the triangle of forces, some convenient scale is adopted and the line of action of the forces is obtained from the left-hand diagram; the triangle of forces can then be scaled off to determine the amount of the thrust in the spokes represented by *X*, *Y*, *Z*, etc. For example, the line *A* is drawn to represent 21,000 pounds on a scale of 14,000 pounds to the inch, and by measuring the line *Y*, we find that it represents a thrust of 3660 pounds which is the compression load carried by each of the upper spokes. These spokes came under the mechanical treatment of columns fixed at both ends.

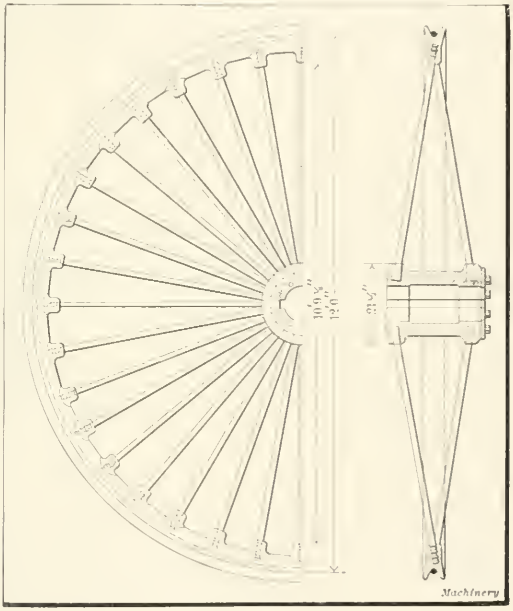

Fig. 1. A Common Type of Pit Head Rope Pulley

In the preceding treatment, no account has been taken of the amount of the load which is carried by the spokes in the lower half of the pulley. As the load they will carry in tension depends entirely upon the gripping power of the cast-iron rim on the spokes, it is not possible to calculate what part of the load they can be depended upon to take. The stiffness of the rim against deformation from its circular form also adds something to the total strength of the pulley, and to cover these two items, the writer's practice is to add one-third to the strength arrived at in calculating the safe load on the spokes in the upper half. The same result may be obtained by deducting one-fourth of the actual pull of the rope. To take a concrete example, we will assume that a pulley is required to carry a load which puts a tension of 28,000 pounds in the rope, the diameter of the pulley being 12 feet from center to center of the rope. As previously stated, we will consider that one-fourth of this load is carried by the lower spokes which are in tension, leaving 21,000 pounds to be carried by the upper spokes in compression. It will be necessary to assume the required number of spokes and for a 12-foot pulley, the usual number is thirty-six. The load on each spoke is 3660 pounds, as determined in Fig. 2. To find the required diameter of the spokes, the design must be carried out far enough to determine the unsupported length of the spoke which is shown in Fig. 1 to be 4 feet, 5 15/16 inches, or say 54 inches. Referring to Kent, we find that Gordon's formula for wrought-iron columns is as follows:

---

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$$P = \frac{40{,}000}{1 + \dfrac{1}{40{,}000}\left(\dfrac{L}{R}\right)^2}$$

in which:

P = ultimate strength per square inch,

L = length of the spoke in inches,

R = least radius of gyration of the spoke section in inches.

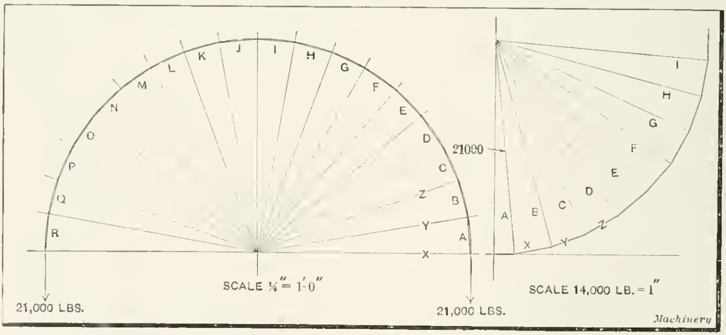


Fig. 2. Graphical Method of determining Thrust in Pulley Spokes

With this formula, it is necessary to find the correct diameter by a "cut and try" method; we will try a diameter of 1⅜ inch. The radius of gyration of a circle 1⅜ inch in diameter is 0.34375 inch. Substituting this value for R, and 54 inches for L in the column formula, we have:

$$P = \frac{40{,}000}{1 + \dfrac{1}{40{,}000}\left(\dfrac{54}{0.34375}\right)^2} = 24{,}950 \text{ pounds per sq in.}$$

The area of a circle 1⅜ inch in diameter is 1.4849 square inch, and multiplying the result obtained by substitution in the column formula by this figure, gives the value of the collapsing load on the 1⅜-inch spokes as

$$24{,}950 \times 1.4849 = 37{,}000 \text{ pounds.}$$

This value must be divided by a factor of safety to find the safe load that the spokes can carry. The writer's experience has shown that a factor of safety of 10 is correct for this service, as the stresses form a "live load" varying from a maximum compressive load to a maximum tensile load for each revolution of the pulley. It must also be remembered that a sudden jerk in starting, due to slack rope, may cause the strain to become double that due to the normal load. Using 10 as the factor of safety, we have a safe load of 3700 pounds, which is on the safe side, the value determined by the graphical method being 3660 pounds.

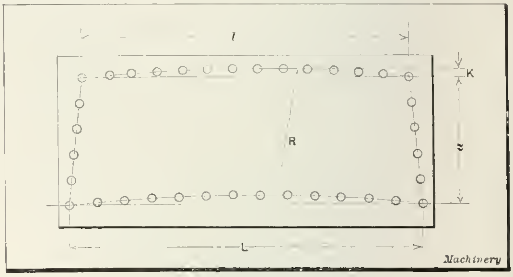
Reduced to the least number of words, the method may be said to consist of the following steps: Consider that three-fourths of the load on the rope is carried by the upper spokes in compression, and one-fourth by the lower spokes in tension. Then by the triangle of forces, find the resultant strain on the spokes and make them large enough to carry that load as a column fixed at both ends.

* * *

CAMBER IN PLATES

BY R. H. CREVOISIER*

When the specifications for certain work do not allow the drifting of rivet holes, or in a stack or stand-pipe, when the plates are thick and the lower lap of the top ring is on the outside of the upper lap of the bottom ring, it is necessary, in order to have the holes match, to throw a camber in the plates. This can be determined by the following formula:



Notation used in Formulae

$$K = \frac{L\,(L - l)}{8a} \qquad (1)$$

in which the reference letters denote the dimensions given in the accompanying engraving.

As an example, assume that a stand-pipe is 20 feet in diameter on the outside of the inner lap and 20 feet 1½ inch in diameter on the outside of the outside lap. This would make the thickness of the plates in the rings ¾ inch. Assume that four plates are used for each ring, and that the center to center distance a of the girth seams is 5 feet, or 60 inches. We then have:

Circumference of outside of inner lap = 754 inches;

Circumference of outside of outside lap = 758.7 inches.

From this we get:

$l = 754 \div 4 = 188.5$ inches;

$L = 758.7 \div 4 = 189.67$ inches.

Then, by applying Formula (1), we have:

$$K = \frac{189.67\,(189.67 - 188.50)}{8 \times 60} = 0.46 \text{ inch.}$$

* * *

A patent has recently been granted in England for the use of solid cylindrical rollers cut from round rods of vulcanite or similar material to be used in roller bearings. The use of rollers of this material will not, it is claimed, injure the journal of the shaft which is rotating in the bearing nor the bearing itself in which the rollers work, but will reduce to a minimum the wear of both journal and bearing. The rollers, when worn, may be replaced by new rollers of the original dimensions which will render the roller bearing equal in all respects to a new one.

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*Address: Wickes Boiler Co., Canton, Ohio.

METHODS OF LUBRICATING MACHINE TOOLS—2

A REVIEW OF OILING DEVICES AND SYSTEMS OF DISTRIBUTION

BY JOSEPH HORNER*

Continuing our study of various distribution systems, there are numerous instances in which the difficulty of reaching concealed bearings results in the adoption of special pipings, or passages, which betray ingenuity in their disposition. The advent of all-geared drives for speeds and feeds greatly complicated the matter. One of the commonest practices is to drill a longitudinal hole in the shaft, and connect radial holes with this to lead out to the various bearings or wheels. Usually the lubricant is supplied through the shaft end, but it may have to be fed from a radial or inclined hole in some circumstances. Fig. 27 is selected to illustrate both ways, the pinion and clutch *A* and *B* receiving oil through the shaft from the end oiler, and the wheel *C* its supply from the inclined passage fed from the piped bearing adjacent. The reason for turning the semicircular groove in the shaft at the place where *B* is situated is that, as the latter does not revolve, there would be no opportunity for the oil to spread itself circumferentially. Fig. 28 shows a method of supply to a fixed pin on which is a pinion and a distance-piece. A groove is turned in the pin where it rests in the bearing bracket, and a transverse hole leads the oil from this to the central passage. In places where it is not feasible to lead a pipe in from above, as shown, on account of the proximity of gears or other details, a lateral pipe can be inserted (see the detail view, Fig. 28) to fill the vertical hole up which the oil rises to the pin. This pipe is either disposed horizontally, or slopes down, or if a head is available from a well or tank or pump supply, it can be brought up from below.

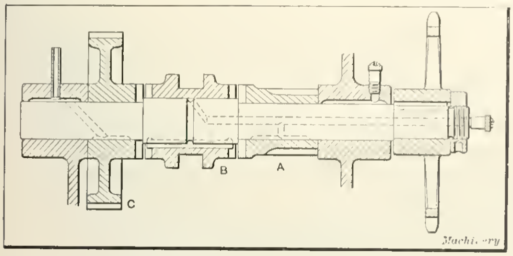


Fig. 27. Lubrication from Inside of Shaft

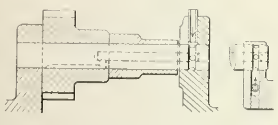


Fig. 28. Mode of supplying Oil through Hollow Pin

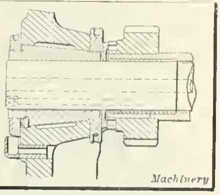


Fig. 29. Lubrication of Loose Wheel through Separate Hole

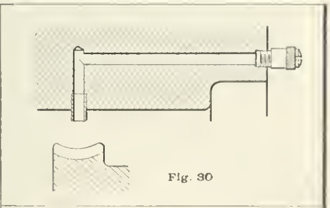


Fig. 30

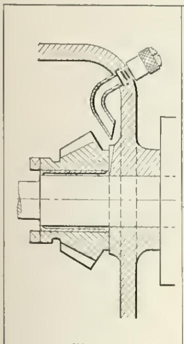


Fig. 31

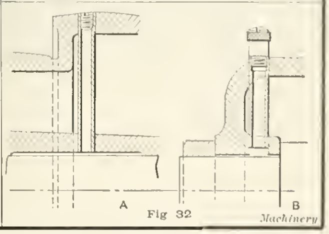


Fig 32

Fig. 30. Holes and Directing Pipe to prevent Waste Fig. 31. Directing Pipe inside Gear-box. Fig. 32. Pipes employed to span Gaps

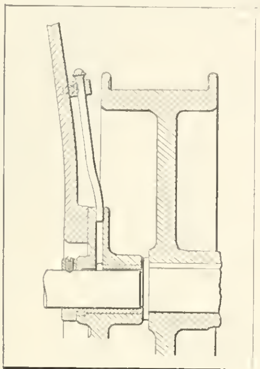


Fig. 33. Pipe fitted to Inaccessible Bearing

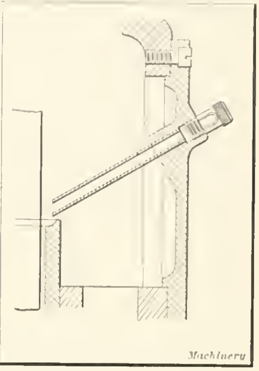
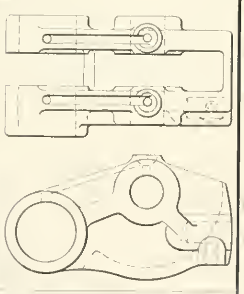
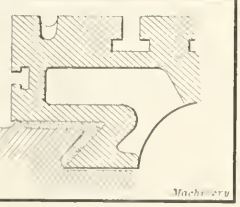


Fig. 34. Directing Pipe Lead through Cover

In a few instances it is impracticable to conduct oil through the center of a spindle, on account of this being wanted for the passage of a draw-rod or a chuck tube. In such a case a special oil-hole is drilled, Fig. 29, in the metal between the central hole and the outside. This is from a Brown & Sharpe milling machine spindle.

The combination of holes and pipes is frequently necessary to conveniently reach awkward situations; sometimes the oil passes for a certain distance through a hole and then finishes its journey by way of a pipe for precision of location. The ease with which pipes can be bent and carried around angles greatly assists in their disposition, and often saves awkward or expensive drilling. But sometimes a pipe is fitted solely to prevent creeping, such as is seen in Fig. 30. Here the oil is fed through the oiler at the side of the table, and passes to the vertical hole, from which a bit of pipe depends and





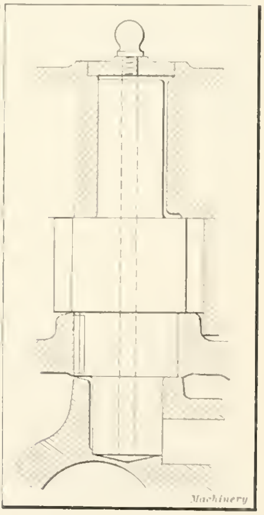


Fig. 35. Tumbler Bracket with Long Troughs. Fig. 36. Felt Pad let into Pocket of Milling Machine Slide Fig. 37. Lubrication of Top and Bottom Journal

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causes the oil to drop on the worm-wheel, none of it being wasted by creeping along the under side of the slide. Fig. 31 shows the location of a short bent pipe to reach just inside a gear-box, and lubricate a clutch bevel gear bushing, which is grooved to distribute the oil that drips down the recess cut in the bearing face.

Piping is largely utilized to span gaps where the lubricant could not be supplied with certainty, and without waste, to the interior oil-hole. With but a short distance for the oil to travel, and an ample bell-mouthing of the hole, it would be feasible to dispense with the conducting tube, but even here some waste is likely to occur, and carelessness of the attendant or movement of the parts before the oil has reached its destination will increase the loss. Two kinds of tube fittings are seen in Fig. 32, *A* being that applied to a loose-running cone-pulley, to span the gap between boss and rim, and the other, *B*, in a gear-box where it is necessary to put the oiler on top, and a pipe then carries across the space between the walls. The close proximity of a pulley or other detail often renders it impracticable to reach a bearing with an ordinary oil-can spout, and as it is not worth while using a special can for such purposes, the plan of arranging a pipe is followed, as in Fig. 33, the top being closed with a plug, or an oiler. When a number of such pipes have to be used, it is usually best, if circumstances allow, to bring the terminations all together at one spot, not necessarily into a tank, but alongside into a holding block, and thus have them handy for attention.

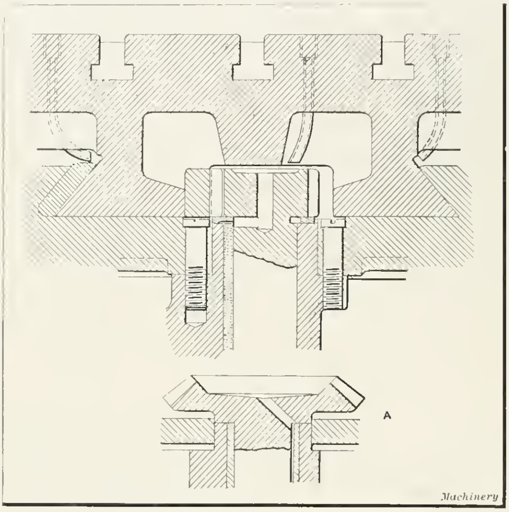

Fig. 38. Lubrication from Top of Table

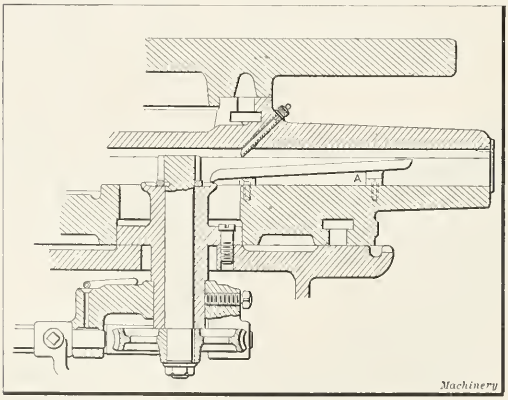

Fig. 39. Arrangement of Trough to catch Oil from Pipe

Fig. 34 illustrates a mode of applying a pipe to lead a supply to the recessed top of a bearing for a vertical shaft, the tube and its oiler being screwed into the door, which need not be removed except for purposes of repair.

The practice of covering in sets of gears with casings which are necessary for protective purposes, or may form an integral part of the design of bearings and lever anchorages, frequently renders some amount of piping necessary, to lead from the external oilers to the various bearings. The alternative is to drill the shafts and convey the oil by way of these, but it is sometimes inconvenient to do so. The oil-pipe either leads from the cover to the bearing, or hangs some little way off and lets the oil drop into the cupped hole, or a raised rim, as the case may be. Sometimes a bushing is screwed into the bearing and has a flanged head, with an ample bell-mouth, to catch the oil. The cover can be removed and replaced without disturbing any connections, which is not the case when the pipes actually enter the bearings and fit into them.

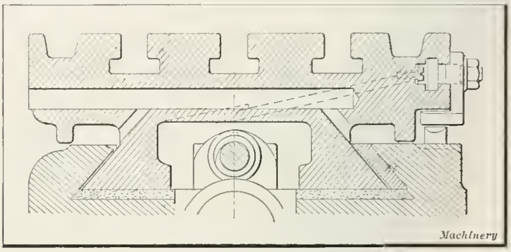

Fig. 40. Milling Machine Table oiled from the Side

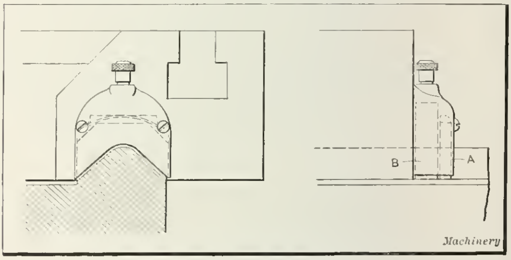

Fig. 41. Shear Wiper, with Leather Strip and Felt Pad

In a great many feed-gears and other details it is impossible to apply oil directly to certain of the bearings, because of their inaccessibility, and in such cases it is often the practice to provide a single trough on the top of a fixed or a tumbler casting, and drill holes and fit and bend pipes suitably to reach the other bearings. In order to prevent waste of oil, the trough is sometimes divided by partitions, thus providing each leading-out hole with its own receptacle. When a tumbler bearing has to be lubricated, the feeding-in should be so arranged as to avoid loss of oil through the tumbler moving out of the range of the hole, or pipe, or tray from which it drops. This is done by casting a narrow trough of appropriate length

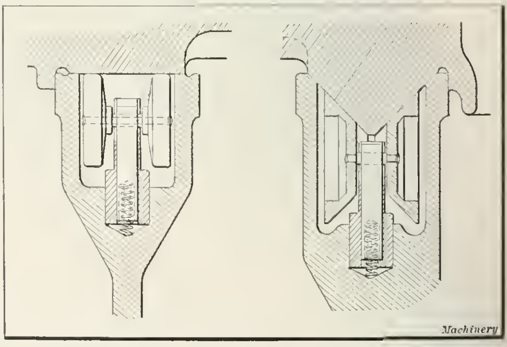

Fig. 42. Lubricating Rollers for B. & S. Grinding Machines

on the tumbler. Fig. 35 illustrates a common design, with a cup on the higher bearing communicating by a groove with the hole in the end hole. The groove comes under the end of the pipe through which the oil is fed, and never moves out of its reach.

In some of the more complicated designs of machines, special provisions are necessary to lubricate parts that are subject to frequent change of position—slides specifically. This is seen for example in the portion of a Brown & Sharpe grinding machine, Fig. 39, where a sloping chute, *A*, receives the oil from the tube and oiler in the slide above, and conducts it over the lip of the bearing to the vertical shaft. Any alteration in position of the upper slide consequently makes no difference, and there is no waste, but all the oil from the inlet is caught. In slides not suitably provided in this manner, it may be essential to bring them to a definite position, put in the oil, and wait for a certain time to permit it all to escape. In this illustration the bearing for the shaft by the worm-wheel is lubricated from a bent pipe taken to the outside of the frame.

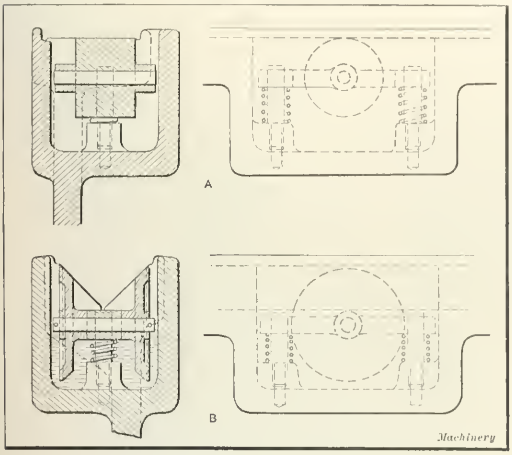

Fig. 43. Lubricating Rollers and Well for Birch Grinding Machine

Another illustration of an awkward situation is seen in Fig. 45 (also by Brown & Sharpe) the vertical shaft obtaining its supply from the pipe above, discharging into the groove and thence to the bush groove, while the worm is lubricated from a combination of holes and pipes, with a trough to maintain the worm in oil constantly. Fig. 45 *A* shows a little point in connection with the conduction of oil through slides, from an upper one to another; to prevent the oil from spreading in a film under the slides, the lower face is counterbored to catch the drip from the edges of the hole and lead it properly into the continuation hole.

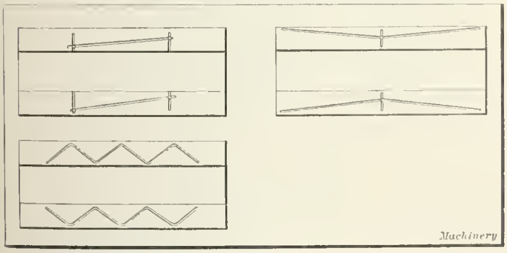

Fig. 44. Various Arrangements of Oil Grooves on Flat Surfaces

The lubrication of tables presents some rather interesting variations in methods of supply and distribution. Much depends on the size and weight to be dealt with, and on the speed of movement. A slow moving table or slide, or one subject only to occasional alterations in position does not require so much lubricant as a rapidly moving one in which the oil is swept off more quickly, or squeezed out by pressure. A small table, such as on a cutter grinder, for instance, can be oiled satisfactorily enough by the can, pouring onto the surfaces while the table is run back. If the length prevents this being done, lateral oil-holes are drilled, and vertical ones to communicate with the under side of the table face. Or, if vee slides are used, diagonal holes are drilled. Grooves or pads distribute the film evenly over the surfaces, and pads have the merit of retaining a portion of oil and keeping the surfaces moist for considerable periods. Several such pads can be inserted in pockets in the slide, see the sectional view, Fig. 36, and the oil is then supplied by a passage to each pad.

The location of the oil-holes or plugs or oilers is a matter for consideration in certain types of tables. In some grinding machines there is no objection, for instance, to drilling the holes vertically from the table top, and letting in plugs or spring caps. But in other machines these areas might be covered for a long time with fixtures or other fittings, and there would be no chance to get at the apertures without removing the fixtures. Then the lubrication might perforce be neglected. Such would be the case with Fig. 38, in which the two vee slide faces are fed by the bent tubes let through the table. This illustration incidentally shows a way of lubricating a vertical shaft with a hole and felt pad, while the detail at *A* represents a hole drilled obliquely through a bevel gear, communicating with a groove on the shaft. Side oiling is seen in Fig. 40, with an extra pipe to lead to the bearing at the center.

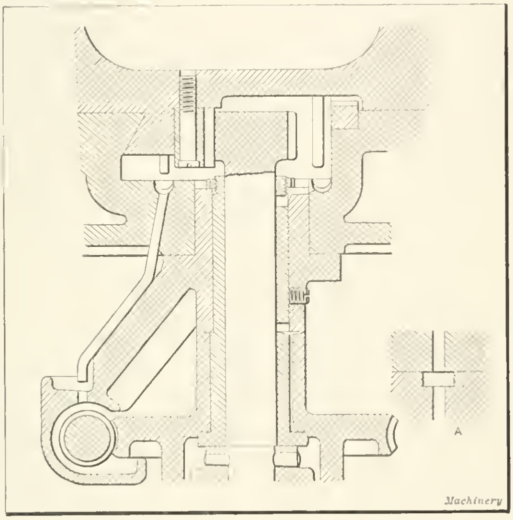

Fig. 45. Conduction by Tubes, Grooves and Passages

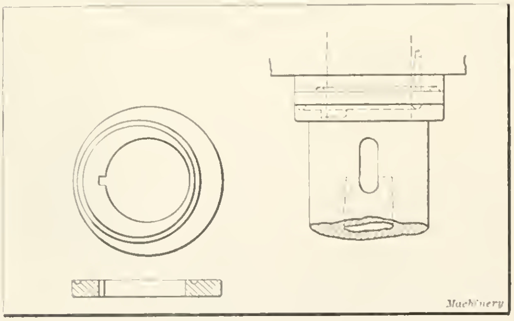

Fig. 46. Eccentric Groove for distributing Oil

A felt pad happens to serve conveniently as a means of keeping surfaces clear of cuttings, although it is often applied in conjunction with something more solid, such as a piece of leather *A*, Fig. 41, in front of the oiling pad *B*. This is from the Lodge & Shipley lathes.

The most effective method of lubricating a heavy table or slide, such as that of a planer, or heavy shaper, or grinder, or boring mill, is to employ rollers sunk into oil-pockets, thus forming an automatic device independent of the operator's care, and providing a supply of lubricant at each return of the table, or as fast as it is squeezed out. The primitive device is simply to float a wooden roller in the oil-pocket, but it should have some means of attachment to prevent its rising unnecessarily high after the table has passed. Of course, in rotating tables, as in boring mills, a roller would remain in the same position. But even then it is as well to afford a definite pressure by springs, which will result in proper rotation and an increase in the amount of oil smeared on. Fig. 42 illustrates the type of roller fitting used in the Brown & Sharpe grinding machines, for the flat and the vee ways, respectively. The wheels are mounted on a cross-pin held in a central plunger, which slides up and down in a casing, being maintained in the normal position at the top by the coiled spring. Messrs. G. Birch & Co., Ltd., of Manchester, England, employ frames like those seen in Figs. 43, *A* and *B* to lubricate the tables of their grinding machines. Screwed into bosses at the ends of the oil-pocket are studs, encircled by springs, and receiving the ends of the frame which supports the roller. This construction permits the plain roller (Fig. 43 *A*) to be made without a break across its face. It will be noted that the vee wheels do not reach right across the slope of the vee, but this is a matter of no consequence, since gravity makes up for the deficiency in this respect.

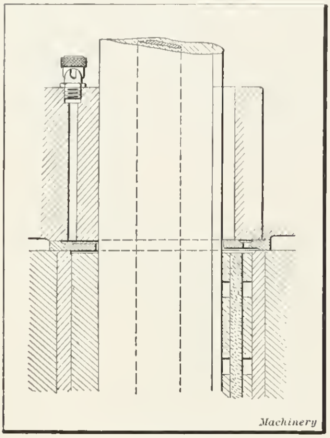

Fig. 47. Lubrication of Washer and Vertical Bearing

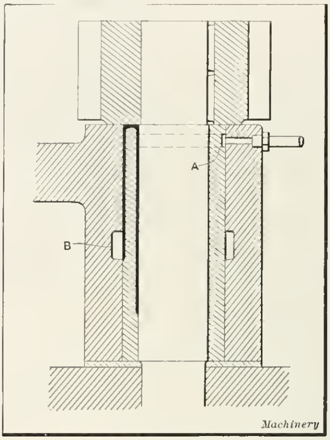

Fig. 48. Wick-oiling from Annular Reservoir

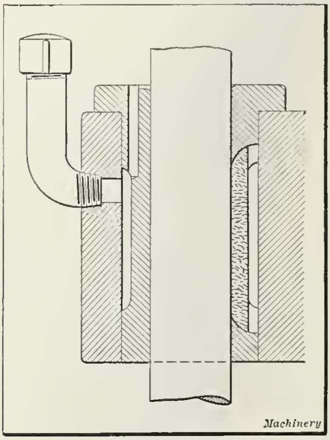

Fig. 49. Vertical Shaft lubricated from Reservoir and Felt Pad

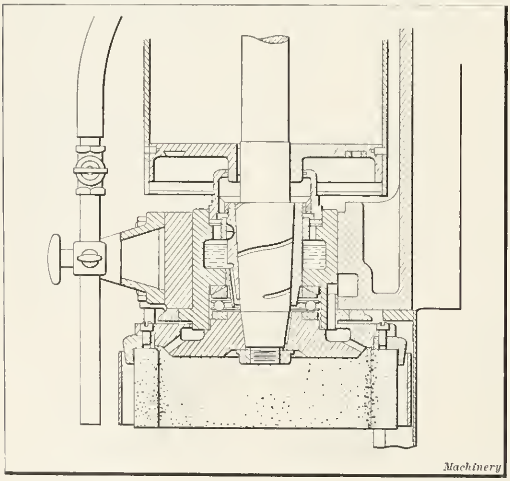

Fig. 50. Blanchard Grinder Spindle with Spiral Oil-raising Groove

Slides which are not lubricated across their bearing width by rollers or pads require grooves to properly distribute the oil. The aim in the disposition of these is to spread it nearly across the width, and numerous fashions are followed, though results are much the same. The precise arrangement may often depend on the position and number of the oiling holes. In a vertical knee or slide with a single oiler at the center on the top edge, the grooves radiate from this to right and left. Fig. 44 gives three alternative dispositions for milling-machine tables moving horizontally. The zig-zag style is a favorite one, and is used also largely on circular tables like those in boring mills, carrying a good supply of lubricant in its length.

Relating to the question of spreading oil on the class of surfaces just dealt with is that of lubricating collars and washers disposed horizontally. Grooves are used variously, and in washers that have to make running contact on both sides, the oil is usually carried through holes, Fig. 47. This, from a Brown & Sharpe vertical spindle milling machine, includes provision for feeding the vertical drilled bush of the spindle. Fig. 46 shows a method of grooving, for horizontally and vertically set washers, which is easily produced; the washer or collar is set eccentrically in the lathe, and the groove turned as seen. This distributes the oil all over the faces, excepting at the extreme edge, where it is necessary to keep the groove from opening out.

The action of the centrifugal force is utilized in more than one instance to spread oil over faces, a good example being that of boring-mill spindles. The conical face is submerged in oil, and when the spindle starts running the oil is thrown outward against the guard lips surrounding the face, and then runs back down through grooves cut in the bearing face, constantly flushing the same. The same supply is also generally utilized to oil the vertical portion of the spindle through an overflow, or by pads, or spiral grooves.

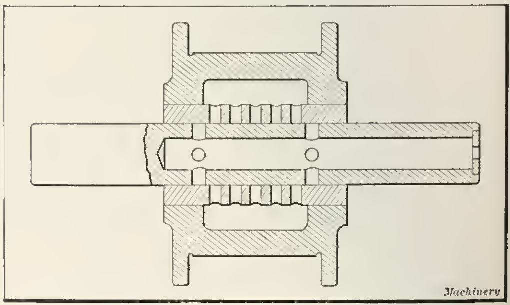

Fig. 51. Loose Pulley with Perforated Bushing and Grease Chamber

Vertical spindles present some difficulties in regard to efficient lubrication which do not exist in horizontal ones; this is due to the inevitable tendency of the oil to run down and out of the bearings quickly. Ring-oiling is out of the question, and if a considerable quantity of oil is required, pads must be used, or the oil must be kept in constant motion and supply by spiral raising grooves. An ordinary mode of supply is adopted in the vertical shaft illustrated by Fig. 37; the oil is poured in, on the removal of the stopper, both through the central hole, and around the top of the shaft, thence flowing by the bearing grooves around the bottom and top journals.

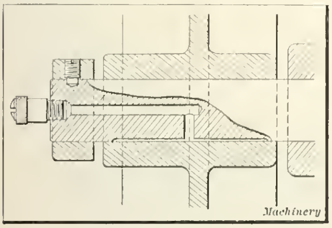

Fig. 52. Loose Pulley oiled from Hollow Shaft

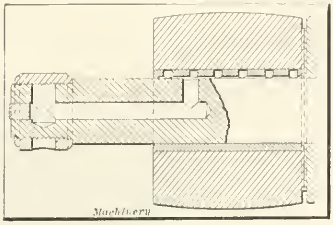

Fig. 53. Loose Pulley greased from Hollow Shaft

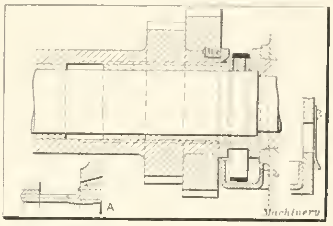

Fig. 54 Lubrication of Loose-running Wheels

Wicks are employed very extensively to conduct and distribute oil to vertical bearings, such as shown in Fig. 48; the annular groove *A* near the top of the bush is fed from a pipe, and the oil runs down into the reservoir, *B*, from which the end of a wick (indicated in black) is carried up and down into a groove cut in the bush. Bringing the wick to the top also provides the lubrication of the pinion face. If a reservoir of oil is close at hand, the wick can be brought direct from this, and the piping is not then required. The application of felt to retain oil is shown by Fig. 49 (from the American Tool Works Co.'s radial drills). The chamber cut around the bronze bushing stores a good supply of lubricant, which is fed slowly to the shaft by the felt pad. Waste leakage occurs at a slow rate.

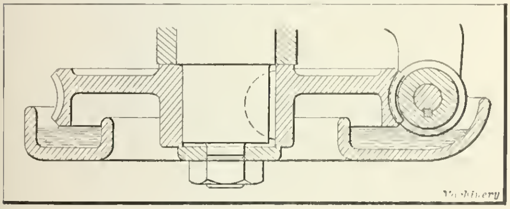

Fig. 55. Open Trough for Use in Enclosed Situation

A good example of the use of raising grooves is shown by the sectional view of the Blanchard Machine Co.'s grinder bearing, Fig. 50. Several points may be noted in this. In the first place the bearing casting is cored out to hold about a quart of oil, which flowing through the passage drilled in the phosphor-bronze bushing, communicating with an annular recess, is caught by the tail end of the spindle groove and thence is screwed upwards to the top of the tapered journal thus distributing a film of oil all over the surface. It then overflows into the oil guard, and falls down through the holes in the same and so again into the reservoir. An oil-gage (not shown) indicates the height, and serves for replenishing. A fact which helps to the efficient operation of this system is that the casting being also cored out with passages for the transmission of the water going to the wheel, this water passing in close proximity to the oil chamber, keeps the latter cool, and consequently the heat is carried away. The lubrication of the ball-thrust bearing is from a separate compression grease-cup.

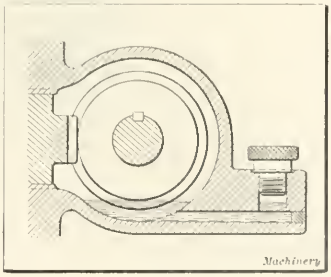

Fig. 56. Completely Enclosed Trough for Spiral Gears

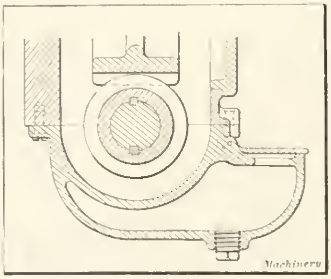

Fig. 57. Trough with Filling Cover and Drain Plug

We have already dealt with some examples of the lubrication of loose-running wheels, but there are other aspects to which attention may be drawn. The loose pulley forms an interesting subject for consideration, for it is likely to give a good deal of trouble if neglected. Roughly, there are three main systems of lubrication (1) The simple use of a lubricator of ordinary, or Stauffer type, screwed into the hub, and giving a moderate supply as required; (2) A chambered hub with capacity to hold oil or grease sufficient for a long run; (3) A hollow shaft through which oil is fed, and thence distributed to the bore by a perforated bushing, or grooves, or a wick, or pad. In the chambered hub design the oil or grease simply exudes through on to the shaft or it is properly distributed by a wick or pad laid in the bore. Fig. 51 shows a grease chamber within the pulley, and a perforated bush, the lubricant being fed in through a hole at the end of the fixed pin. The simplest mode of oiling through the hollow shaft is shown by Fig. 52, with grooves in the shaft for distributing purposes; often two more holes are drilled in to meet the central one, if the bore is exceptionally long. In Fig. 53 a perforated bush is shown, and the grease is admitted to the shaft on turning the cylindrical closing cap, which has a large opening.

Fig. 54 represents an ingenious arrangement designed to oil a loosely-running set of gears, of which one end only is shown. An ample quantity is provided by putting an oiling ring on the shouldered portion of the sleeve, to dip into an oil trough screwed to the inside of the framing, and the oil thus raised goes through the holes below the ring, and also down a sloping hole connecting with longitudinal oil-grooves. Constant lubrication is therefore assured without need for stopping the machine. The trough is replenished through the opening in the frame—a detail of this is seen on the right—with a swivel closing door. Another way of leading oil to a grooved shaft is seen in the detail, *A*, there being a hole led from outside, down which the oil flows and into the shaft groove. But this does not act constantly, like the ring device.

Submerged lubrication, that is by running parts in a bath of oil or grease which they continually stir up and spread over themselves, exists in many forms. In the oil-bath as correctly arranged there is never any lack of lubricant and the chief care is to see that sediment does not become thrown up, or that any parts are shielded from the spread of oil. The familiar worm-gear and spiral gear drive running in an oil trough was followed by the geared-drives in which other classes of gears are caused to dip in oil and splash it over the teeth. Fast-running gears necessitate complete covering to prevent the oil from flying out of the box. But in worm-gears it is not always necessary to afford absolute protection, as for instance where the trough is situated within a framing, and dust or grit cannot enter. A half-trough, as in Fig. 55, is all that is required then. When, however, the box is situated in the open, complete enclosure is usually desirable, Fig. 56. Fig. 57 shows an oil chamber cast on to the under cover of a worm-gear box (Brown & Sharpe), with provision for filling, cleaning, and draining. The main body of oil being outside the worm casing proper, all the dirt and sediment collects in a place where it is not churned up by the rotation of the worm.

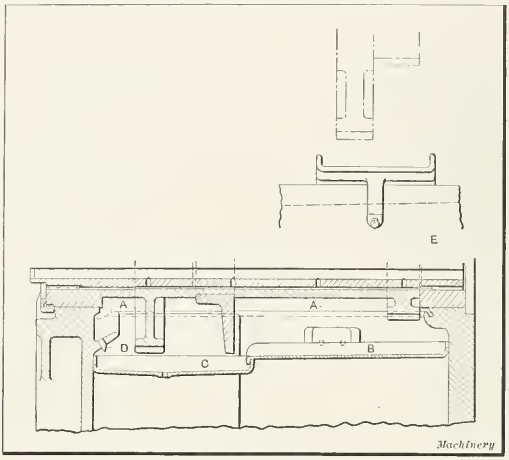

Fig. 58. Lips and Troughs to catch Waste Oil

The action of gears running in an oil-bath can be sometimes utilized to lubricate the adjacent bearings as well, in place of fitting separate oilers to these. But care must be observed that these bearings get a sufficient amount, which is not always the case in badly designed boxes. The oil which is thrown up by centrifugal force to the roof of the box may have to be deflected by various arrangements so as to direct it into the oil recesses above the bearings. Sometimes a passage is forced in the casting to lead down to these points, or ribs are cast or screwed on to catch the flying oil and let it run down and drip at the place required, without actually confining it in grooves. Or a piece of piping, or bent wire may be fitted and arranged to accomplish a similar function. Occasionally a strip of metal is attached and sloped in such a fashion that the oil is thrown against it, and thence off at an angle onto the bearing, or to a channel communicating therewith.

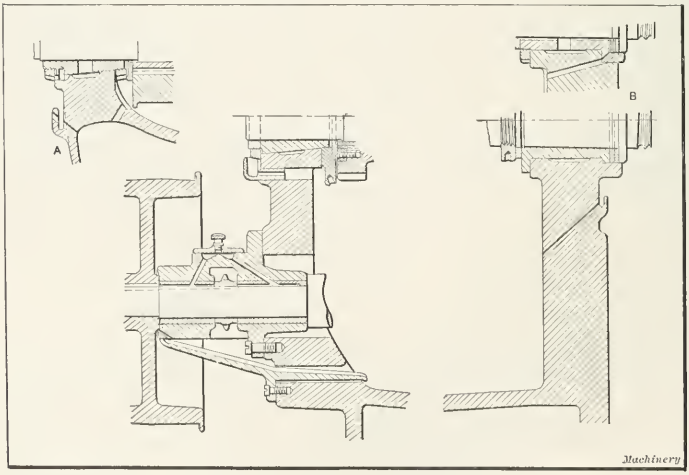

Fig. 59. Various Methods of Collecting Waste Oil

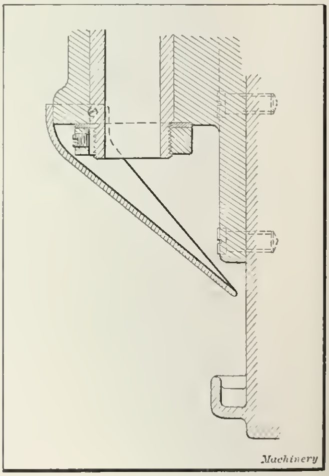

Fig. 60. Guard to divert Waste into Lip

Proper provision for the prevention of waste and the saving of oil must be incorporated in the design of machine tools. There is much diversity of practice in these respects, because conditions vary so widely. In certain instances oil is purposely retained within its working area for some time, while in others no such attempt is made, and it is allowed to flow away immediately. This difference is reflected in the draining arrangements, which are of a very complete character in the continuous flow system, and as all the oil flows back to the tank there is no external waste. On the other hand, with simple oiling systems some amount of waste may occur, which is detrimental also to the appearance of the machine. And what is worse, the oil may get onto belts or other portions where it is very undesirable; frequently special devices are fitted to prevent oil creeping or flying in such a fashion.

The principal means of prevention of waste are the fitting of felt disks or pads, the use of closed oil-grooves, caps on the ends of bearings, and the inclusion of ledges or lips to arrest flying or flowing oil. The saving or catching is done by channels, by lips, by troughs, by pipes, or by the simple flow down the inside of a framing to the tank at the base. A return of waste to definite positions is required in the case of wells which carry rollers or pads, or wicks, or rings, etc., and this is done by first confining the oil by channels and leading these to the spot required.

In a machine which has a flooded system of lubrication of gears and bearings the design must be accommodated so as to enclose all the drainage outlets, and conduct the oil to a common tray, or to the bottom of the box framing. But there are many systems in which a partial arrangement is adopted, in the form of lips, grooves, cups, sloping trays, etc., to collect the waste from the various locations and pass it to a final collecting area. The two illustrations from Brown & Sharpe milling machine construction, Figs. 58 and 59, indicate various points. The first shows the fitting of cast-iron trays below a set of gears (a portion only of the lowermost shaft being seen). The oil lost from the various bearings runs down from drain lips and holes up above, and finally reaches the continuous lip *A*, extending around inside the framing, and the upper tray *B*, whence it drips into the lower one *C*. A bit of pipe inserted in the lip at *D* conducts the oil from that point into the tray. Further up, under the main spindle bearings, special provision is incorporated for preventing the oil getting on to the belt cones, by means of troughs, and a guard under the cones. The detail *E* shows how the oil thrown or dripping from the spur gears seen dotted is collected by a catcher attached to a lip, which is not wide enough to receive the oil by itself.

In Fig. 59 the waste has to be collected from the two bearings and from sundry gears and bearings, not shown but situated between and below these bearings. The sides of the framing in this view are drawn close together for convenience. The spindle bearings are served by catchers immediately below, the one cast on being of half-moon shape, the other fitted separately, and the holes drilled through the frame permit the waste to run down into the web extending across between the sides, which has an outlet to the tank. The long bearing adjacent to the pulley—supplied from a trough and two oil-holes—is drained by a special sloping catcher screwed on, this also leading to the web. The detail at *A* illustrates the inclusion of a groove and outlet hole close to the pulley, which prevents the oil going further down the slope, while that at *B* represents a neater method of draining into the frame, in place of the external lip. This necessitates an unsightly trickle of oil on the frame, while at *B* nothing appears externally.

Fig. 60 is an example of a guard to direct the drippings from a vertical shaft down into the draining lip of the main casting, a class of fitting that is applied to gear-boxes or to main frames where one or two bearings are located on the outside. A great many kinds of trays and troughs are hung under bearings to catch the oil that would otherwise fall on the floor, or run on to the frame. A double type of catcher is seen in Fig. 61, serving to receive the oil from the sides of the rocking gear case, and from the other end of the bearing also. Channels connecting with the one under this bearing slope down to the main reservoir.

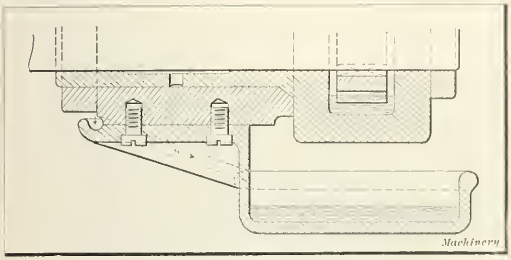

Fig. 61. Trough receiving Waste from Both Ends of Bearing

The waste which runs from the table slides of planing and other reciprocating machines is collected in a variety of ways. Oil-pots or catchers are hooked on at the ends of the bed, or are cast on, or a long box is screwed on to cover the whole width. Or the bed is cast with a rim if flat ways are adopted, running all around. Fig. 62 shows a neat mode of catching, by casting a chamber at the end of the bed, connecting each vee way with a central aperture located above a shallow tray resting on lugs. This is removed and emptied at intervals. In some designs pipes are let into the ways to conduct the oil into a similar kind of tray inside the bed.

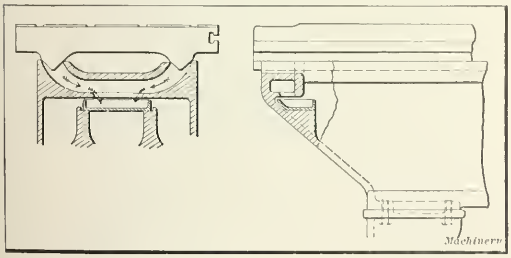

Fig. 62. Drainage from Planing Machine Ways

* * *

An impressive collection of enlarged photographs exhibited by the U. S. Department of Agriculture at the Grand Central Palace section of the National Automobile Show, showed sections of highways before and after being improved. Roads which in the spring, fall and winter were morasses through which a team could hardly drag a light empty wagon and in which horses often fell and were smothered, have been converted into hard smooth highways on which heavy loads may be hauled to market at any time of the year. The economic value of good roads is beyond computation. The mere money saving in hauling loads is really a minor consideration compared with the moral, mental and spiritual uplift conferred on rural communities by highways that afford easy and quick means of communication.

TWIST DRILL AND STEEL WIRE GAGES

BY JAMES R. ALLAN*

There are too many gages for small diameter twist drills and steel wire. The differences in these gages are a constant source of trouble to those who have to deal with drills and steel wire; and gage numbers mean nothing except if the name of the gage employed is specified. It would be desirable if one standard gage could be adopted for the smaller sizes of twist drills, drill rods, and steel wire, all other gage systems used being canceled. An agreement between the drill manufacturers on a standard which would also be recommended by the American Society of Mechanical Engineers, and adopted by the steel makers, would soon become a universally accepted standard and would eliminate confusion and misunderstanding.

Some drill manufacturers are discouraging the use of gage sizes and are asking that the sizes of drills ordered be denoted in decimals of an inch. There are three well-known standards for twist drills and steel wire that are commonly used at the present time. These are the Stubs steel wire gage, the gage used by the Standard Tool Co., and the gage used by other leading manufacturers, such as the Morse Twist Drill & Machine Co., and Brown & Sharpe Mfg. Co. The latter the writer has termed "the manufacturers' standard."

TABLE FOR COMPARISON OF TWIST DRILL AND WIRE GAGES

Gage Number	Stubs Steel Wire Gage Diam., Inches	Drill Manufacturers' Standard Diam., Inches	Gage Number	Stubs Steel Wire Gage Diam., Inches	Drill Manufacturers' Standard Diam., Inches	Stubs & Standard Tool Co.'s Gage Nos.*	Manufacturers' Standard Gage Nos.	Diam., Inches
1	0.227	0.2280	31	0.120	0.1200	60½	61	0.0390
2	0.219	0.2210	32	0.115	0.1160	61	62	0.0380
3	0.212	0.2130	33	0.112	0.1130	62	63	0.0370
4	0.207	0.2090	34	0.110	0.1110	63	64	0.0360
5	0.204	0.2055	35	0.108	0.1100	64	65	0.0350
6	0.201	0.2040	36	0.106	0.1065	65	66	0.0330
7	0.199	0.2010	37	0.103	0.1040	66	67	0.0320
8	0.197	0.1990	38	0.101	0.1015	67	68	0.0310
9	0.194	0.1960	39	0.099	0.0995	68	..	0.0300
10	0.191	0.1935	40	0.097	0.0980	68½	69	0.0292
11	0.188	0.1910	41	0.095	0.0960	69	..	0.0290
12	0.185	0.1890	42	0.092	0.0935	69½	70	0.0280
13	0.182	0.1850	43	0.088	0.0890	70	..	0.0270
14	0.180	0.1820	44	0.085	0.0860	71	71	0.0260
15	0.178	0.1800	45	0.081	0.0820	71½	72	0.0250
16	0.175	0.1770	46	0.079	0.0810	72	73	0.0240
17	0.172	0.1730	47	0.077	0.0785	73	..	0.0230
18	0.168	0.1695	48	0.075	0.0760	73½	74	0.0225
19	0.164	0.1660	49	0.072	0.0730	74		0.0220
20	0.161	0.1610	50	0.069	0.0700	74½	75	0.0210
21	0.157	0.1590	51	0.066	0.0670	75	76	0.0200
22	0.155	0.1570	52	0.063	0.0635	76	77	0.0180
23	0.153	0.1540	53	0.058	0.0595	77	78	0.0160
24	0.151	0.1520	54	0.055	0.0550	78		0.0150
25	0.148	0.1495	55	0.050	0.0520	78½	79	0.0145
26	0.146	0.1470	56	0.045	0.0465	79		0.0140
27	0.143	0.1440	57	0.042	0.0430	79½	80	0.0135
28	0.139	0.1405	58	0.041	0.0420	80	.	0.0130
29	0.134	0.1360	59	0.040	0.0410	.	.	. . .
30	0.127	0.1285	60	0.039	0.0400	. .	. .	. .

Machinery

* Half sizes are only included in Standard Tool Co.'s gage.

The Stubs steel wire gage is used for measuring steel wire and drill rod, but it is not used at the present time as much in this country as in the past. The gage used by the Standard Tool Co. was originally adopted for drill sizes in this country, but other manufacturers changed the numbers corresponding to certain sizes, while the Standard Tool Co. retained the original numbers, but interpolated half sizes in order to agree as to the actual diameters of drills furnished by other manufacturers. The Standard Tool Co.'s gage agrees with the "manufacturers standard" for the sizes from No. 1 to No. 60, inclusive, but does not agree with the Stubs steel wire gage. From No. 61 to No. 80, inclusive, it agrees with the Stubs gage, half sizes being omitted. It also agrees with the "manufacturers' standard," as far as the diameters used are concerned, but the numbers corresponding to given diameters are different.

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INCREASE OF BORE OF WHEELS BY CENTRIFUGAL STRESSES*

APPARATUS FOR MEASURING RECORDS OF TESTS, DESIGN OF HIGH-SPEED WHEELS, ETC.

Recent advances in high-speed steam turbines and the apparatus driven by them have opened up a great many new problems. One of these is the fact that, under certain circumstances, unless proper precautions are taken, a high-speed turbine wheel expands at the hub a sufficient amount to cause an appreciable increase in the bore, so as to make the wheel slightly loose upon the shaft.

Nature of Stresses in a Wheel or Ring

It is the purpose first to give a general account of the methods of computing stresses in circular bodies. It is assumed that the disk is thin, that is, that the thickness is negligible compared with its diameter. Then conditions are the same at all points on a line parallel to the axis. This is not strictly true, as the central part of a hub is strained differently from the ends. However, in most cases this effect is slight. At each radius in the disk there are two stresses, one in the radial direction denoted by S_r and one in the tangential direction denoted by S_t. If we consider the effect of these stresses on the metal of a thin ring at the interior of the disk, we find the circumference of the ring to be increased mainly by virtue of the tangential stress, and the thickness mainly by the radial stress. However, when a metal is extended in one direction by a stress there is a shrinkage in a direction at right angles, the ratio of the deformations being called "Poisson's ratio," which we will denote by V. For ordinary kinds of steel this has a value of 0.3; that is, the increase of the circumference of a thin ring in the interior of the disk is less than that which would be produced by the tangential stress if acting alone, by an amount which is 0.3 of the extension which would be produced by the radial stress if acting alone. Similarly, the increase in the thickness of the ring is less than that produced by the radial stress if acting alone. In any case, the ratio of stress to extension per unit length produced by it if acting alone, is given by the modulus of elasticity E, usually taken as 29,000,000 pounds per square inch.

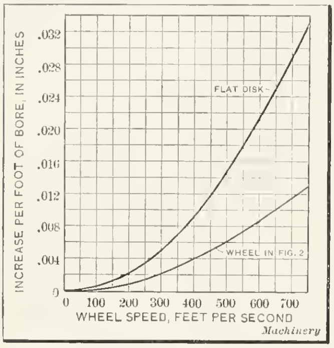

Fig. 1. Increase of Bore of a Rotating Wheel

In most cases of properly designed rotating wheels with a hole at the center, the maximum stress is the tangential stress at the bore. This is, therefore, the stress which is to be considered in order to ascertain if the wheel is safe, and is, further, the stress which must be determined in order to discuss the present problem.

Formula for Increase of Bore

As we proceed outward from the bore in a rotating wheel, the radial stress mounts up rapidly, due to the fact that the centrifugal forces of the outer portions of the disk pull outward on the inner portions. The nearer the center, the less the material in the inner circle, and therefore the less resistance to radial elongation. At the bore there is no force whatever resisting radial elongation, so that the radial stress becomes zero as this inner diameter is reached. We have then, on the inner wall of the cylinder forming the bore, material which is stressed only in the tangential direction, and the increase of circumference is exactly the same as if we had a straight bar of the same length stressed an amount equal to the tangential stress at the bore. This is expressed by the simple relation which is the fundamental equation of our problem:

$$X = \frac{S_{to} D_o}{E} \qquad (1)$$

where

X = increase in diameter in inches of the bore, due to the centrifugal stresses at a given speed;
S_{to} = tangential stresses at the bore in pounds per square inch at the same speed;
D_o = original diameter of bore in inches;
E = modulus of elasticity, 29,000,000 for steel.

It can be shown that the stresses at any point in a given wheel, or at a similarly situated point in any other wheel of similar proportions, are directly proportional to the square of the peripheral wheel speed. Hence the increase of bore varies directly with the square of the peripheral wheel speed with a given wheel. In any case of the same or geometrically similar wheels, the increase per foot of bore increases directly with the square of the wheel speed.

Numerical Magnitude of Increase of Bore

The allowable values of the tangential stress at the hub are quite high, since a centrifugal load is of the nature of a pure dead load in a beam. It is not possible to apply or remove a centrifugal load suddenly. Also, the maximum stress usually occurs only in a single set of fibers which are reinforced by adjacent fibers with decreasing stresses. There need be no "factor of ignorance," and maximum stresses can be known with as great accuracy as it is desired to give to the mathematical computations. In many cases 20,000 pounds per square inch is a conservative stress. In some cases, with special grades of steel, 30,000 pounds per square inch is possible. For a wheel with a 12-inch bore and 30,000 pounds maximum stress the increase in bore computed from (1) is 0.0124 inch, which is an appreciable amount. For other stresses and other dimensions of bore, the increase of bore is in direct proportion. When the stress is 29,000 pounds per square inch the increase in bore is 1 mil per inch of bore.

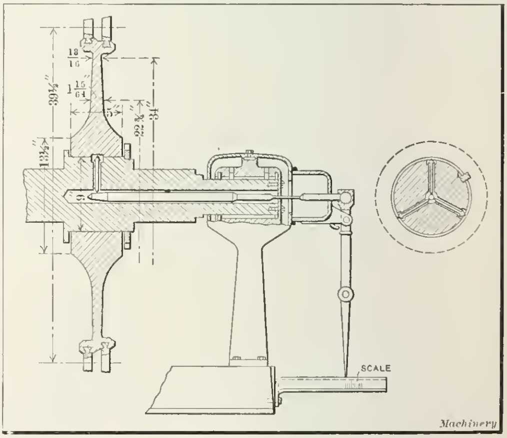

Fig. 2. Diagram of Device used for measuring the Increase of Bore during Rotation

Fig. 1 gives numerical values of increase in bore for various wheel speeds for two different shapes of disks. The upper curve is for a disk of uniform thickness. This shape is only possible with comparatively low wheel speeds and the stresses become excessive with speeds ordinarily used in turbine practice. The lower curve is for a disk of the shape shown in Fig. 2. In both cases the computations are made for a turbine bucket wheel with a load due to centrifugal force of buckets, at 3600 R. P. M. (534 feet per second), of 100,000 pounds per foot of circumference. The shapes of the curves are affected somewhat by the magnitude of this outer dead load. In both cases the ratio of bore to disk diameter is 0.353. The curves are not greatly affected by a difference in this ratio. They give very nearly the values of increase in bore per foot of bore for various wheel speeds for a disk of uniform thickness, which is about as poor a shape as would ever be used, and for a disk of what is probably as efficient a shape as would ever be used, with an average bucket load. The increase in bore for disks of any shape whatever will probably lie between the two curves.

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* Abstract of a paper presented by Mr. Sanford A. Moss of West Lynn, Mass., before the Boston meeting of the American Society of Mechanical Engineers, May 17, 1912.

Experimental Measurement of Increase of Bore of a Rotating Wheel

The magnitudes of the increase of bore in a number of actual turbine wheels, as determined by substituting computed stresses in Equation (1) came out so large that it was decided to make an actual measurement of the increase in bore when a wheel was rotating.

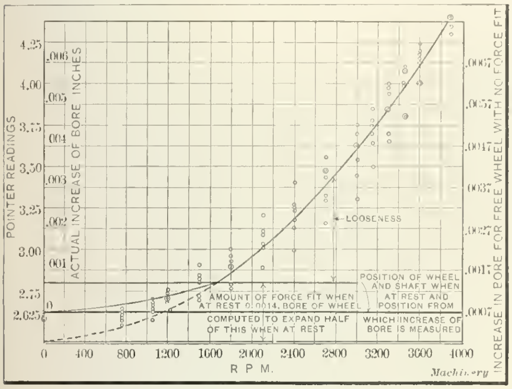

Fig. 3. Increase in Bore of a Rotating Wheel—the Points are from Tests and the Curve is drawn from Computations

Fig. 2 shows the apparatus diagrammatically and Fig. 3 the results obtained. The turbine wheel was mounted on a shaft with a light force fit. A delicate micrometer arrangement was provided so that the change in bore of the wheel while it was rotating with the shaft could be observed. The wheel was gradually increased in speed and meanwhile the readings of the micrometer taken. These showed that the bore expanded at each speed an amount almost exactly equal to the value computed by the methods previously given. The micrometer arrangement proved very positive, and there was no uncertainty regarding the measurement of the increase of bore. The maximum amount measured was about 0.007 inch. The observations were accurate to about 0.0005 inch. The wheel was forced on the shaft with a force fit of 0.0014 inch, so that it was loose on the shaft by about 0.0056 inch at maximum speed.

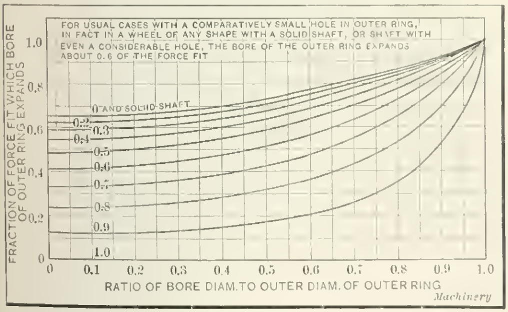

Fig. 4. Ratio of Expansion of Bore to Force-fit Allowance. Figures on Curves denote Ratio of Diameter of Hole in Inner Ring (Hollow Shaft) to Diameter of Bore of Outer Ring (Hub)

Measuring Device

The measuring device shown in Fig. 2 consists of three pistons sliding in radial holes in the shaft. These pistons are pushed outward by means of a tapered plug moving axially in a hole in the center of the shaft. The motion of the central plug is produced by means of a lever with a ball and socket joint fulcrumed so as to give considerable multiplication at a pointer passing over a scale. A displacement of the pointer by 1 inch corresponds to an increase of bore of 0.004 inch. As the speed varied from low values to maximum value the pointer moved a distance of about 2 inches so that the change in bore was quite perceptible.

In order to find the relation between the readings of the pointer and the actual values of increase of bore, and also to demonstrate that the apparatus would give correct measurements at high speed, a calibrating sleeve was made. This was a thin sleeve bored out at each end so as to be a sliding fit on the shaft, and with two different bore diameters in the central portion, either of which could be brought over the pistons of the measuring device. Readings of the pointer were taken at each of these bores, stationary and rotating, at various speeds. The stationary readings gave the motion of the pointer for the known change of bore. The readings taken while rotating showed that the instrument gave correct readings at all speeds.

Test with Rotating Wheel

Next, the rotating wheel was pressed on the shaft. A number of readings of the diameter of shaft and bore of wheel showed that the average amount of force fit was 0.0017 inch. After this, a pair of outside calipers was set to fit the shaft at various points and a pair of inside ones set to fit the wheel bore. The difference between the two calipers was then found by means of a thickness gage. The mean of these observations gave 0.0011 inch as the amount of force fit. The mean of these two values, 0.0014 inch, was considered to be the actual amount of force fit. It was necessary to know the amount of this force fit in order to make comparisons between the computed and observed amounts of increase of bore of the rotating wheel, since the wheel at zero speed is expanded somewhat.

READINGS OF POINTER IN TESTS WITH ROTATING WHEEL

	Test No. 9		Test No. 10		Test No. 11		Test No. 12		Test No. 13	
R. P. M.	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
0	2.61	2.62	2.62	2.63	2.62	2.63	2.63	2.62	2.61	2.62
750	2.61	2.54	2.63	2.59	2.63	2.59	2.64	2.62	. . .	
1050	2.64	2.58	2.70	2.68	2.68	2.67	2.66	2.70		
1200	2.69	2.63	2.74	2.72	2.72	2.74	2.72	2.75		
1500	2.72	2.70	2.80	2.82	2.82	2.80	2.84	2.90		
1800	2.78	2.79	2.90	2.96	2.92	2.90	2.96	3.00		
2100	2.84	2.89	3.03	3.10	3.02	3.10	3.11	3.20		
2400	2.99	3.14	3.18	3.25	3.18	3.24	3.26	3.40	.	.
2700	3.16	3.30	3.32	3.44	3.32	3.48	3.48	3.56	.	.
3000	3.30	3.45	3.54	3.63	3.54	3.63	3.70	3.75		.
3150	3.50	3.64	3.70	3.78	3.75	3.85	3.85	3.85	. .	
3300	3.65	3.70	3.85	3.94	3.85	3.98	4.00	4.00		
3450	3.80	3.80	4.01	4.08	4.00	4.08	4.10	4.08		
3600	4.00	4.00	4.13	4.20	4.15	4.18	4.24	4.20		
3750	4.12	4.12	4.24	4.28	4.30	4.29	4.34	4.33		
3900	4.30	4.30	4.34	4.31	4.38	4.38	4.38	4.38	4.38	4.38

Machinery

Readings of the pointer were taken at various speeds as shown by the table, and the results plotted in Fig. 3, as mentioned. Owing to the fact that the wheel was forced on the shaft, the measured diameter of the wheel at zero speed is greater than the actual free diameter of the wheel. By methods given in the following, it was computed that the wheel was expanded by the force fit one-half of the difference in free diameters, the remainder being compression of the shaft. Hence the base line for increase in bore of the wheel, from the free condition, is the lower line of Fig. 3, which is 0.0007 inch below the base line for increase in bore from the actual initial value when on the shaft. The computed curve for the increase in bore for the free wheel at the various speeds is drawn in Fig. 3 beginning with the lower base line. At the speed at which the expansion of the free wheel is equal to the amount of the force fit, 0.0014 inch, the shaft is just released from its compression and wheel and shaft are of just the same diameter. For speeds beyond this point, the wheel expands exactly as if there were no initial force fit. The wheel is loose on the shaft by whatever increase in bore occurs beyond this point. The observed points are seen to fit the computed curve very closely. For all speeds below that at which the wheel and shaft just touch, there is compression of the shaft and expansion of the wheel by the force fit, the amount being successively less as the speed increases. The effective force fit at any speed is the difference between the force fit at rest, and the expansion of the free wheel at the given speed. The effective force fit is, therefore, the difference between the dotted curve and the upper horizontal line. As shown later, when there are different amounts of force fit with a given wheel and shaft, the expansion of the wheel is always a constant fraction of the amount of force fit. This is one-half in the present case. Hence the curve showing the increase in bore of the wheel, as the force fit is gradually relieved, is drawn halfway between the dotted curve and the upper horizontal line.

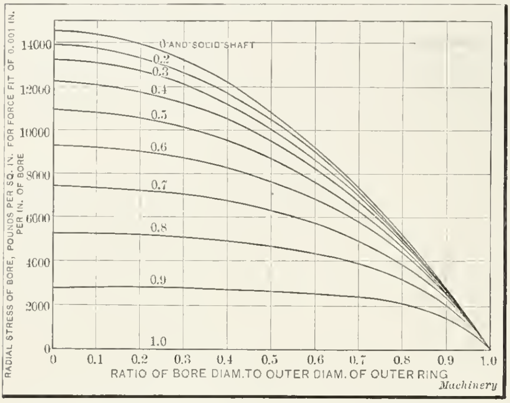

Fig. 5. Radial Stress at Bore with Allowance for Force-fit of 0.001 inch per inch of Bore—The Figures on the Curves denote Ratio of Diameter of Hole in Inner Ring (Shaft) to Diameter of Bore of Outer Ring (Hub)

In the present case the amount of the force fit is comparatively small. It was originally intended to repeat the experiments with successively increasing amounts of force fit. The measuring apparatus was arranged so that it could be torn down and reassembled without change in the absolute initial value of the readings. This was done with the idea of actually measuring the change in the initial bore of the wheel when put on the shaft with different amounts of force fit, giving curves in Fig. 3 which would start with successively greater amounts of force fit and meet the curve of a free wheel higher up. However, the results of the first experiment agreed so closely with the theory and everything was so obvious after study of the subject that no further experiments were made.

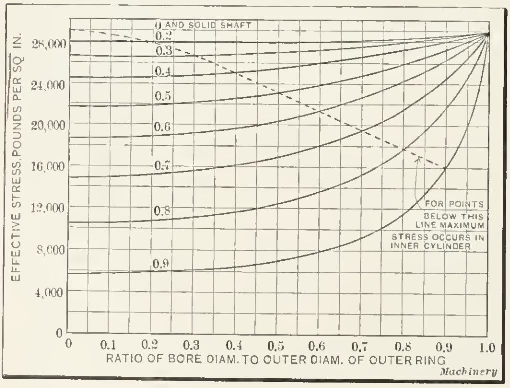

Fig. 6. Effective Tensile Stress at Bore of Outer Ring (Hub)

Design of Wheel subject to Increase of Bore by Centrifugal Stresses

The method used to prevent difficulty due to loose wheels is to force the wheel on the shaft with a force fit, or difference in diameters between wheel bore and shaft, greater than the computed amount of increase of bore at maximum speed. In some cases this has resulted in large amounts of force fit requiring very heavy pressures for forcing. Special material is necessary for the bushings between the wheel and the shaft. However, all of these points have been successfully met and ill effects due to loosening of the wheels wholly eliminated.

In some cases the wheel hubs do not fit along their entire length but only in places. The radial pressure when the fit occurs for only a short distance is obviously increased by the ratio of the total length of hub to the actual length of the fit. The numerical values of this radial pressure on the bushings come to very high figures in many cases. Of course, some relief is offered by the fact that this pressure is pure compression and that the metal of the bushings is constrained on nearly all sides so that the resistance to flow is considerable. Under such circumstances much higher values of compression stress can be used than when there is no resistance to the deformation which the compression tends to cause. There is reason to believe that in the ideal case of a piece subject to pure compression in every direction, there would be no failure even with an infinitely large stress. It is to be remarked that when the force fit is just sufficient to prevent loosening at full speed and the shaft is solid, the effective stress in the hub due to the force fit at rest, is exactly equal to the stress at full speed.

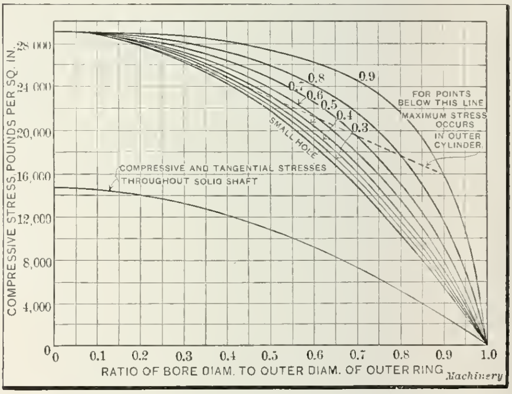

Fig. 7. Compressive Tangential Stress at Inner Diameter of Inner Ring (Shaft)—Values given are Maximum Effective Stresses in Inner Ring

Computation of Force and Shrink Fits with Steel

A wheel hub is affected by the stresses imposed only for a very short distance outward, so that the nature of the outer portion has little or no influence. The condition near the hub in a flat disk with an outer diameter only ten times the diameter of the bore is practically the same as in a disk with an infinitely large outer diameter. We, therefore, consider only the case of a ring forced upon another ring of equal axial length. We estimate the outer diameter of the outer ring so as to make it equivalent, so far as expansion is concerned, to a given wheel of any shape. For instance, for a solid wheel comparatively thin at the outer portion, we would estimate the equivalent flat disk to have one-half or one-third the diameter of the wheel. For a wheel with spokes, we have little more than the hub only. Owing to the comparatively slight influence of the parts of the rings furthest from the fit, a considerable error in estimation of the diameters of the equivalents will cause a comparatively small error in the results. Figs. 4, 5 and 6 give amount of expansion and stresses in an outer ring or hub pressed or shrunk on an inner ring or shaft.

The difference in the free diameters is called the force fit, which we will denote by X. When the hub is in place on the shaft and there is no rotation, it is expanded by a certain amount F'. The shaft is also compressed by a considerable amount. The sum of the increase of hub bore F' and the compression of the shaft is evidently the amount of the force fit. Fig. 4 gives values of $\frac{F''}{X}$, the fraction of the force fit which the hub expands.

Fig. 5 gives the radial stress at the bore of the hub, which is also the stress at the outside of the shaft, as well as the pressure per square inch between hub and shaft when there is actual contact for the full length of the hub. Fig. 6 gives the maximum effective stress at the bore of the hub. This is the greatest stress in the system unless the shaft is hollow and relatively thin. Figs. 5 and 6 are for a force fit of one mil per inch of bore. Stresses for other values are in proportion. The abscissas of these figures give the ratio of the bore to the outer diameter of the hub. The upper curve in each of these three figures is for a solid shaft or one with a small hole and the other curves are for rings with various sizes of holes. When the abscissa is zero the outer diameter of the hub is infinitely large as compared with the bore. The curves are nearly horizontal for a considerable distance in this region and the results for an outer diameter ten times the diameter of the bore, that is, a ratio of 0.1, are almost the same as for an infinite outer diameter. The values for an outer diameter five or three times the diameter of the bore change but little.

Similarly, as will be seen by noting the curves for the various values of the ratio of the diameter of the hole in the shaft to the shaft diameter, the hole has but little influence unless it is comparatively large. The usual case of a shaft with a comparatively small hole is practically equivalent to a solid shaft. As will be seen by a study of the curves, the cases where the diameter of the hub is seven times the diameter of the bore, giving a ratio of 0.11, and where the hole in the shaft is 0.3 of the shaft diameter, give very nearly the results of any usual case. Hence, for usual cases the hub bore expands about 0.6 of the amount of the force fit and for a force fit of one mil per inch of bore the radial stress is about 13,000 pounds per square inch and the effective tangential stress is about 27,000 pounds per square inch. For a solid shaft, however, the maximum effective stress is 29,000 pounds per square inch for a force fit of 1 mil per inch of bore, regardless of the character of the wheel or hub. The stress for other amounts of force fit is in proportion.

Force fits of 1 mil per inch are, therefore, about as large as will give no permanent set of the hub for steel and a solid shaft. Force fits up to about 1½ mil are frequently used. These give some set of the fibers very near the bore. This set is almost entirely eliminated, however, by the elastic force of the outer fibers if the hub is ever removed from the shaft. Fig. 7 gives the maximum stress (at the inside) in the shaft or inner ring. This is usually less, but for a relatively thin ring may be greater, than the stress in the hub. A solid shaft has a stress one-half as great as one with a small hole.

A rational expression for the force in pounds required to press the hub on the shaft is

$$0.12\, dlS_r$$

where l is the length; d, the diameter of bore of the hub in inches; and S_r the radial stress at the bore found from Fig. 5. The coefficient 0.12 was obtained from actual tests and gives a coefficient of friction of 0.038. For a force fit of one mil per inch of bore, the forcing pressure is about 1560 pounds per inch of bore and per inch of hub length. The forcing pressure, of course, varies widely on account of the influence of surfaces and lubricants. The formula gives an average value.

* * *

The ordinary carpenter's level is not commonly regarded as an instrument of precision, but it is nevertheless more sensitive to variations in the level of planes than many mechanics suppose. The bubble of a good carpenter's level indicates variations of level in the ratio of four to one to the foot. Thus in a length of one foot a change from level of 1/64 inch should change the position of the bubble in the glass 1/16 inch. The highest grade precision levels magnify variations from a level plane thirty-two times. Hence a precision level one foot long should indicate a change of height of 0.0001 inch at one end by a bubble movement of 0.032 inch, an amount easily seen with the naked eye.

SECTION MODULI FOR RECTANGLES*

BY KARL E. BARRETT†

The tables presented in the current Data Sheet Supplement give the strength moduli for various sizes of rectangular sections which the writer originally compiled for his own use. These tables have drawn forth considerable comment among fellow designers, and on this account the idea of presenting them to the readers of MACHINERY suggested itself.

In designing, the problem of determining the required size of a rectangular member to carry a given load frequently arises. Evidently such a member can be of different shapes and still possess the necessary strength for the intended purpose. The method of using the tables in the supplement can be best illustrated by an example. A cast-iron beam is required to withstand a bending moment of 10,000 inch-pounds. Taking the ultimate strength of cast iron in flexure as 25,000 pounds per square inch, and dividing this value by the factor of safety of 10, which is used in the case of variable loads gives a working fiber stress of 2500 pounds per square inch. The strength modulus Z of the required section is found from the equation

$$\frac{25{,}000}{10} = \frac{10{,}000}{Z}$$

from which the strength modulus of the section will be seen to equal 4. Reference to the tables will show that the designer has a choice of six different sections of the following sizes:

3/8 by 8 inches; 7/16 by 7½ inches; 1/2 by 7 inches; 1 3/16 by 4½ inches; 1½ by 4 inches; 2 11/16 by 3 inches.

Several advantages are secured from the possibility of making this selection. These may be briefly enumerated as follows: 1. If one dimension is limited by the available space, the designer can tell at a glance what the second dimension must be to give the section the required strength modulus. 2. If the existing conditions do not limit either the width or depth, a choice of sizes can be made which will enable the most satisfactory shape to be used. 3. It will also be readily understood that the use of these tables saves a lot of time as compared with cut and try methods which would otherwise be necessary in proportioning a given member.

The tables were compiled from the equation for the section modulus of a rectangle. The section modulus for a rectangle equals $\frac{WD^2}{6}$, where W is the width of the section and D its depth. The results have been carried out to two decimal places in all cases, although in the case of sections deeper than 5 inches, this is really unnecessary. It will be seen that for the larger sections, the modulus increases by increments of 0.2 or more for every increase of 1/16 of an inch in the width of the section.

The writer has used these tables constantly in the designing room of E. & T. Fairbanks & Co., scale manufacturers, where their use has been the means of effecting a material saving in time and labor.

* * *

The moving picture machine is being applied to some interesting purposes other than mere amusement. It is being used successfully in scientific studies of motions required of workmen in doing work. Frank B. Gilbreth, well known as a scientific management expert, has applied the moving picture machine to motion study in the New England Butt Co.'s plant in Providence, R. I. The workman goes through the normal cycle of operations before the moving picture machine. In the same view is a clock having one hand only that shows plainly in every picture. The clock hand makes one revolution in six seconds, and intervals as short as one-thousandth minute may be noted, if required. The moving pictures obtained may be studied at leisure and the time of every movement accurately computed by reference to the clock dials at the start and finish. The advantage of consecutive and definite time records of all movements, both in detail and in the aggregate, is obvious to those familiar with the difficulty of obtaining accurate time studies of work being done.

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* With Data Sheet Supplement.

† Address: Care of E. & T. Fairbanks & Co., Sherbrooke, Quebec, Canada.

GRAHAM MFG. CO.'S PRODUCTION LISTS

Production lists are considered essential in all modern manufacturing shops, but on account of the trouble incident to their preparation and upkeep they are often regarded in the light of a necessary evil. At the shops of the Graham Mfg. Co., Providence, R. I., manufacturers of drill speeders, a production list system is in vogue which requires a minimum of work for its maintenance. Fig. 2 shows a fac-simile of one of the lists which is used in the production of their No. 2 drill speeder. A zinc engraving was made having the name of the firm, a border and division lines, the numbers for the parts from 1 to 36 at the left side, and the headings for the columns. By printing 9- by 12-inch sheets of "Archive" bond paper with this engraving it became a simple matter to fill in the drawing numbers and other necessary data on the blueprint. No tracings are necessary as this bond paper is readily blueprinted through. By the use of item numbers, it is easy to refer to the different parts quickly when talking over the telephone or writing.

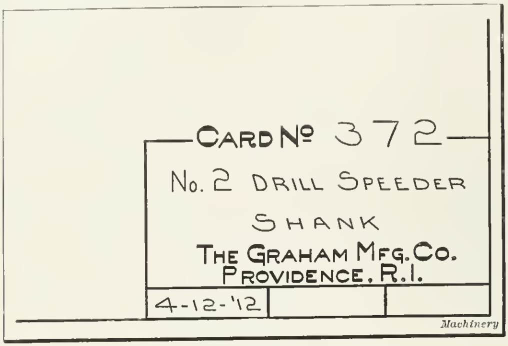
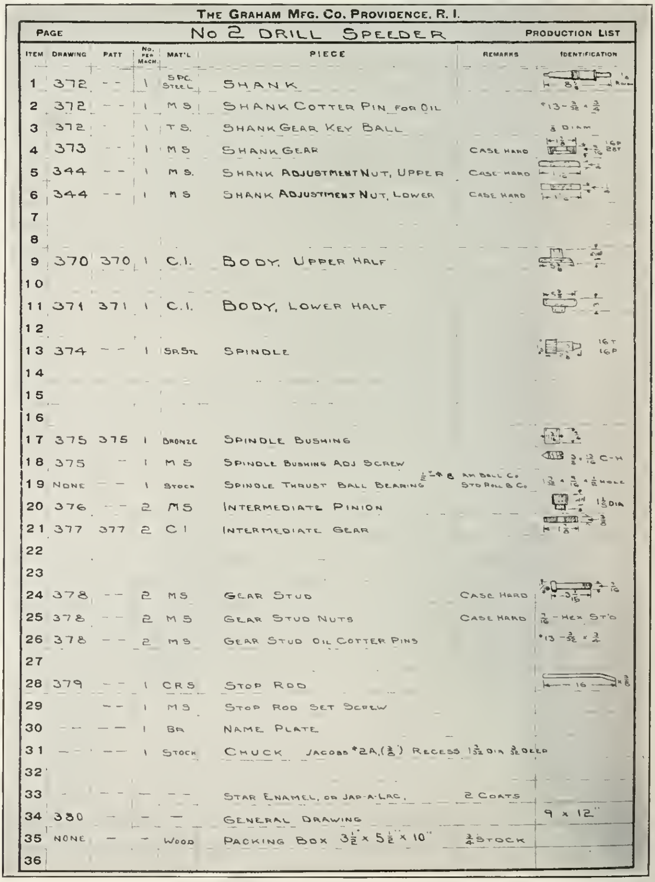


Fig. 1. Corner Form used on Drawings. Usual Margin Lines are omitted

Another interesting feature of the Graham Mfg. Co.'s production lists is the identification sketches which are shown at the right of each part description. These little sketches, which are made free-hand, serve to identify the part quickly when running down the list or when checking up any line of the list. The dimensions used in connection with the identification sketches are not intended to be worked to, but simply serve to give a general idea of the proportions of the piece. This feature of the production list is a great help to a new workman, who is less likely to make mistakes when identification sketches are used with each item of the list.

In connection with the general drawing system of the Graham Mfg. Co. it is interesting to note that all drawings are kept to standard sizes of 9 by 12 inches, 12 by 18 inches, and 18 by 24 inches. No border lines are used around the drawings, but they are made with merely a corner outline having the card number, title of the drawing, firm name, date, etc., as indicated in Fig. 1. By the elimination of the border lines a larger working space on the drawing is secured, and lines and figures may be run very close to the edge of the paper and still look well. In addition, when cutting blueprint paper the exactness required for bordered sheets is not necessary, and if sections of any print must be sent outside of the shop for estimates there are no border lines to disfigure such sections. One drawing is provided for each distinct piece, although there may be small screws or pins thereon, all of which are itemized upon the production list. Thus, referring to Fig. 2, it will be seen that on drawing 372 there are three items. This method of making production lists has saved considerable trouble and expense.

C. L. L.



The Graham Mfg. Co. Providence, R. I.

Page No 2 Drill Speeder Production List

Item	Drawing	Patt	No. per Mach.	Mat'l	Piece	Remarks	Identification
1	372	– –	1	Spc. Steel	Shank		8 5/8
2	372	– –	1	M S	Shank Cotter Pin for Oil		#13 – 3/32 × 3/4
3	372	–	1	T S.	Shank Gear Key Ball		3/8 Diam
4	373	– –	1	M S	Shank Gear	Case Hard	16P 28T
5	344	– –	1	M S.	Shank Adjustment Nut, Upper	Case Hard	
6	344	– –	1	M S	Shank Adjustment Nut, Lower	Case Hard	
7							
8							
9	370	370	1	C.I.	Body, Upper Half		
10							
11	371	371	1	C.I.	Body, Lower Half		
12							
13	374	– –	1	Sp.St.	Spindle		16T 16P
14							
15							
16							
17	375	375	1	Bronze	Spindle Bushing		
18	375	–	1	M S	Spindle Bushing Adj Screw		3/8 × 13/16 C-H
19	None	– –	1	Stock	Spindle Thrust Ball Bearing	1/2"–4 B Am Ball Co Std Roll B Co	1 3/32 × 9/16 × 1/2 Hole
20	376	– –	2	M S	Intermediate Pinion		1 1/5 Dia
21	377	377	2	C I	Intermediate Gear		1 1/8
22							
23							
24	378	– –	2	M S	Gear Stud	Case Hard	3 1/16
25	378	– –	2	M S	Gear Stud Nuts	Case Hard	7/16 – Hex St'd
26	378	– –	2	M S	Gear Stud Oil Cotter Pins		#13 – 3/32 × 3/4
27							
28	379	– –	1	C R S	Stop Rod		16 × 3/8
29		– –	1	M S	Stop Rod Set Screw		
30	– –	– –	1	Br	Name Plate		
31	– –	– –	1	Stock	Chuck Jacobs #2A, (3/8") Recess 1 3/32 Dia 3/32 Deep		
32							
33	–	– –	—	– –	Star Enamel, or Jap-a-Lac,	2 Coats	
34	380	–	—	—	General Drawing		9 × 12"
35	None	—	–	Wood	Packing Box 3½ × 5½ × 10"	¾ Stock	
36							

Fig. 2. Form of Production List used by Graham Mfg. Co.

* * *

An address made recently by James J. Hill before the Railway Business Association in New York on the need of greater railway facilities and terminals, has attracted widespread attention. What Mr. Hill said regarding the need of larger terminals is undoubtedly true—if our railroads continue to handle freight as they do now. But there is the possibility of revolutionizing the present methods with great consequent improvement in service and lessened need of large terminals. The need for large terminals arises from the fact that freight is not promptly unloaded as soon as it reaches its destination. If the railroads fully filled their function as transporters of freight, they would not stop with it at a great freight yard, but would unload it and deliver the smaller lots by wagon to the consignees, as is done in England and other European countries. No doubt if the influence of the express companies had not paralyzed the natural development of transportation, we would not now have in vogue the unnatural and inefficient methods of handling freight. The fact that the average mileage of a freight car is only twenty-four miles a day is proof that the greater part of its possible active earning capacity is wasted standing on sidings and in terminals. To greatly increase terminal capacity will be only to add enormously to the debt that American railroads stagger under and which is the one great cause of inefficient operation.

FORMULAS FOR SPIRAL GEAR COMBINATIONS

BY L. G. ZESBAUGH[*]

The following gives useful formulas for finding the diameters and angles of spiral gears for cases where the distance between centers of the shafts, speed ratio and approximate diameter ratio have been assumed.

Let D_1 = diameter of driver;
D_2 = diameter of follower;
S_1 = speed of driver;
S_2 = speed of follower;
P = diametral pitch;
x = angle of teeth of driver with its axis;
N_1 = number of teeth in driver;
N_2 = number of teeth in follower.

The method of procedure is shown below.

Assuming trial values for D_1 and D_2, an approximate angle is derived from the formula

$$\frac{D_2S_2}{D_1S_1} = \cot x \qquad (1)$$

Find, by trial, the number of teeth for each of the gears which will most nearly balance the formula

$$\text{Twice distance between shafts} = \frac{N_1}{P\cos x} + \frac{N_2}{P\sin x} \qquad (2)$$

Balance Equation (2) by correcting the sines and cosines until the exact value of x is found.

Then

$$D_1 = \frac{N_1}{P\cos x} \qquad (3)$$

$$D_2 = \frac{N_2}{P\sin x} \qquad (4)$$

Application in a Practical Problem

Considering a case in which the distance between centers is 4.125 inches, the speed ratio of the driver to the follower 2 : 1, and the ratio of $D_1 : D_2$ about 9 : 8. It is required to find the diameters and angles of the teeth of the spiral gears.

Substituting known values in Equation (1), we find an approximate value of cotangent x as follows:

$$\frac{D_2S_2}{D_1S_1} = \frac{8\times 1}{9\times 2} = 0.4444 = \cot 66 \text{ degrees (approximately.)}$$

We find that 14 and 28 teeth will best balance Equation (2). Substituting these numbers of teeth and the functions of 66 degrees in this equation, we have

$$\frac{14}{8\times 0.4067} + \frac{28}{8\times 0.9135} = 8.134$$

Subtracting, $8.250 - 8.134 = 0.116$

We see that the angle of 66 degrees introduces an error of 0.116 inch for twice the distance between centers of shafts. This shows that 66 degrees is not exactly the required angle. Trying 66 degrees 50 minutes, we get

$$\frac{14}{8\times 0.3934} + \frac{28}{8\times 0.9194} = 8.254$$

Subtracting, $8.254 - 8.250 = 0.004$

We see that 66 degrees 50 minutes is very close to the required angle, as the error for twice the distance between the centers of the shafts is now only 0.004 inch; trying an angle of 66 degrees 48 minutes, we get

$$\frac{14}{8\times 0.3939} + \frac{28}{8\times 0.9191} = 8.25$$

The angle of 66 degrees 48 minutes gives exactly the required distance between centers. We can now use this angle in determining the required diameter for the driver and follower by substitution in Equations (3) and (4).

$$D_1 = \frac{N_1}{P\cos 66^\circ\, 48'} = \frac{14}{8\times 0.3939} = 4.442 \text{ inches}$$

$$D_2 = \frac{N_2}{P\sin 66^\circ\, 48'} = \frac{28}{8\times 0.9191} = 3.808 \text{ inches}$$

By reference to a table of natural functions, we find that sine 66 degrees 48 minutes equals cosine 23 degrees 12 minutes, and this determines the angle of the teeth in the follower as 23 degrees 12 minutes.

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STANDARDIZING DRAFTING-ROOM AND SHOP TERMS

There appears to be a demand for a more definite understanding of certain drafting-room and shop terms, among which are: "tolerance," "working tolerance," "permissible tolerance," "necessary tolerance," "clearance," "working clearance," "allowance," "working allowance," "running fit," "sliding fit," "snug fit" and "finish." Confusion has resulted from the loose manner in which these terms have been used in technical papers, hand-books, etc. Now in the writer's opinion, there are three terms which adequately cover the meaning conveyed by the preceding list. They are "finish," "tolerance" and "clearance."

The term "finish" implies the final touches or elaboration that is given to the work, and should not be confounded with the accuracy or final dimensions that are required. The class of finish required should be specified on the drawing. For instance: polish, buff, paint, etc., according to the appearance that is desired. The term "tolerance" implies the amount of deviation from the specified dimensions that is permissible. Neither all mechanics nor all machines are capable of turning out work with the same degree of accuracy, and to allow for such inaccuracy, a certain degree of tolerance is allowed although it is not desirable. This deviation from the specified dimensions must be expressed in the form of an exponent, of the proper sign, as ±, —, or +, to the actual dimensions of the article. "Clearance" is used to denote the space between adjacent parts, whether it is merely to avoid interfering or to signify the different classes of fits previously mentioned. The clearance allowed between different parts is governed by the condition under which such parts are to work, the amount being left to the judgment of the designer. Clearance should be taken into account when giving the actual dimensions of individual parts, and should always be indicated on the drawing as the actual size of the part and not as an exponent as in the case of tolerance.

In specifying tolerance and clearance, care should be taken to make sure that the parts can be properly assembled. The importance of this measure will be made apparent by the following example: A shaft for a 2-inch hole should be specified as $1.997^{-0.002}$ inch, polish. This signifies that the 0.003 inch clearance is the space between the shaft and the hole which the designer considers necessary for good running, minus a tolerance of 0.002 inch which will be allowed for inaccuracy in workmanship; the work is then to be finished with a polished surface. The size of the hole to carry the shaft would be specified as $2\ 0^{\ 0.002}$ inches. These dimensions refer to diameters in both cases. It is true that if the workmanship is poor, there will be an actual clearance of 0.003 inch + 0.004 inch = 0.007 inch between the shaft and the hole. This error can be reduced by making the specified tolerance less, or in other words by requiring more careful and accurate workmanship. The practice of making drawings which specify the exact amount of clearance between different parts and the amount of tolerance is to be advocated. Where such a practice is followed, there can be no controversy when the work comes up for inspection, because everything is plainly stated and there is no opportunity for misunderstandings to arise from the use of such terms as "running fit," "necessary tolerance," "working clearance," etc. S.

* * *

A booklet entitled "Machine Tools in Latin America," will be issued shortly by the Bureau of Foreign and Domestic Commerce, Washington, D. C. It comprises a series of consular reports with a valuable list of firms and individuals in Latin-American countries who use or sell machine tools. Considerable attention is also given to sales methods, credit terms, etc. There seems to be an increasing demand for machine tools in these countries, especially in connection with railway repair work.

DESIGNING STEEL TOWERS FOR WOOD TANKS—3

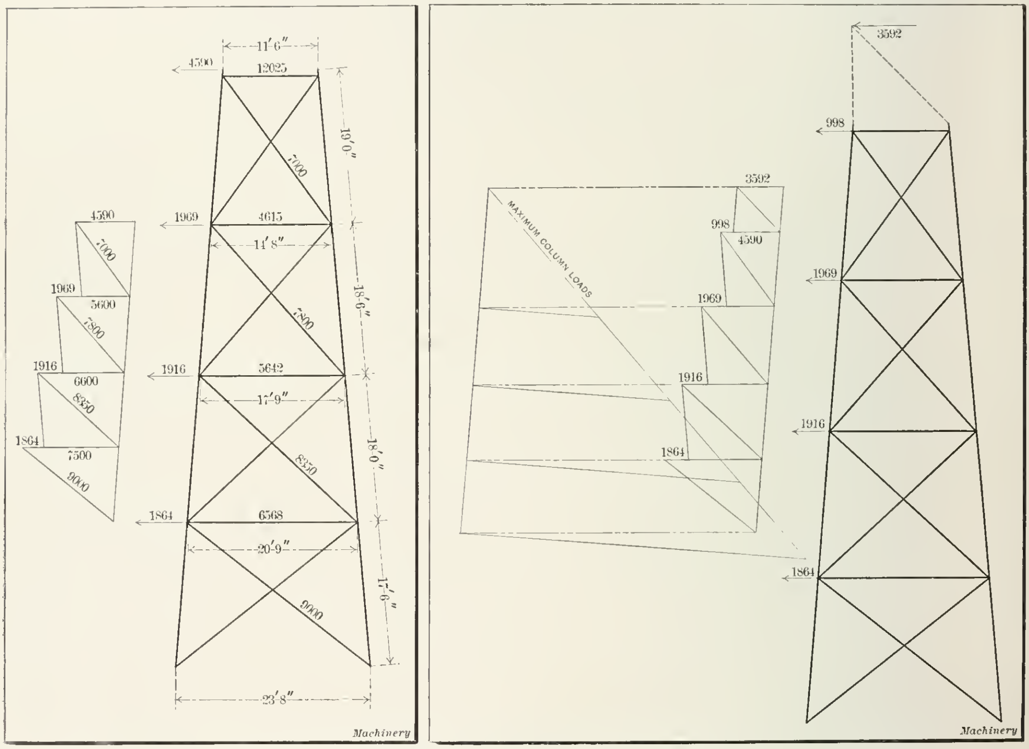
A COMPLETE ANALYSIS OF THE STRESSES IN THE TOWER STRUCTURE

BY EDMUND B. LA SALLE[*]

Determination of Loads in Bracing

We have now proportioned the columns and can turn our attention to the diagonal rods and struts or girts as we will call them, as that is the usual name as applied to towers. For this purpose we will use graphical statics, constructing a frame diagram of the tower to represent the dimensions given to a convenient scale, as shown in Fig. 12. The initial force in the diagram when worked out according to H (preceding installment) is:

$$\frac{7184}{2} + \frac{19 \times 210}{4} = 4590 \text{ pounds.}$$



Figs. 12 and 13. Graphical Determination of Wind Loads in Tower Structure and Columns

The wind concentrated at the second girt from the top, according to J is:

$$\frac{(19 + 18.5) \times 210}{4} = 1969 \text{ pounds.}$$

The force for the third girt is:

$$\frac{(18.5 + 18) \times 210}{4} = 1916 \text{ pounds.}$$

The force for the bottom girt is:

$$\frac{(18 + 17.5) \times 210}{4} = 1864 \text{ pounds.}$$

With these forces worked out construct the stress diagram as shown and scale off the loads. From the girt loads subtract one-half the values calculated by J to get the actual loads in the girts. For the load in the top girt we refer to I which gives a value of:

$$\frac{401{,}415 - 20{,}500}{48} + 4590 = 12{,}525 \text{ pounds.}$$

From this we subtract one-half the value obtained under J which is:

$$\frac{19 \times 210}{4} = 998 \qquad \frac{998}{2} = 499, \text{ say } 500 \text{ pounds.}$$

$$12{,}525 - 500 = 12{,}025 \text{ pounds load in top girt.}$$

The reader will probably have noticed that the stress diagram Fig. 12 is slightly different in appearance from the one shown in the first installment. This is due to adding the loads J at each corresponding point instead of on the load line at the top as before. The method used in the present discussion is somewhat simpler and easier to understand. The letters are also omitted as the diagram can readily be followed without them.

Graphical Method for Finding Column Live Load

In Fig. 13 is shown a diagram from which we can get the wind loads in the column directly, instead of calculating as previously explained. Of course the first method is more accurate, but considerably longer. There is one valuable feature in the graphical method, and that is that we can get the column wind load in any panel by scaling the diagonal column load line. To draw the diagram, lay out the frame diagram as before. On top of the frame diagram, construct a triangle. The vertical line of the triangle is drawn to a height equal to the distance of the center of gravity of the tank wind, which coincides with the center of the tank. The diagonal is drawn from the top of the right-hand post to the top of the vertical line. This gives us the point of application of the tank wind as regards the tower. Next, draw the top line or initial load of the stress diagram equal in length to half the tank wind. In this case, we do not add one-half the top panel wind, as in the other diagram, that being added later. Now draw the right-hand line of the diagram of indefinite length and parallel to the left-hand post of the frame diagram. From the left-hand end of the initial load line, draw a diagonal line parallel with the diagonal line of the tank wind triangle on top of the frame diagram. Extend this line to intersect the column load line, as shown, and at the intersection draw a horizontal line of indefinite length. From the left-hand end of the initial load line, draw a slanting line parallel with the column load line and intersecting the hoizontal line just drawn. We now have a polygon of forces which represents the reaction at the top of the columns due to the overturning moment of the wind on the tank. We next add the wind on the upper half of the top panel to the line forming the bottom of the polygon, as represented in Fig. 13 by 998 pounds. That force then becomes 4590 pounds which the reader will notice is the same as the initial force in the previous diagram, Fig. 12. We have done nothing else here but add the polygon representing the reaction on the columns, due to the overturning moment of the wind on the tank, to the diagram Fig. 12, in order to represent the addition to the column load line of the reaction of the tank mentioned above. The shape of the polygon is governed by the location of the center of gravity of the tank, as represented by the triangle which was added to the frame diagram.

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Starting with the horizontal force of 4590 pounds we can now complete the diagram as we did in Fig. 12. The lines will all scale the same except the column load line which, of course, will be longer. If we now multiply the amount we get by scaling the column load line by 1.4142, we will have the maximum column wind load, as previously calculated for the wind blowing diagonally across the tower. The line gives the true column wind load when the wind is acting parallel with the sides or trusses of the tower, but as that is not the most severe condition, we do not use that value. In order to scale the maximum column wind load in any panel, we project the panel points and the column load line to one side of the diagram as shown. Then draw a line parallel with the column load line and erect a perpendicular at its base equal in length to the column load line. Join the ends of these two lines by a diagonal. This diagonal, when scaled, will give the maximum live load in the column due to the wind. If we now erect a perpendicular at each panel point to intersect the diagonal line, as shown, we can scale the column live load in each panel by measuring from the left-hand end of the diagonal in each case to the point in question. The scaled live load, added to the dead load, gives the total column load, and it should check closely with the computed load if the diagram is properly drawn.

Size of Girts

The maximum length of girt recommended gives a value of 175 for $\frac{L}{R}$. Some specifications call for 150 for the factor $\frac{L}{R}$, but in that case the girts become so heavy that they are out of proportion to the columns, when the columns are proportioned according to the two formulas given in the preceding installment:

$$\text{Strength per square inch} = 17{,}100 - 57\frac{L}{R} \qquad (1)$$

$$\text{Strength per square inch} = 16{,}000 - 70\frac{L}{R} \qquad (2)$$

Of the two formulas, the writer favors the second as it cuts off faster, *i. e.*, it grows safer as the columns or girts grow longer. In regard to the maximum length of the columns, it may be said that in no case should they exceed a length that makes $\frac{L}{R}$ over 125. Nearly all girts are made of two unequal leg angles placed one above the other with the longer leg horizontal (as shown on page 371 of the January, 1912, issue of MACHINERY), and connected by batten plates at the ends and by flat lacing bars between the plates, similar to a standard channel column. The top girt in this case can be placed so that its center line is 9 inches below the top of the column, and the center-to-center length then becomes 139½ inches. The required radius of gyration is 139.5 ÷ 175 = 0.80.

The smallest angles it is practical to use are two 3 by 2 by ¼ inch. The radius of gyration about the axis parallel with the small leg or flange is 0.97 which is a little more than is required.

$$\frac{L}{R} = \frac{139.5}{0.97} = 144.$$

According to Formula (2) this gives a value per square inch of 5920 pounds for the strength of the girt; 5920 × 2.38 = 14,090 pounds, total strength of the girt.

We will now try the formulas derived from the results of U. S. Government tests (page 455, February number), and see what safety factor the girt has. As the girts are fastened to the columns by means of rivets or bolts, we will call them pin-ended compression members, and use 30,000 — 200 (141 — 125) = 26,200 pounds.

26,200 × 2.38 = 62,356 pounds, ultimate strength of girt; 62,356 ÷ 12,025 = 5.18, actual safety factor.

It is a good plan to have a large safety factor for the top girt, as this member receives a heavy and constant load, while the other girts do not receive a constant dead load, but only the varying load due to the wind.

The center-to-center distance of the second girt from the top is 14 feet 8 inches = 176 inches; 176 ÷ 175 = 1.00, required radius of gyration.

The nearest size to this is two 3½ by 2½ by ¼ L-sections. They have a radius of 1.12. It is best to keep the number of sizes used as small as possible, and to stick to the sizes most commonly used. The reader will find that there are sizes in other sections that come nearer to the required radius of gyration than those mentioned, but they are not so common and are therefore harder to get quickly when wanted. The sizes which will be considered are the ones generally used for tower girts.

$$\frac{L}{R} = \frac{176}{1.12} = 157.$$

This gives 5010 pounds as the strength per square inch; 5010 × 2.88 = 14,429 pounds, strength of girt.

This shows that the girt selected is somewhat too strong for the wind load, but it would not be advisable to use one making $\frac{L}{R}$ greater than 175. During erection, the girts are used as supports for the scaffolds, and sometimes a considerable weight is supported by them as beams; therefore, they should have a good factor of safety as far as the wind is concerned, and it will be found after a number of trials that a value of 175 for $\frac{L}{R}$ will give satisfactory results.

The third girt from the top has a length between centers of 17 feet 9 inches = 213 inches and $\frac{213}{175}$ = 1.22, required radius of gyration. Two 4 by 3 by 5/16 inch L-sections have a radius of gyration of 1.27 and a cross-sectional area of 4.18 square inches.

$$\frac{L}{R} = \frac{213}{1.27} = 168.$$

This gives a strength of 4240 pounds per square inch and a total strength of 4240 × 4.18 = 17,723 pounds for the strength of the girt.

The bottom girt has a length of 20 feet 9 inches = 249 inches; 249 ÷ 175 = 1.43, required radius of gyration. Two 5 by 3 by 5/16 inch L-sections have a radius of gyration of 1.61 and an area of 4.82 square inches.

$$\frac{L}{R} = \frac{249}{1.61} = 155.$$

This gives the strength of the girt a value of 5150 pounds per square inch and 5150 × 4.82 = 24,823 pounds, total strength of girt.

We have seen that for all girts other than the top one, we do not need to calculate their strength as regards the wind load, because that load is comparatively light, and when the length limit giving 175 for $\frac{L}{R}$ is adhered to, the girts are always amply strong. This assertion applies to standard towers only, *i. e.*, to those with a column slant or batter of one inch per foot, and not to those having a large batter or other special features of construction. We should always be sure that the girts have a safety factor of at least 4, which can be ascertained by using any of the formulas derived from the tests. For girts we would use, as before:

$$S = 30{,}000 - 200\left(\frac{L}{R} - 125\right)$$

Size of Diagonal Rods

The diagonal brace rods come next into consideration. The best fiber stress to use for them is 12,500 pounds per square inch. The top rods have a load of 7000 pounds. Hence 7000 ÷ 12,500 = 0.56 square inch, required area.

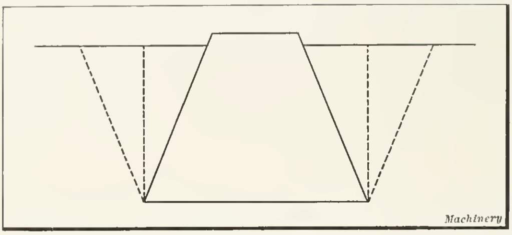

Fig. 14. Diagram showing Method of Calculating Pressure of Piers

If we do not want to upset the rods on the threaded ends, it will be necessary to use rods one inch in diameter. This size of rod will have a fiber stress of 12,750 pounds per square inch which is not seriously in excess of the specified limit. It is considered better practice not to upset the rods at the end, as when they are upset there is danger of their being burnt in heating. It is, however, more economical of material to upset them. In the upset rod it would require a ⅞-inch diameter rod to upset to 1⅛ inch. By the same method, using rods that are not upset, we will find that the next three sets of rods will have to be 1⅛ inch in diameter, and have a fiber stress not exceeding 13,000 pounds per square inch. It is not advisable to exceed 13,000 pounds per square inch for the fiber stress. Now if the designer chooses he can also make the top rod 1⅛ inch in diameter in order to have all of the rods alike, and simplify the work.

Size of Anchor Rods

The load in the anchor rods obtained according to *G* of the outline in the preceding installment was found to be 21,170 pounds. As two rods are used for a double-angle column, we divide the load by 2 and obtain 10,585 pounds in each rod. The fiber stress in the anchor rods should not exceed 13,000 pounds per square inch, as in the case of the diagonal rods, but 12,500 pounds is a preferable figure. Hence 10,585 ÷ 12,500 = 0.85 square inch, area at root of thread, which calls for a 1¼-inch rod.

Foundation Piers

The concrete piers are one of the most important details in tank tower construction, as the stability of the whole structure depends on them. The size of the base should in each case be proportioned to suit the class of soil on which the tower is to be located. When lack of definite information is at hand, we can assume 3000 pounds per square foot of soil as a safe bearing value. In the present case we have a total column load of 136,030 pounds and a maximum uplift on the anchor rods of 21,170 pounds. The complete load on the soil includes the column load, the weight of the pier and the weight of the earth on top of the pier as shown in Fig. 14. It would be rather difficult to tell what the actual effect of the earth on the pier would be, that is, how much it would increase the pressure on the soil. The writer has adopted the assumption that the weight due to the pier and soil is equal to a prism of the same height as the pier and with other dimensions equal to those of the base of the pier, having a weight of 140 pounds per cubic foot. Area of base × height × 140 = load on soil due to weight of pier and earth. This added to the maximum column load is the total load on the soil. To arrive at the approximate size of the pier base, add 50 per cent to the column load and divide by 3000, or divide the column load by 2000; thus 136,030 ÷ 2000 = 68.02 square feet.

Taking the nearest greater 6 inches, we find the size of the required base to be 8 feet 6 inches square. A pier should not be made less than 5 feet deep in order to get below the frost line. We will call this one 6 feet deep and 3 feet square at the top, and then calculate its weight. The cubic contents of a pier of this shape equals

$$\frac{H}{3}(a^2 + b^2 + ab)$$

where

H = height;

a = side of top;

b = side of base.

Substituting in this formula gives:

$$\frac{6}{3}(9 + 72.25 + 25.5) = 213.5 \text{ cubic feet.}$$

At 140 pounds per cubic foot, the weight of the pier would be 29,890 pounds. The weight of the pier should at least equal the uplift on the anchor rods and in this case it exceeds it. We can now determine the unit load on the soil as follows: 8.5 × 8.5 × 6 × 140 = 60,690 pounds, weight of pier and earth; 60,690 + 136,030 = 196,720 pounds, total load on soil; and 196,720 ÷ 72.25 = 2723 pounds per square foot, pressure on soil.

This shows that our assumption of 50 per cent added to the column load was a trifle high. It will probably be found, if we revise our figures, that we can use a pier 8 feet square. Before we reduce the size of the pier we must first ascertain whether the weight of the proposed pier will equal the uplift.

$$\frac{6}{3}(9 + 64 + 24) = 194 \text{ cubic feet, volume of pier.}$$

194 × 140 = 27,160 pounds, weight of pier.

64 × 6 × 140 = 53,760 pounds, weight of pier and earth.

$$\frac{53{,}760 + 136{,}030}{64} = 2966 \text{ pounds per square foot, pressure on earth.}$$

We have now proportioned all the principal members of the tower to safely sustain the load to which they are subjected. The only thing that remains is for the designer to so design the splices and connections that they will develop the full strength of the members they connect. Of course the usual rules of structural engineering are to be followed in the present field of design.

* * *

One of our contemporaries relates the following story which illustrates very well the attitude of the "political" engineer: A mining-machinery salesman recently walked over to a city rock pit where rock for making roads was excavated and crushed. The drills in use there were manufactured by the company he represented, but were of extremely antique pattern. The young salesman, with characteristic enthusiasm, began to tell the engineer in charge of a very efficient one-man drill that was making a record for itself. He claimed that if the city would install the improved type, at least one-half the present force of men could be dispensed with. At this point the city official spoke up: "Young man," he said, "if you can give us a drill that will require more men to operate and make more jobs that aren't too hard, we'll be interested, but this new machine is not in our line."

* * *

The Society of Automobile Engineers has invited a party of members of the British Society of Automobile Engineers and the Society of Motor Manufacturers & Traders, Ltd., to make a visit to the United States in the spring. The visit will coincide with the annual summer meeting of the Society of Automobile Engineers. A number of automobile factories and factories engaged in the production of automobile parts will be visited and arrangements have been made for a three days' excursion on the Great Lakes.

AT THE AUTO SHOW—TRADE JOURNALS

"There are many interesting things at the auto show," said the editor, "and some that are not so interesting. One class of stands that I steer clear of as much as possible, is that of the auto trade journals."

"Why, that's strange, seeing that you are in the trade journal business yourself."

"Yes, I'm in the business, and that's why I feel sensitive about it. I don't want to feel ashamed, but I do every time I see the frantic methods they employ to get subscriptions. If an unsuspecting visitor stops momentarily to look at *Motor Mucker* or *Auto Bazoo*, a peroxide blonde or a callow kid will collar him and tell him that his everlasting salvation depends on taking a subscription right there and then.

"It's all right to go after business, and I believe in going after it as hard as anyone, but soliciting subscriptions from every passer-by at an auto show is poor policy. It cheapens the proposition and makes the publisher look like a piker. If his journal is worth reading, the people who want it and will be subscribers worth having, don't need to be lassoed, thrown and hog-tied before they'll subscribe. They'll come up all right, plank down their dollars and be glad of the chance. No Coney Island barkers are required to get subscribers who are really interested and who will be worth while to advertisers."

* * *

THE "STEEL-EATING" WORM

An interesting account of the "steel eating" worm is given in one of our contemporaries. About 1866, a number of workingmen employed in the various iron, steel and chemical works, in the district surrounding Haspe, in Germany, used to meet at certain intervals at a hotel to discuss subjects of general interest. At one of these meetings, the discussion gave one of the members an idea which resulted in the creation of the "steel-eating" worm. The editor of a newspaper in one of the neighboring towns was made the subject of the joke. The worm was manufactured from a piece of rubber tubing and was exhibited in a bottle half full of steel chips. The worm was filled with dilute hydrochloric acid, and when properly disturbed with a glass rod it would emit a drop of the acid, which, on attacking the scale, served to prove that the corrosion was due to a secretion of the worm, and that the oxides formed its food. The editor accepted the exhibit in good faith, and published an account of the alleged discovery, with the consequence that it reappeared in many other journals, and has since been reproduced at intervals.

* * *

At the Philadelphia & Reading R. R. shops in Reading, Pa., a novel method is employed for keeping the aisle space adjacent to the tracks which run through the shop clear. At the required distance which must be kept clear on each side of the rails, strands of wire are set into the floor flush with its surface, and held in place by small staples. These wires are called "dead lines" and it is much easier to impress upon the workman's mind that material must not be placed over these lines than to say that he must keep material a specified distance from the rails. During the day, the general foremen occasionally glance down these dead lines and thus easily ascertain if the aisles are properly cleared.

DIE FOR PIERCING RODS AND RIVETS

BY CORWIN LAMOREAUX[*]

In the factory where the writer is employed, folding sleds, door hangers and various other hardware specialties are made, which require one or more rivets or pins, principally of 5/16 inch diameter and varying from 5/8 inch in length up. There is a hole near one end of these rivets for a 1/8-inch cotter pin, which, in cases where accuracy and good finish are essential, is drilled in a simple jig adapted for the work. However, there are a number of the articles which do not require a nicely drilled hole, and to reduce the cost of piercing the thousands of pieces that are needed, a die was designed to do this work in a punch press. This die is shown in Fig. 1 set up in the press ready for use; this illustration also shows the gage extending in front of the die. This gage is adjustable to accommodate pieces of different lengths, and locates the pin or rivet in the die so that the hole is pierced in the proper place. It will be noticed that the press is large for the light character of the work, but this is explained by the fact that it is necessary to have a rather slow action to operate the die, in order to avoid upsetting and breaking the punches. The press shown makes about eighty revolutions per minute.

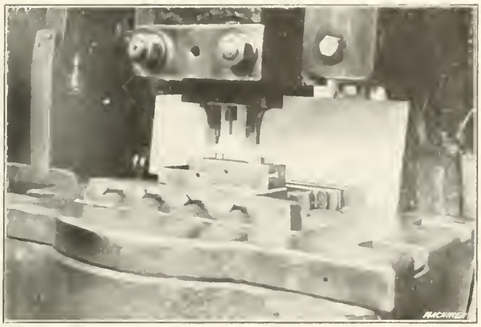

Fig. 1. Piercing Punch and Die mounted in Press

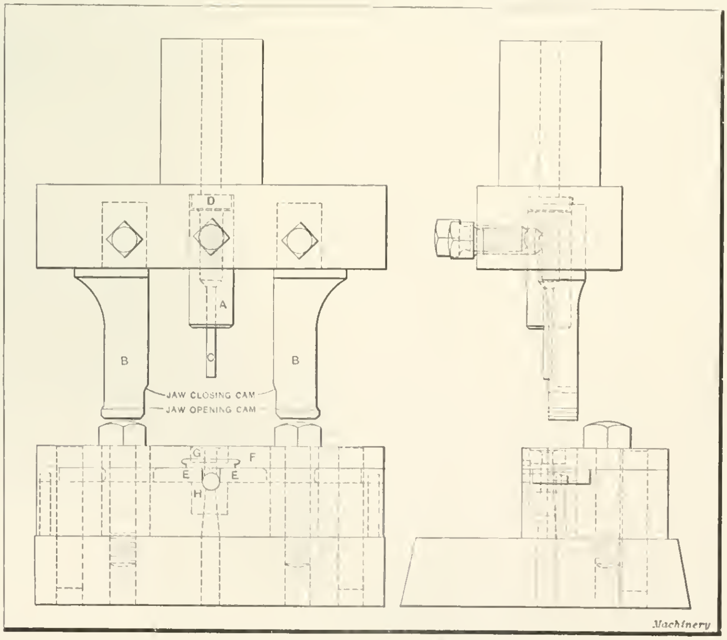

Fig. 2. Details of Design of the Rivet Piercing Punch and Die

Fig. 3 shows the punch, die and gage in detail. In this connection, it might be of interest to state that an adjustable gage was originally placed at the rear of the die, consisting of a hardened screw bearing against the end of the pin being pierced. This arrangement was unsatisfactory, as the metal flowing away from the pressure of the punch pressed against the end gage and the reaction against the slender piercing punch caused it to be bent forward and broken. After adopting the present gage, there was no trouble from that source.

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Fig. 2 shows the details of construction of the punch and die. The punch-holder is made of machine steel and has the straight shank punch quill *A* and cams *B* inserted in it. The piercing punch *C* is made of No. 20 carbon steel drill rod inserted in the hardened and ground tool-steel quill *A*; the punch is backed up by the hardened tool-steel screw *D*. The drill rod punches are hardened to within ⅛ inch of the head, and are drawn to a blue near the top which gradually runs down to a brown color near the end. The jaws *E* are made of tool steel and are machined to fit the upper surface of the rivet closely; the plug die *H* fits the lower surface of the rivet, so that the latter is held in the opening between the jaws *E* and the plug die *H*. On the down stroke of the ram, the jaw-closing cams on the members *B* press the jaws tightly against the rivet, and on the up stroke, the opening cams spread the jaws apart. Two stop-pins *I*, Fig. 4, are provided at each end of the die to prevent the jaw from moving too far back. The tool-steel bushing *G* is provided to guide the punch and prevent it from buckling. The small tool-steel piece *F* keeps the rivet from bending upward and wearing the hole out of round. To make the work easier on the punch, the hole in the plug *H* is made about 1/32 inch larger than the punch.

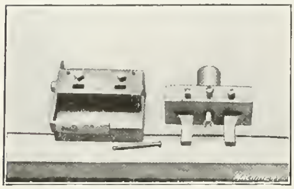
Fig. 3. Piercing Punch and Die and One of the Pierced Rivets

In operation, the rivet is placed in the hole in the gage and pushed into the die, the head of the rivet abutting against the gage; this provides for piercing the hole at the required distance from the head. From four to five thousand pieces have been pierced with one punch before bending or breaking, and as it is but a few minutes work to replace the punch, the cost is trifling. A saving of about 80 per cent in the cost of piercing the rivets was effected by the use of this device in place of the drill press, not to mention the convenience of quick production of parts for immediate use in the factory.

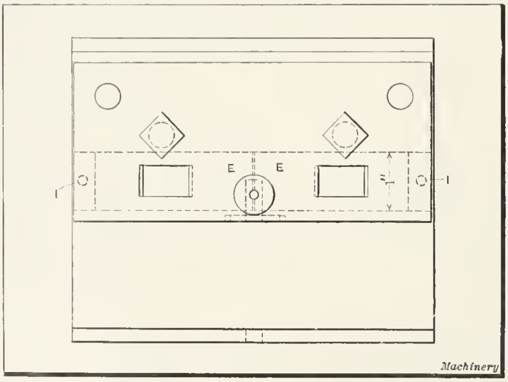

Fig. 4. Plan View of the Die

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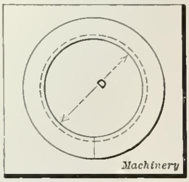
A demonstration has been given at Southport, in England, of a vacuum street sweeper brought out by a Sheffield firm. The machine, which is the invention of an Italian engineer, resembles an ordinary automobile, and is fitted with an apparatus producing a suction effect. It is claimed that the machine will sweep a road or street without raising any dust and without causing any damage to the surface.

LENGTH OF ANGLES BENT TO CIRCULAR SHAPE

BY R. H. CREVOISIE

It is sometimes required to calculate the length of an angle-iron used either inside or outside of a tank or smokestack. The following formulas and table of constants can then be used to advantage.

Assume, for example, that a stand-pipe, 20 feet inside diameter, is provided with a 3 by 3 by ⅜ inch angle-iron on the inside at the top. The circumference of a circle 20 feet in diameter is 754 inches. From the table of constants we find the constant for a 3 by 3 by ⅜ inch angle-iron to be 4.319. The length of the angle then is 754 − 4.319 = 749.681 inches. Should the angle be on the outside, we add the constant instead of subtracting it; thus, 754 + 4.319 = 758.319 inches.



Angle-iron bent to Circular Shape

When a shell ring is made of several plates, use one length of angle-iron for every two plates in the shell ring. When, for instance, a stand-pipe is made up of four plates around its circumference, use an angle-iron consisting of two equal lengths. For splicing these angle-irons, a shoe is made from a plate ½ inch wider than the sum of the two legs of the angle, and 1/16 inch lighter than the plates in the ring to which this angle is riveted. This shoe is usually made long enough for three rivets in each angle.

TABLE OF CONSTANTS USED FOR CALCULATING LENGTH OF ANGLES BENT TO CIRCULAR SHAPE

Size of Angle	Constants	Size of Angle	Constants
¼ x 2 x 2	2.879	½ x 3½ x 3½	5.235
5/16 x 2 x 2	3.076	⅜ x 4 x 4	5.366
⅜ x 2 x 2	3.272	½ x 4 x 4	5.758
¼ x 2½ x 2½	3.403	⅜ x 5 x 5	6.414
5/16 x 2½ x 2½	3.600	½ x 5 x 5	6.804
⅜ x 2½ x 2½	3.796	⅜ x 6 x 6	7 461
½ x 2½ x 2½	4.188	½ x 6 x 6	7.854
¼ x 3 x 3	3.926	¾ x 6 x 6	8.639
5/16 x 3 x 3	4.123	½ x 8 x 8	9.949
⅜ x 3 x 3	4.319	¾ x 8 x 8	10.734
½ x 3 x 3	4.711	1 x 8 x 8	11.520
⅜ x 3½ x 3½	4.843	....	......

Machinery

* * *

The Walker Magnetic Chuck & Grinder Co., Worcester, Mass., long ago found that there is a marked difference in the action of a planer tool and a face milling cutter as regards the chipping of castings on the outside edges. The company has for years made magnetic chucks, the faces of which are cast-iron grids or spiders with various arrangements of the poles. The space between the poles is filled in with non-magnetic soft metal of the nature of babbitt. The castings are roughed on a planer fitted with an Adams milling head carrying an inserted-tooth face milling cutter. This tool sweeps off the rough surface without breaking out the edges, which is a very necessary requirement. When the chuck is assembled and the filling metal is poured and peened in place, a finishing cut is taken on a planer, using a planer tool. Notwithstanding the fact that the cut is a thin finishing cut and the edges are supported somewhat by the soft metal in the slots, the edges will break out unless the planer tool is made with a shearing cutting edge. What is the cause of the difference in the action of the two tools as regards chipping the edges of the castings?

* * *

The annual per capita fire waste in the United States is $2.51 as compared with 33 cents in Europe. The reason for this difference is partly to be found in the better construction of buildings and less carelessness in Europe. If the buildings of the United States were as nearly fireproof as those in Europe, the annual fire losses and the cost of prevention of fires could be reduced to one-fifth of what it now is.

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* Address: Wickes Boiler Co., Canton, Ohio.

STEAM POWER PLANT PIPING DETAILS—2

LAY-OUT OF STEAM PIPING AND CONNECTIONS

BY WILLIAM F. FISCHER*

Having decided upon the general arrangement of the steam piping system best suited to the lay-out of the plant and apparatus, the designer should turn his attention to the important details of the piping and connections. The design of a boiler header and its connections is not such a simple problem as it at first appears, for there are many details of importance to be taken into account. In most cases of bursting steam mains and fittings, the trouble has been traced to faulty design and incorrect methods of erection, rather than to defects in the material of the piping system. High-pressure piping, valves and fittings are, as a general rule, designed to safely withstand a pressure of from six to twelve times the working pressure, or the pressure they are to be subjected to in actual service; therefore, it rests with the engineer or designer to see that the piping system is properly arranged and carefully erected, so that no part will be unduly strained in service, either by expansion and contraction, water-hammer, or sagging of the pipes due to incorrect methods of supporting them. In the following examples, taken from practice and experience with the design and erection of numerous piping systems, the writer will try to give a general idea of correct and incorrect methods employed in the lay-out of steam piping between the boilers and prime movers.

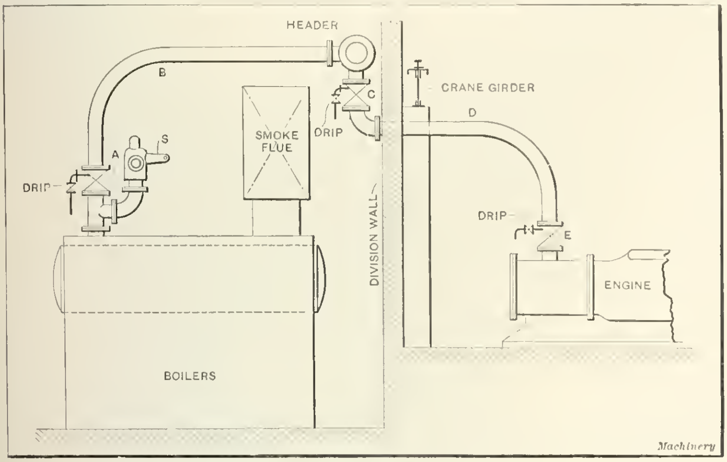

Fig. 6. An Example of a Poor Arrangement of Piping from Boiler to Engine

A poor arrangement of steam piping between the boilers and engines in a certain plant is shown in Fig. 6. In this case, *A* is a gate valve placed directly above the steam outlet and safety valve connection of the boiler. A pipe bend *B* rises from the gate valve and makes connection with the side of the main steam header. As will be noted, the steam connection to the engine is taken from the bottom of the main steam header through gate valve *C*, bend *D* and throttle valve *E*. The piping system was so arranged in order to carry the bend *D* underneath the crane girder in the engine room, as shown. This piping system is very poorly arranged, although it would not appear so at first glance. For instance, when gate valve *A* on any of the boilers is closed, bend *B* will gradually fill up with water, due to condensation in that branch of the system, and to water passing over to it through the main header. When valve *A* is opened again to put the boiler into service, the water in bend *B* will be driven over to the main header and from there to the engine cylinders, causing water-hammer and possibly damage to the piping system and the engines. High-speed steam engines are usually provided with but a very small clearance space in the cylinders at each end of the piston. If this clearance space between the piston and the end of the cylinder were to be filled with water while the piston was traveling at a high rate of speed, the water, being practically incompressible, would cause the full force of the piston to be transferred almost instantly to the cylinder cover, which would probably cause rupture.

If the engine is cut out of service by closing valve *E*, leaving valve *C* open, the bend *D* will fill up with water and drain into the engine cylinder when valve *E* is opened again. If both valves *E* and *C* are closed when shutting down the engine, water will still collect in the header above valve *C*, and unless properly drained off will return to the engine again when the valves are opened to put this unit in operation. Wherever a valve forms a water pocket in a steam line, as shown by valves *A*, *C* and *E*, the valves should be drained from above the seat. The system illustrated in Fig. 6 was arranged with drip connections placed above each valve seat, but experience in this plant shows that the water of condensation was not always drained off before starting up the plant in the morning, and quite frequently the piping system was subjected to heavy shocks from water-hammer; the engines have also been stalled by slugs of water coming over with the steam flow and lodging in the engine cylinders.

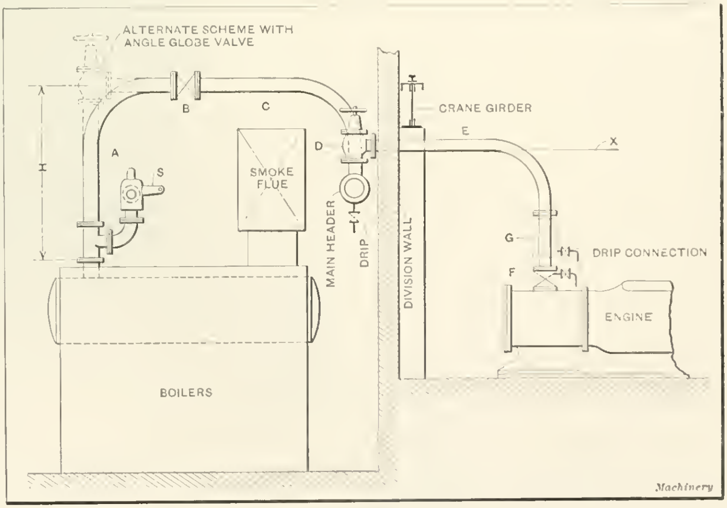

Fig. 7. Improved Arrangement of Piping for the Same Installation as shown in Fig. 6

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Fig. 7 shows a much better arrangement of the piping system, in which the same number of valves is used as in the previous case. Boiler stop valve *B* is placed at the highest point of the piping system and does not form a water pocket in the line when closed, as any condensation occurring in bend *A* will drain back to the boiler, and condensation occurring in bend *C* will drain into the header by gravity as fast as it forms. The same result would be obtained by placing an angle valve above the boiler, as shown in dotted lines; this angle valve would take the place of the straight-way valve *B*. This valve should preferably be what is known as an automatic stop and check valve, for reasons to be stated later. An objection to placing the boiler valves as shown in Fig. 7 is that where valves are placed so high above the boiler nozzle, there is a tendency toward vibration of the piping system, unless they are properly supported or anchored. It will be noted that the valve is at a distance above the point of support as indicated by *H*. In this case, the steam for the engine is taken from the top of the main header through angle valve *D*, bend *E* and throttle valve *F*. When the angle valve *D* is closed, only a very small quantity of water will collect above valve *F* from the condensation of a small volume of steam remaining in bend *E*. If the angle valve *D* is not absolutely steam-tight, however, any leakage of steam through the valve will condense in bend *E* and gradually fill the pipe with water. Modern practice calls for a steam separator to be placed above or close to the engine throttle valve as shown at *G*. This separator does not add greatly to the cost of the piping system and is a protection to the engine cylinder, besides insuring drier steam and more economical operation. With the separator placed as shown in Fig. 7, if the throttle valve *F* is closed and angle valve *D* left open, the water of condensation forming in pipe *E* will drain into the separator as fast as it collects. Without the separator, the water of condensation would form in pipe *E* up to the point *X*, unless the valve *D* were closed and in a steam-tight condition. Experience shows that where two valves are placed as shown at *D* and *F*, the valve *F* is closed in, shutting down the engine, and quite frequently the operator neglects to close valve *D*. As will be noted in Figs. 6 and 7, only one valve is placed in the piping between the boiler and the main header. It is advisable to have two valves in this line, as mentioned later in connection with the discussion of automatic stop and check valves.

In each of the cases just described, it was necessary to provide for a safety valve connection in the piping system, as shown at *S* in Figs. 6 and 7. This arrangement was necessary as no separate connection was provided for a safety valve on the boilers, and in all cases a safety valve should be provided for each boiler. It will be noted that the boiler stop valve is placed above the safety valve connection. In no case should a valve of any kind be placed between the safety valve and the boiler, for if such a valve was to be closed at any time while pressure was on the boiler, it would prevent the safety valve from acting, and any excess pressure in the boiler might cause a disastrous explosion, killing or maiming the attendants and causing the plant to be shut down until repairs could be made.

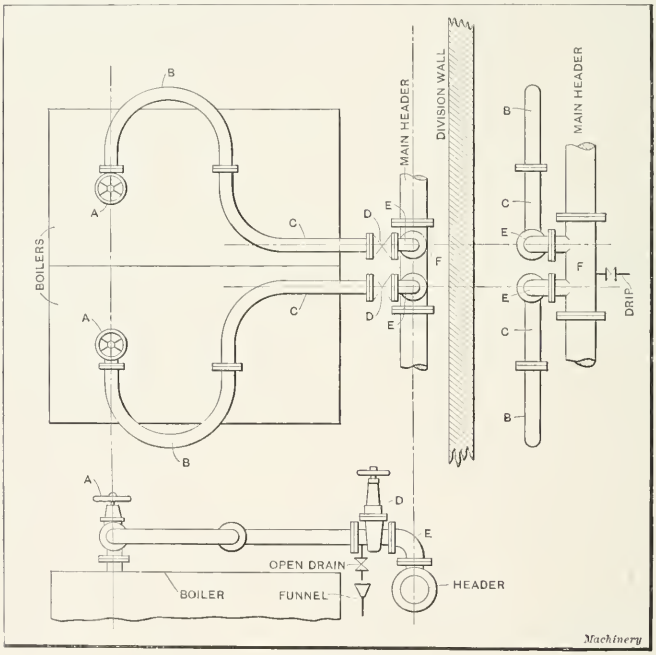

Fig. 8. Arrangement of Piping between Boilers and Main Header possessing Considerable Flexibility

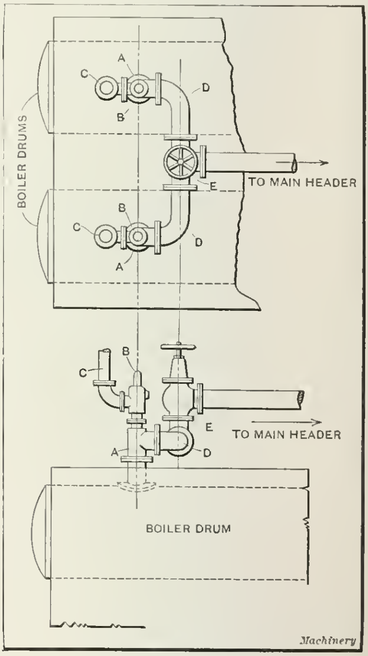

Fig. 9. Cross-over Connection between the Steam Drums of a Large Water-tube Boiler

Automatic Stop and Check Valves

Modern practice in steam power plant design calls for two valves in each steam lead from the boilers—the steam pipe which connects the boiler with the main header. One of these valves should be placed at the steam outlet of the boiler and the other at the main header, as shown in Fig. 8. The valve placed next to the boiler nozzle should be what is known as an "automatic stop and check valve," so called because it closes automatically when the pressure in the boiler falls below the pressure in the steam main, and opens automatically when the pressure in the boiler exceeds the pressure in the steam main. Automatic stop and check valves are coming into more general use every day, and where two or more boilers feed into a common main or header, they are required by law in some countries. If several boilers feed into the same main and are not properly protected by these automatic stop valves, it is evident, that if a tube blows out in any one boiler, the steam from the other boilers will discharge through the main into the damaged boiler and out through the ruptured tube. This sudden rush of steam to the disabled boiler will cause a rapid drop of pressure in the other boilers, and as the pressure decreases in the boilers a large quantity of water will be rapidly converted into steam at the lower pressure, thus causing violent water-hammer; in extreme cases, the result of this condition may even cause an explosion in one or more of the sound boilers. A sudden drop in pressure in a boiler causes water to be lifted over with the steam, and this water flowing to the engines may result in an engine wreck. If a tube should blow out in a boiler that is properly protected by an automatic stop and check valve, the automatic valve will close when the pressure in the boiler falls below that in the main. In this case, as soon as the damaged boiler empties through the ruptured tube, the attendants can return again to their stations and continue the operation of the plant, thus avoiding a shut-down while making repairs. Automatic stop and check valves can now be purchased in all the standard sizes, and as they cost but little more than the regular hand-operated stop valves, they should be given the preference, regardless of the slight difference in cost. Boiler explosions have been caused by opening the boiler stop valve by hand to put the boiler into service before the pressure in the boiler was the same as the pressure in the main. When the valve was opened, the steam from the main rushed into the boiler, causing water-hammer which resulted in an explosion. This could have been avoided by equipping the boilers with automatic stop and check valves, in which case the valve would open automatically when the pressure in the boiler slightly exceeded that in the steam main, or boiler header, as the case might be.

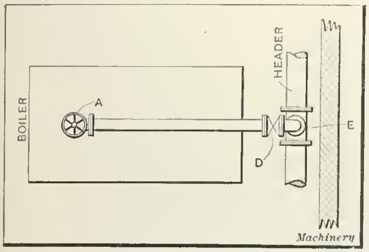

Fig. 10. Straight Connection between Boiler and Main Header with Practically no Flexibility

Steam Connections between Boilers and Main Header

When making connections between the boilers and the main steam header, proper provision should be made for taking up or relieving expansion and contraction strains. The piping should, if possible, be free from water pockets of any kind, and where such pockets are unavoidable, they should be automatically dripped free from water at all times during operation and before starting operation. The entire piping system, and particularly the valves, should be located and arranged to provide for convenient operation. A method quite frequently employed in connecting a battery of boilers to the main steam header is shown in Fig. 8. Automatic stop and check valves are placed at the outlet of each boiler, as shown at *A*. The U-bends *B* and the square bends *C* provide for expansion and contraction and for any slight movement of the main header. These bends, if properly proportioned, are quite flexible and will give sufficiently to relieve the strain at the joints. From the gate valves *D* the piping makes connection with the top of the header through the elbows *E* and the manifold tee *F*. If so desired, the elbows *E* may be replaced by angle valves, in which case the gate valves *D* will not be required. The automatic stop valves *A* may be closed by hand when required, and the gate valves *D* used as stop valves only in cases of emergency when the automatic stop valves get out of order, or when it is necessary to pack joints, or renew gaskets in the piping between the boiler and main header.

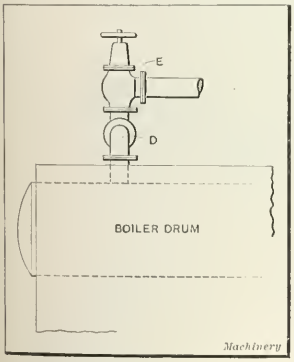

Fig. 11. Simplified Form of Cross-over Connection where Separate Connections for Safety Valves are used

If the gate valves *D* were omitted, there would be no means of shutting down a boiler for cleaning or repairs, in case the automatic stop valves were out of order, without shutting down a section of the main header to do so. The system shown in Fig. 8 contains no water pockets or low spots in which water could collect, except the header, and this should be dripped at frequent intervals. If either valve *A* or *D* should leak under pressure when both valves are closed, however, the steam leaking past the valve seat will condense in the bends *B* and *C*, and in time this section of the piping will fill up with water. This water will be driven back to the header when the valves are opened again and cause trouble. For this reason it is advisable to pitch the piping slightly from valve *A* to valve *D*, so that any water that condenses will drain in that direction and provide an open "test drain" connection at the inlet side of valve *D*. This drain may be arranged to discharge into a funnel and it can then be piped to some convenient source of waste. In this case if both valves *A* and *D* were closed when shutting down the boiler, the drain could be opened before putting the boiler on the line again so that any water in bends *B* and *C* would be drained off. This open drain connection will also be found useful, when testing the valves for leakage, by simply closing both valves *A* and *D* while under pressure and opening the drain valve. If the valves leak, steam will continue to escape through the drain. The manifold tee *F* takes the place of two single tees and saves one pipe joint in the main header for each battery of boilers. Manifold tees are special fittings that are seldom kept in stock, and for this reason they cannot be obtained as quickly as standard stock fittings. Although special, however, they should not be much more expensive than the equivalent number of standard tees required for the same purpose. The manifold tee shown at *F* has four flanges to be faced and drilled, whereas two standard tees to answer the same purpose would have three flanges each to be faced and drilled; this means a saving in machine work on two flanges which should, to a large extent, offset the additional cost of the special casting, pattern work, molding, etc.

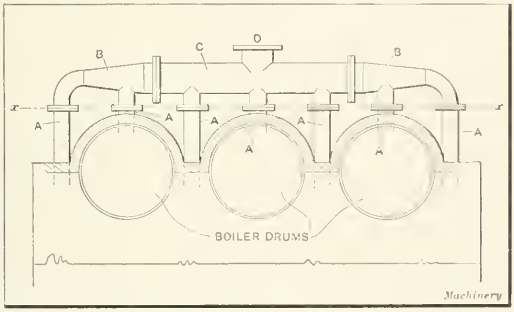

Fig. 12. Cross-over Connection between Superheater Outlets of a 650 H. P. Three-drum Water-tube Boiler

Fig. 10 shows a straight connection between the boiler and main header. This is a very rigid arrangement, as no provision is made for expansion and contraction, vibration, etc. It is quite evident that any movement of the main header in either direction will cause a twisting movement on the joints at the automatic check valve *A*, the gate valve *D* and the elbow *E*, and in a short time, this will grind away the material in the gaskets and cause the joint to leak at the flanges. Piping connected in this manner is a constant source of worry to the engineers in charge of the station, as they find it difficult to keep the joints steam-tight. In all cases flexible pipe connections should be provided between the boilers and the main header, as well as between the engines and main steam header.

Cross-over Connections between Boiler Drums

Large water-tube boilers are quite frequently built with two or more steam drums to a boiler, in which case it is customary to provide a cross-over connection between each boiler drum, and lead off to the main steam header through one automatic stop and check valve and one branch pipe, rather than to connect each steam drum of the boiler independently to the main steam header. Fig. 9 shows an example of a cross-over connection for a two-drum boiler. A flanged tee is placed next to the steam outlet of each boiler drum at *A*. An outlet at the top of each tee is provided for the safety valves *B*. These safety valves discharge through pipes *C*, which should project at least six or eight feet above the top of the boiler setting to prevent scalding the attendant, should he be standing on the boiler at the time the safety valve opens due to excess pressure in the boiler. In some cases, the discharge pipes *C* are carried above the roof line, but in such a case the boiler attendant would not be able to tell which safety valve was discharging unless he climbed up on top of the boilers or went up on the roof to see from which pipe the steam was escaping. In the writer's opinion it is best to have the safety valves discharge into the boiler room below the roof line, as this makes it possible for the attendants to tell at a glance which valve or valves are discharging. In case any of the safety valves leak, a steady jet of steam may be seen issuing from the end of the pipe, and the attendants will know that the valve is in need of repairs. The elbows *D* provide a common connection between each boiler drum and the automatic stop and check valve *E*, from which a pipe connection is made to the main steam header. In case a separate safety valve is connected on each boiler drum, in addition to the main steam outlet, the cross-over connection may be simplified by arranging the piping as shown in elevation in Fig. 11. In this case, the two tees *A* of Fig. 9 are not required and the elbows *D* make connection direct with the steam outlet of each boiler drum. The valve *E* is of the automatic stop and check type. Boiler cross-over fittings should be cast of steel, in preference to iron, especially for high-pressure service and where superheated steam is used.

A cross-over connection between the superheater outlets of a large three-drum water-tube boiler is shown in Fig. 12. The steam, when it leaves the boiler drums, passes down through the superheaters (not shown) and out through the superheater pipes *A*, from which it passes to the cross-over manifold fittings *B* and *C*. The automatic stop and check valve is placed next to the main steam outlet at *D*. The superheaters and the pipes *A* are provided by the boiler manufacturers up to the point *x–x*, and the piping contractor provides the piping beyond this point. The cross-over manifold is made in three pieces and should be of cast steel in preference to cast iron.

In some cases it is desirable to operate the main engine units on superheated steam, and the auxiliary engine units on saturated steam. Under such conditions, the reader will readily understand that two separate connections will be required at each boiler drum and that separate branches and headers will be necessary to convey the steam to the different units, that is, two separate and distinct steam piping systems, one for the superheated steam and one for the saturated steam.

* * *

HOW TO CURE A DUSTY CONCRETE FLOOR

The Aberthaw Construction Co. of Boston, contracting engineers specializing in concrete, recommend the following method of curing a dusty concrete floor: Get the surface entirely dry, then paint it with a mixture of boiled linseed oil thinned with gasoline. Give it several coats, until the oil shows glossy on the top. The theory of this is that the linseed oil, having been boiled, has lost most of its volatile components and is practically permanent. The gasoline thins this down enough so that it will strike into the pores. A little experimenting will show the proper proportions. The thinner it is, the more coats will be required and the deeper it will strike in. The floor that is causing serious trouble from dust can often be cured with very little trouble and expense in this way.

* * *

The Pennsylvania R. R. is vigorously prosecuting its campaign for greater safety and has lately distributed 50,000 copies of a book of "don'ts" for employes working on trains, tracks and in the shops. These "don'ts" include prohibitions of common practices fraught with danger, such as standing between cars when coupling, stepping on footboards when locomotives are approaching, going under trains to make repairs or adjustments without proper protection, piling coal on tenders in such a manner that it may fall off, etc.

WIRE BENDING IN THE FOOT-PRESS

It is not often that the ordinary foot-press can be fitted with tools for bending, or working wire, and still compete with the four-way automatic wire bender, but there are exceptions. The first illustration, Fig. 1, shows both the press and tools, and Fig. 2, the successive operations necessary to form the spring. The springs, which are used on the ordinary spring clothes-pin (shown at the bottom of Fig. 2), were wanted in comparatively small lots (two or three hundred thousand of a kind), and the first cost of the tools was an important matter.

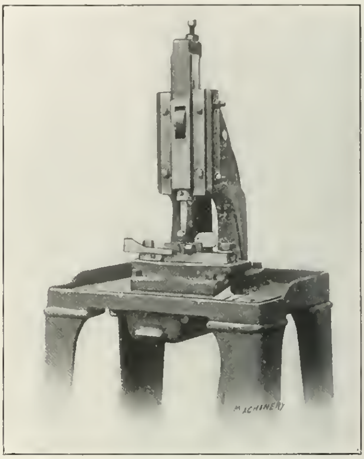
Fig. 1. Foot-press fitted with Tools for bending a Clothes-pin Spring

Fig. 1 shows the press, which is of the ordinary "kick" type, fitted with a punch, which, taking the wire direct from the straightener, cuts it off to the proper length, and then in the three successive operations shown, bends it to the required shape. The spring, which is made of 0.0625 inch piano wire, is, as any one who has had experience in working wire well knows, very hard to "set" to make it hold its shape properly, and this was the reason for choosing the foot-press rather than a bench bender.

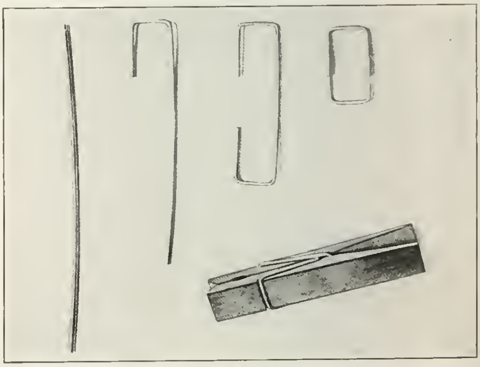
Fig. 2. Successive Operations of Bending the Spring, and Clothes-pin for which the Spring is made

The first operation is cutting off the wire. The second and third, bending, these being made without any change in the tools. The fourth is effected by the addition of a guide to the punch only. A boy or girl will turn off about 5000 finished springs per day, which, considering the low cost of the tools, makes the machine a profitable investment. The tools were made for the Carolina Washboard Co. of Raleigh, N. C., by J. L. Lucas & Son, of Bridgeport, Conn.

* * *

The Society of Motor Manufacturers in Great Britain has offered a prize of $10,000 for a fuel for automobile engines which is produced entirely from materials available in Great Britain and which is marketable at a competitive commercial price. It is also stipulated that the fuel must prove satisfactory for present designs of engines, and must be obtainable in sufficient quantities to guarantee an unlimited and continuous supply.

AUTOMATIC SCREW MACHINE EQUIPMENT—2

TOOL EQUIPMENT USED ON NATIONAL-ACME MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINES

BY DOUGLAS T. HAMILTON*

In the previous installment of this article, a collection of the tools used on the National-Acme automatic screw machines for internal cutting and threading were described; in the following, attention will be given to a description of box-tools, shaving tools, knurling and thread rolling tools.

Box-tools

The type of box-tool commonly used on the "Acme" automatic is that known as the over-cut type; this usually carries two cutting tools as shown in Fig. 15. The front cutting tool, when in operation on the work, is set "tangentially" to the work, while the rear cutter is worked radially in relation to the center of the work. The front tool, when used for taking a finishing cut, is set about 0.010 inch in advance of the supports and is ground a little high at the rear to provide for clearance.

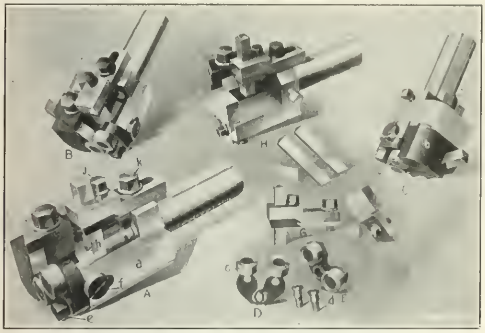

Fig. 15. Group of Over-cut Box-tools used on the "Acme" Multiple-spindle Automatic Screw Machines

Three views of the over-cut type of box-tool appear at *A*, *B* and *C*, in Fig. 15. The body *a* is a machine-steel forging, turned down at the rear end to form a shank, and milled out at the front for the reception of the tool-block *b*. This block is provided with a tongue fitting in a groove in the body of the box-tool, and is held tightly up against the box-tool body by a bolt *l*. The hole in the body through which the bolt *l* passes is elongated to provide for adjustment of the tool-holder. The roller supports *c* which are shown dismantled at *D* and fastened to the holders at *E*, are made of hardened and ground tool steel; they are held to the holders by shoulder-screws *d*, being free to rotate on the latter. The support holders are held to the box-tool body by a cap-screw *e* and are backed up by large headed screws *f*. Screws *f* are adjustable and the under sides of their heads are raised by headless screws located in the body of the box-tool to form a "heel." The rear cutting tool *h* is held in a tool-holder *i* by a wedge (not shown) and a cap-screw *j*. The tool-holder *i* is retained in a V-groove in the body of the box-tool by a cap-screw *k* and is provided with an elongated slot for adjustment. The shank of the tool-holder is provided with a hole and bushing in which a centering tool or other internal cutting tool can be retained.

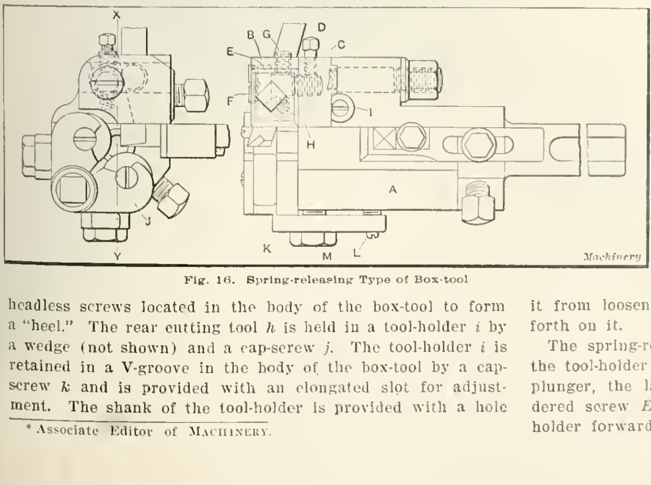

Fig. 16. Spring-releasing Type of Box-tool

The box-tool shown at *H* in Fig. 15 is known as a "round box-tool" because of the rounded shape of its body. It is provided with a solid support, which is very rarely used except on small brass work. It is particularly suited for use in the "first" position when the forming cut overlaps the box-tool cut. The support is held in position by a screw and is backed up by an additional screw. This type of box-tool is also provided with roller supports for general work.

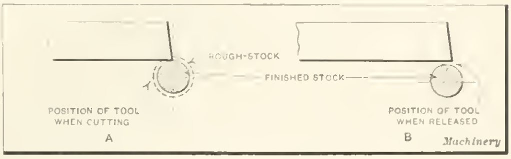

Fig. 17. Diagram showing Different Positions of Box-tool Cutter held in Tool shown in Fig. 16

Spring-releasing Box-tool

The regular box-tool, when used for taking heavy roughing cuts, usually leaves a spiral mark on the work in backing off. This is due to the extreme point of the cutting tool becoming heated, and a certain amount of the cuttings welding to it thus forming a ragged edge, which produces an objectionable mark on the work when the tool is withdrawn. To overcome this difficulty, the National-Acme Mfg. Co. has designed for use on its screw machines the "spring-releasing box-tool" illustrated in Fig. 16. In this design, the front cutting tool is removed from the work on the back stroke, and is thus prevented from producing an objectionable mark. The body of the box-tool is practically identical in construction with those shown in Fig. 15, with the exception, of course, that the front part holding the turning tool is designed especially to provide for the spring-releasing feature. The front part of the body *A* is cut out as shown, and a block *C* is held to it by a bolt and nut. This block is provided with a tongue so that it is adjustable in a vertical direction on the face of the box-tool body. The tool-holder proper *B*, is provided with an angular groove which fits over a corresponding tongue on the face of the block *C*. The tool-holder is held to block *C* by a shouldered screw *E*, the diameter of which is smaller than the elongated hole in the tool-holder, to provide for a slight movement. Screw *E* is backed up by headless screw *F* to prevent it from loosening when the tool-holder is moved back and forth on it.

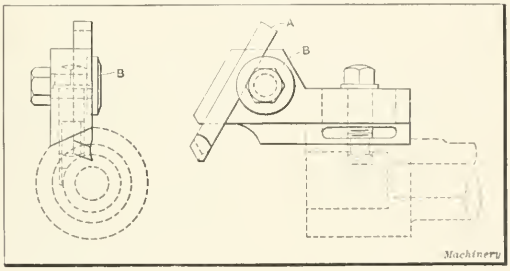

Fig. 18. Chamfering Attachment for Standard Drill-holders

The spring-releasing device is simple in construction. In the tool-holder *B* is held a spiral spring *H* which acts on a plunger, the latter bearing against the body of the shouldered screw *E*. The action of this spring draws the tool-holder forward toward the center line of the box-tool body, its movement being stopped by the headless screw *G*. Now as the tool-holder *B* works on a tongue which is at an angle to the horizontal line *X–Y* of the box-tool, it follows that the spring *H* will always keep the tool up at its highest point, as illustrated at *B* in Fig. 17. When the front cutting edge of the tool strikes the work, it compresses the coil spring *H*, forcing the tool and holder back until its movement is stopped by the shouldered screw *E*. This position is illustrated diagrammatically at *A* in Fig. 17. Then when the main tool-slide stops advancing and begins to retreat, the pressure on the cutting tool is released, allowing the spring to force the tool-holder up on the inclined "angle" (or tongue) and thus raise the tool from the work as illustrated at *B* in Fig. 17. The block *C* carrying the tool-holder is adjusted vertically for turning different diameters by means of the collar-head screw *I*.

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* Associate Editor of MACHINERY.

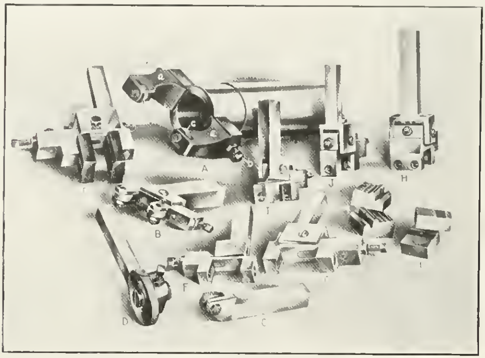

Fig. 19. Group of Knurling, Thread Rolling and Shaving Tool-holders

The manner in which the roller supports are held in this box-tool also differs to a slight extent from the method used in the box-tools shown in Fig. 15. In this case, the roller supports are held in holders *J* which are backed up by blocks *K*; these blocks are held in place by a cap-screw *M* and drilled out to receive a headless screw *L*, the latter forming a heel on which the rear part of the block rests. As the diameter of the work increases, the screw *M* is released, allowing the roller support holders *J* to drop back to bring the rolls to the proper position. Then the screw *L* is brought out until the block *K* is practically in a parallel position, when the screw *M* is tightened.

An attachment for a regular drill-holder which carries a cutting tool for chamfering or facing is shown in Fig. 18. This is held to the body of the drill-holder, and is provided with a groove for the cutting tool *A* which is held in place by a clamp bolt *B* and a nut. The attachment is adjustable along the body of the holder so that the cutting tool can be brought to the desired position.

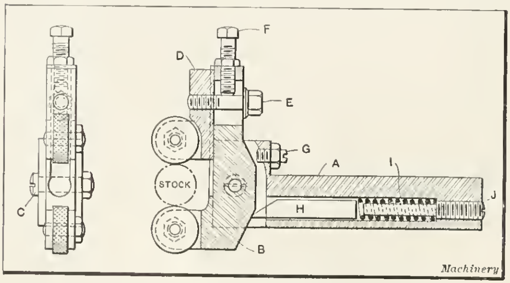

Fig. 20. Double Knurl-holder of the Adjustable Type for Use on the Top- or Side-working Tool-slides

Knurling and Thread Rolling Tools

A group of knurling and thread rolling tool-holders is shown in Fig. 19. The knurl-holder shown at *A* is used in the end-working tool-holders, being provided with a cylindrical shank for this purpose. The knurl-holders proper, *a*, are made in the form of slides, tongued in the shank, and are held to the latter by a cap-screw in the same manner as the shaving tool shown in Fig. 24. The knurl-holders are located by set-screws *b*. The knurls *c* which are cut right- and left-hand, respectively, are held in slots in the holders by a screw, and are used for producing a diamond knurl on the work.

A double adjustable knurl-holder is shown at *B* in Fig. 19, and in detail in Fig. 20, to which reference should now be made. This holder is usually held on the top-working tool-slide and is used for producing a diamond knurl on the work. two knurls of different hands being employed. The shank *A* of this holder, which is retained in the slot in the top-working tool-slide, is slotted on the front end to receive swinging member *B*, which is pivoted on a screw *C*. The lower knurl is retained in the holder *B* on a threading stud provided with a nut, and the top knurl is held in an adjustable holder *D* in the same manner. Holder *D* is provided with a tongue fitting in a corresponding groove in the part *B* and it is held to the latter by a cap-screw *E*, which works in an elongated hole in *B* and is stopped by the screw *F*. The movement of the member *B* is controlled by the stop-screw *G*, against which the holder is held by a bevel pin *H* and a coil spring *I*. Pin *H* is stopped by a headless screw *J*. The spring and stop arrangement in this holder gives it a certain amount of flexibility, thus making it unnecessary to set the holder accurately, as it is possible for it to accommodate itself easily to the work.

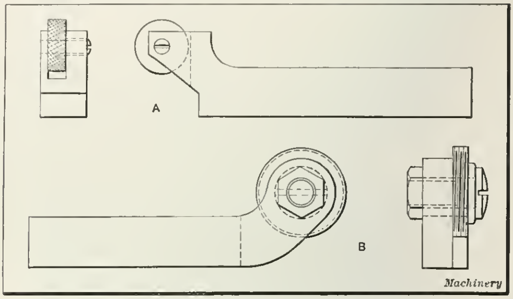

Fig. 21. Single Knurl holder and Thread Roll-holder

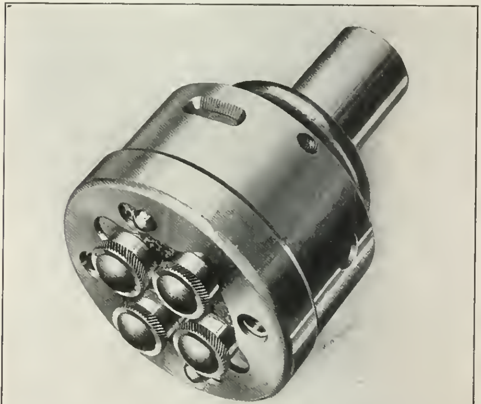

Fig. 22. "Acme" Self-opening Die Head used as a Knurl-holder

A holder for retaining a single knurl is shown at *C* in Fig. 19 and also at *A* in Fig. 21. This holder generally carries a knurl for producing diamond knurling, but, of course, can be used for holding a spiral knurl, with equally good or better results. It is held on the top- or side-working tool-slide, but generally on the former, and is usually applied radially to the work. That is, it does not pass either under or over the work, but is forced directly up against it.

Two types of thread roll-holders commonly used, are shown at *D* in Fig. 19 and at *B* in Fig. 21. The holder shown in the latter illustration is of simple design, and when in use is presented radially to the work and slightly off center so as to permit the tool springing away a certain amount to follow the arc of the stock. This makes it unnecessary to set the tool absolutely correct in regard to position for depth of thread. Of course the tool should not be set so that it will spring much—just enough to relieve the strain which would be imposed on the tool if it were presented at "dead centers." The roll in the holder shown at *D* in Fig. 19 is held on a shouldered stud, which is retained in the holder by a nut and is prevented from turning by the set-screw shown. This thread roll-holder is shown applied to the work in Fig. 25.

A knurling tool-holder which is held in the end-working tool-spindle and carries four knurls is shown in Fig. 22. This is a regular "Acme" self-opening die-holder in which four knurls are held by studs, the latter being threaded into the chasers and separated from them by washers as shown. Two of the knurls are cut right-hand and the others with left-hand spirals. Applying four knurls to the work in this manner divides the work between the knurls, and facilitates the production of deeper knurling in less time than would be possible with a single knurl. Two spiral knurls of different hand, of course, produce a diamond knurl on the work.

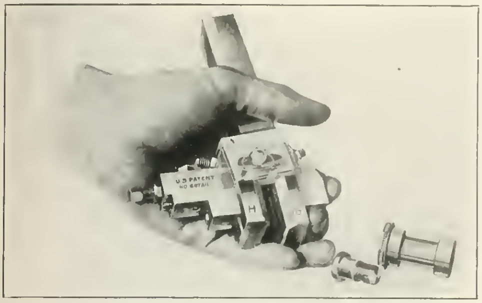

Fig 23. Patented Shaving Tool used on the "Acme" Multiple-spindle Automatic Screw Machine, and Some of the Work on which it was used

Calculating Diameter of Thread Roll

Thread rolling is used in producing a thread behind a shoulder where it would be impossible to cut it with a die, and thus the necessity of a second operation on the work is dispensed with. A thread roll is generally used on brass and similar materials, owing to the difficulty of securing a brand of steel which will stand up on harder materials. The National-Acme Mfg. Co. is now experimenting with different kinds of steel from which to make thread rolls for steel work, and has found that a chrome-nickel steel containing from 15 to 20 points carbon* gives fairly good results on this work. The roll is made anywhere from 1¼ to 2¼ inches in diameter and sometimes larger—depending on requirements—and is provided with a multiple thread when the work is smaller than the largest diameter of the thread roll. The formula used in determining the diameter of the thread roll* is as follows:

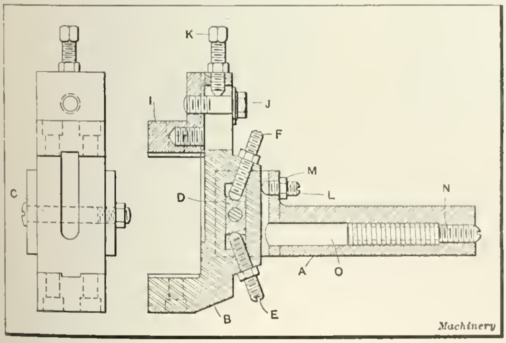

Fig. 24. Construction of Patented Shaving Tool-holder

$$D = N\left(d_1 - \frac{d_2}{0.625}\right)$$

in which

D = outside diameter of thread roll;

N = number of "starts" or approximate ratio between the diameter of the thread roll and work;

d_1 = outside diameter of piece to be threaded—(diameter after completion of thread);

d_2 = double depth of thread.

For example, assume that it is necessary to roll a thread ¼ inch in diameter by 24 pitch. Then as the roll must not be less than 1¼ inch in diameter, our ratio will be 8. Suppose that the piece has a sharp V-thread, then:

$$D = N\left(d_1 - \frac{d_2}{0.625}\right)$$

$$D = 8\left(0.250 - \frac{0.07261}{0.625}\right)$$

$$D = 8\,(0.250 - 0.0451) = 1.6392 \text{ inch.}$$

The thread on the roll should be made with a sharp vee top and bottom, whether it be used for a sharp vee or a U. S. standard thread. A thread roll for producing a thread on brass and similar materials should be made from 3 per cent nickel steel containing about 12 points carbon. The heat-treatment recommended is as follows: Carbonize six hours in straight coarse bone (not bone dust), heating to a temperature of 1600 degrees F., and then let cool off in pots without removing the work. Then heat to 1550 degrees F. and quench in oil. Reheat to 1350 degrees F. and quench in water, after which draw the temper to 400 degrees F. in oil.

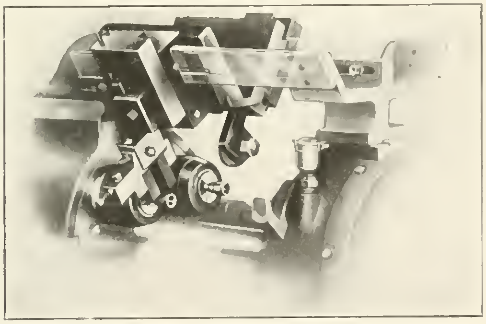

Fig. 25. Illustration showing how a Shaving Tool and Thread Roll are applied to the Work

Shaving Tool-holders

The shaving tool employed for finishing work on the "Acme" automatic is a patented device and is illustrated at *E*, *F*, *G*, *H*, *I* and *J* in Fig. 19, and also in Fig. 23. The holder shown at *E* is supplied with a blade and support, while those shown at *F* and *I* are of light pattern, those at *G* and *J* regular pattern and that at *H* of the heavy type. Plain and irregular form supports and shaving blades are shown at *L* and *M*, respectively. The general construction of these shaving tool holders is clearly shown in Fig. 24. The holder proper, *A*, which is generally held in the top-working tool-slide (see Fig. 25, where a shaving tool is being used to prepare the portion of the work on which a thread is to be rolled) is milled out to receive the L-shaped holder *B*. This is pivoted in the holder by a bolt *C*, on the body of which is held an oblong swivel block *D*, the latter fitting in an elongated slot in the holder *B*. As will be noticed, the block

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* For additional information regarding the composition of chrome-nickel steel, see the Data Sheet Supplement accompanying the June, 1912, number of MACHINERY, engineering edition.

* [The formula here given is that used by the National-Acme Mfg. Co. in making thread rolls for brass and other soft materials. The calculations in this formula are based on the diameter of the work after the completion of the thread instead of the diameter of the blank (which is approximately equal to the pitch diameter), as was the case in the formula which appeared in the August, 1912, number of MACHINERY. For further information on this subject, reference should be made to the article just mentioned.—EDITOR.]

D is considerably shorter than the hole in which it slides, thus allowing for adjustment of the holder *B*. This is effected by screws *E* and *F*, provided with lock-nuts and fitting in slots in the block, the faces of which are at right angles to the axis of the screws. The support *G*, Fig. 23, which has the same contour on its top face as the blade *H*, is provided with a tongue and held to the holder *B* by one or two screws (see Fig. 27), depending on the pattern. The shaving blade *H* is held to the holder *I* in the same manner, the latter being adjustably mounted on the holder *B* by a cap-screw *J*. Holder *I* is adjusted to set the support and shaving tool the required distance apart by a screw *K* which comes in contact with the body of the screw *J* and is provided with a lock-nut.

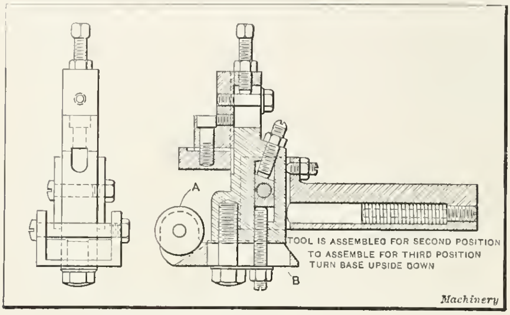

A
TOOL IS ASSEMBLED FOR SECOND POSITION
TO ASSEMBLE FOR THIRD POSITION
TURN BASE UPSIDE DOWN
B
Machinery

Fig. 26. Shaving Tool-holder with Roller Support

In operation, the holder *B* is set in the desired position by adjusting screws *E* and *F* until the support, when in operation on the work, will assume the position shown in Fig. 27, that is, the top face of the support should be parallel with the top of the tool-slide. The screw *L* and the lock-nut *M* (see Fig. 24), are then adjusted to allow the holder *B* to swing up, raising the support by means of the spring plunger *O*, this being stopped by the set-screw *N*. This action makes the support bind slightly in passing over the work, bringing the cutting edge of the blade in contact with the work as lightly as possible.

Now as the support is always slightly longer than the shaving tool, and is set higher on the front end, it comes in contact with the work first, drawing down the shaving blade until the check-nuts prevent further movement of the holder.

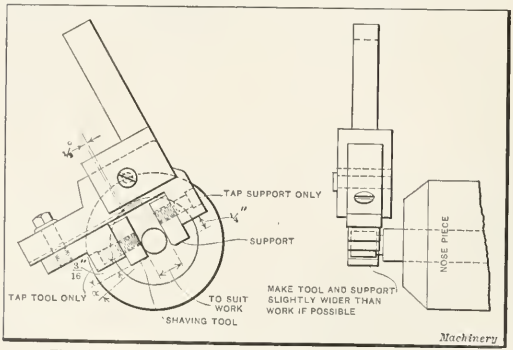


Fig. 27. Diagram showing how the Shaving Tool and Support are applied to the Work

The maximum swing provided for holder *B* is 15 degrees, but only a very few degrees of swing should be employed. In fact, excellent results are obtained by fixing the swinging member so that it is held almost rigidly. As shown in Fig. 27, the front edge of the support is rounded and the lower face of the shaving tool is set off at an angle of ½ degree from the "parallel line," thus providing for ample clearance and free working of the tool.

The type of shaving tools just described are all supplied with solid supports. A shaving tool equipped with a roller support is shown in Fig. 26. The general construction of this shaving tool is the same as that illustrated in Fig. 24, with the one exception that the roll support *A* is held in an arm *B*, which is retained in the swinging member of the tool by a cap-screw as shown. In operation, the cutting edge of the shaving tool should be exactly in line with the axis of the support, so that the blade will be "tangent" with the work when the axis of the work and roll are in a straight line.

Shaving Tools

Shaving tools of the types illustrated are only recommended for taking light finishing cuts and are not designed for removing a great amount of material. In fact, the less material removed, the better the finish. The amount of material that it is necessary to remove to obtain a good finish on the work depends to a large extent upon the character of the operation or tool used prior to the shaving operation. If the work is rough and full of tool marks, of course it is essential that these be removed, and to do this a much heavier shaving cut has to be taken than would be required if the work were comparatively smooth. The action of the shaving tool when on the work is not, practically speaking, a shaving action, but rather a scraping action. The amount to leave for shaving for various diameters of stock under general conditions is as follows:

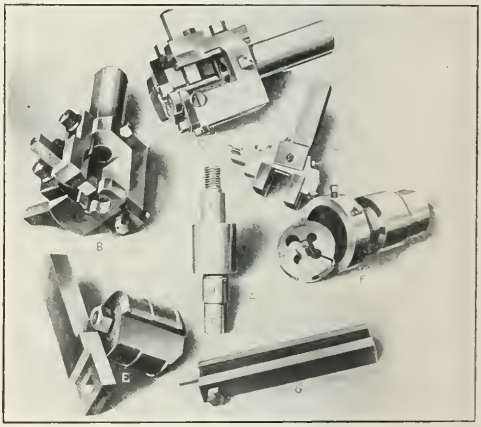


Fig. 28. Representative Group of Tools used on the "Acme" Multiple-spindle Screw Machine for producing a Shouldered Stud

Diameter in Inches	Amount to Remove in Inches
1/16— 1/8	0.0015
1/ 8— 1/4	0.0018
1/14— 3/8	0.0020
3/ 8— 3/4	0.0023
3/ 4—1 1/8	0.0026
1 1/ 8—1 1/2	0.0028
1 1/ 2—1 7/8	0.0030
1 7/ 8—2 1/4	0.0032

Fig. 27 shows the manner in which the shaving tool is applied to the work, and also illustrates the angles on the shaving tool for cutting various materials. For cutting steel, the front edge of the support should be practically at right angles with the lower face, while for cutting brass a negative rake should be provided, as indicated by the angle *a*. This angle varies slightly for different grades of brass, but is usually made 15 degrees. The shaving blades and supports are made from Jessop's tool steel and hardened, and are ground on the top and lower faces when of the plain type.

For cutting brass, shaving tools made from Jessop's high-speed steel have been found to give better results, as it prevents the lapping of the tool by the work. When it is necessary to make the support and shaving tool with an irregular top face, the surfaces are smoothly finished before the tool is hardened, and all the surfaces are lapped down by the work running between them. This takes only a short time to accomplish. When the support and rest are of extremely complicated shape, the support is relieved, and only bears on the wider surfaces.

In Fig. 28 is shown a representative "Acme" tooling group for producing the shoulder stud *A*. The two box-tools *B* and *C*, one roughing and the other finishing, are used to reduce the two diameters *a* and *b*. The large body is left the same diameter as the bar, while the two diameters *d* and *c* are turned with the circular form tool *E*, which also necks the piece. The diameter *d* is finished with a shaving tool *D*. The thread is produced with a round split button die and holder *F*, and the piece is cut off from the bar by the blade-type cut-off tool *G*.

Speeds and Feeds for Internal and External Cutting Tools

This subject has been well covered in a series of articles which appeared in MACHINERY and are now in Reference Book form. Practically the same speeds and feeds used on the Brown & Sharpe automatic screw machines are applicable to the "Acme" multiple spindle screw machine, and it is safe for an operator to start with the data previously mentioned and then speed up the tools to the working speed which will give the best results on the material being worked. The Reference Books which should be referred to in connection with this article are as follows: No. 101, "Circular Form and Cut-Off Tools;" No. 102, "External Cutting Tools;" No. 103, "Internal Cutting Tools;" No. 104, "Threading Operations;" and No. 105, "Knurling Operations."

* * *

The Whitney Mfg. Co., Hartford, Conn., employs a system of storing steel used in the manufacture of Woodruff keys, transmission chain, etc., which enables a count of the tonnage on hand to be made in a few minutes at any time. Most of the steel comes in eight-foot lengths and is stored in steel racks, laid horizontally. As the steel is unloaded from the cars it is weighed in ton lots and these lots are laid in the racks with cross sticks between to separate them. Hence the number of tons in a rack is ascertained by simply counting the lots.

DRAWING A MOTOR-CYCLE MUFFLER BASE

At *I* in Fig. 1 is shown a motor-cycle muffler base made from flat sheet-metal stock in ten operations by the Acklin Stamping Co., Toledo, Ohio. The first operation is cutting the blank from the stock. It is then drawn to the proper depth in a simple push-through die, the result being shown at *A* in Fig. 1. The third operation is similar, except that the punch starts a bulge on the side of the shell, as is shown at *B*. The fourth operation is also formed in a plain push-through die using a punch so shaped that it will gather more metal where the nozzle is to be formed. The result of this operation is shown at *C*.

This die, as well as the die used for the third operation is provided with pads for ejecting the work and the punches are equipped with center knockout pins actuated by the press on the return stroke to insure the piece being pushed off from the punch. This insures the shell leaving both the die and punch.

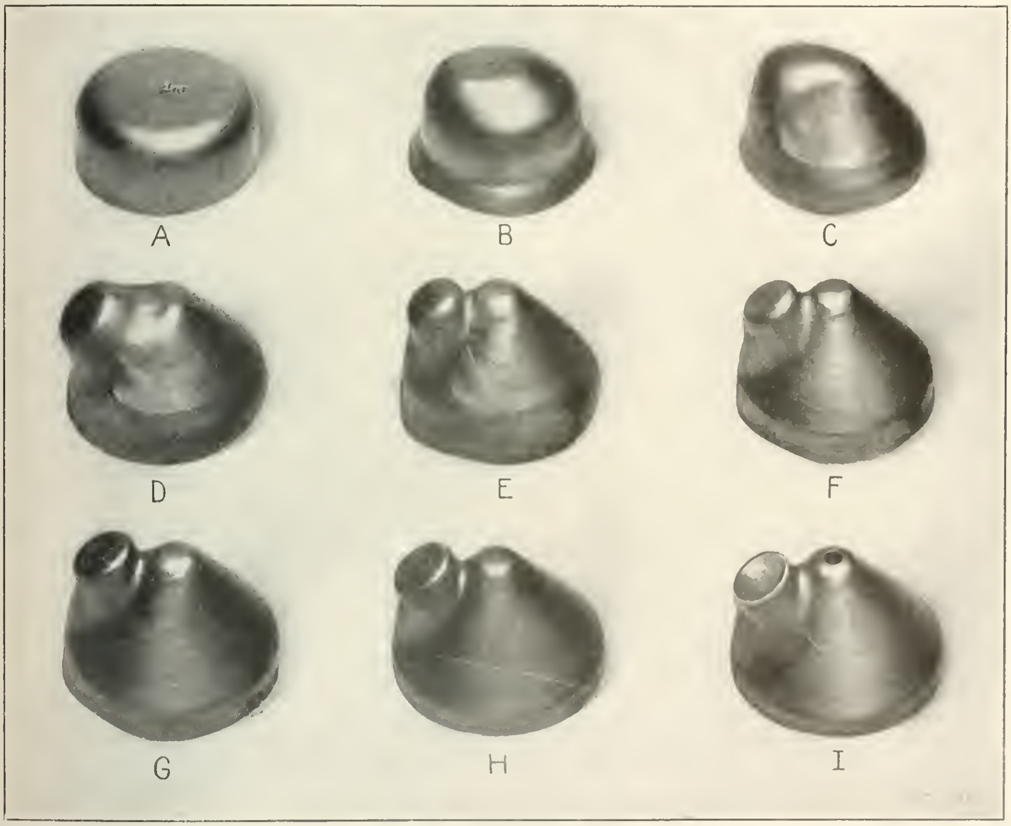


Fig. 1. Successive Drawing Operations on a Motorcycle Muffler Base

The fifth operation is performed by a round punch and die, shown in section, Fig. 2. Although the punch and die are of an ordinary type, it will be observed that the shell is placed underneath the punch in an unusual position, this being necessary in order to draw up the nozzle on the side. The result of this operation is shown at *D*.

The same principle of punch and die construction is employed for the sixth operation, and the nozzle is reduced to within one-sixteenth inch of its finished shape, as shown at *E*. The seventh operation, the result of which is shown at *F*, is accomplished by inserting the shell perpendicularly in the die, the action being to finish the cone and to size and straighten the edge of the shell. A vertical section of the punch and die is shown in Fig. 3, in which it will be seen that the die is provided with a pocket at the right for receiving the nozzle. The punch is a plain cone without projections and is used for forming the cone and straight parts of the shell only. This punch and die, like the others, is provided with center knockout pads.

The eighth operation resizes the nozzle and brings out the perfect lines of the cone and reduces to a minimum the radius on the corner where the nozzle joins the cone. The condition of the piece after this operation is shown at *G*. The shell is then taken to a trimming press and the surplus metal is removed while supported on trimming horns, six strokes of the press being required to make a complete revolution of the shell. The trimmed shell is shown at *H*. The operations remaining to be performed are punching the hole in the apex and the end of the nozzle. This is done in ordinary piercing dies, provided with gages suitable for the work. The drawing of the piece is now finished, as shown at *I*, and requires only nickel plating to be ready for assembling.

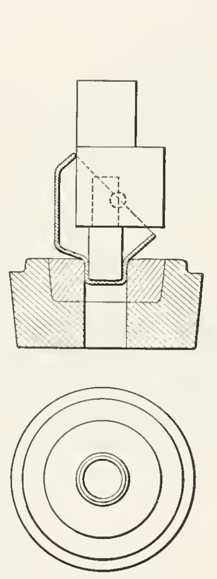
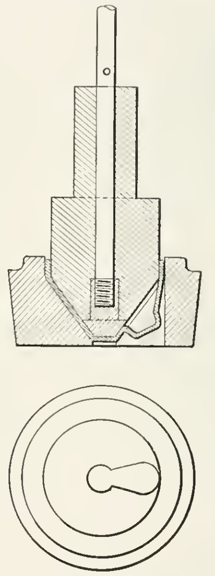


Fig. 2. Punch and Die for drawing the Nozzle



Machinery

Fig. 3. Punch and Die for forming the Cone and sizing the Mouth

Notwithstanding the number of operations, the final cost of the stamping is lower than that of the casting which it replaces. The dies for the various operations are not costly and can be quickly interchanged. On account of their simple design the operator is enabled to turn out a large daily output.

* * *

Automobile specialties, good, bad and indifferent, have been developed in large numbers, all having for their objects saving fuel, promoting comfort, saving labor, warning pedestrians, etc. One of the clever wrinkles for saving labor is an impulse air pump which can be applied to any one of the cylinders in place of the spark plug and used for pumping up the tires. The device consists essentially of a small differential piston working in a cylinder fitted with suitable valves. It is operated by running the engine with three or five cylinders, the cylinder to which the pump is connected being dead, of course, because the spark plug is removed. The air compressed in the cylinder is driven through the pipe connecting with the differential piston and drives it upward. The small piston connected to the larger piston compresses a small charge of air to a higher pressure and forces it into the tire. The residual air remaining in the small cylinder "kicks" the differential piston down as the engine cylinder makes its down stroke, the momentum being sufficient to complete the stroke and draw in a fresh charge of air.

RACK CUTTING ON THE PLANER

BY ALBERT CLEGG[*]

The article entitled "Planing Steel Racks for Frog and Switch Planers," published in the September, 1912, number of MACHINERY, interested the writer very much because his experience in this direction convinces him that the planer, without any special attachments, is almost as efficient when cutting racks as the best fully automatic rack-cutting machine on the market. Furthermore, if a machine were designed along the general lines of a planer but equipped with automatic feed, return and dividing mechanism for the tool-head, the writer is of the opinion that the output from such a machine would be considerably greater than that of a standard automatic rack cutter. Now all this, of course, is mere assertion, but the writer believes he can show that the proposition is a reasonable one. Before doing this, however, it may be of interest if he relates the circumstances which first led him to consider the feasibility of cutting racks commercially in this way.

Some time ago, we found it necessary to replace the rack on one of our largest planers. This rack was of cast iron, 1½-inch pitch by 9-inch face, with a 2½-inch flange on each side to secure it to the table of the machine. (There were five sections, each 54 inches long and weighing about 450 pounds.) The planing of the blanks was, of course, quite an everyday sort of a job which gave no trouble whatever; but when we came to cutting the teeth we "struck a snag." Our gear-cutting equipment included a comparatively light automatic rack-cutting machine, and though we greatly doubted its capacity for doing this work, we decided to give it a trial. The longest work that could be done on this machine without resetting was 42 inches, while the heaviest work previously attempted was cutting 4 diametral pitch in 2¼-inch square mild steel blanks. After getting one of the sections fixed in the machine, we found that the roughing cut on one tooth took fifteen minutes, so that with an equal time for the finishing cut, the actual cutting time required to complete the five blanks would be about ninety hours. While this was pretty bad, the inaccuracy of the teeth was even more serious. The design of the machine was such that when working at the extreme ends of a job, the work-carrying fixture had considerable overhang, and as the planer rack blanks were fairly heavy and 12 inches longer than the machine really admitted, it will be readily understood that this overhang of the work was not conducive to accuracy. We found that the end teeth were 0.015 inch out of square in the width (9 inches) of the blank, and as this inaccuracy was altogether too great, we were forced to the conclusion that it was necessary to employ some other method.

After considering sending the blanks out to be cut and finding that the cost would be $40, we finally decided to try to cut them on the planer—the very machine, in fact, for which we were making the rack. We did not care to rely on the accuracy of the cross-rail screw for spacing the teeth, so we cut a 1½-inch pitch ratchet rack 60 inches in length, and fixed it on the upper side of the cross-rail in such a way that a pawl on the tool-head would engage with it. The indexing was done by moving the head until the pawl dropped into the next space on the rack, and then moving it in the opposite direction as far as the pawl would allow. All the five blanks were bolted on the table of the planer at once, the flanges proving very convenient for this purpose. The spaces were then stocked out by using two ½-inch grooving tools, placed side by side and, of course, of 1½-inch pitch. The cutting speed was about 25 feet a minute and the feed per stroke 0.015 inch, the time taken to rough out two spaces in the five blanks being about eighteen minutes. After all the teeth had been roughed out in this way, a form tool having straight sides with an included angle of 29 degrees was used for finishing. A dead stop was set on the tool-head to give the exact depth of tooth; the automatic feed was used until the tool was just short of full depth, when the automatic feed was disengaged and the last few cuts were fed by hand until the stop was reached. Of course, it will be understood that this method was followed for the roughing as well as for the finishing cuts.

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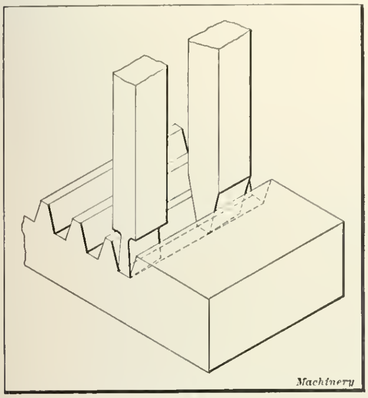
The feed and speed for finishing were exactly the same as for roughing, so that the time required to take a finishing cut was eighteen minutes, five teeth being finished in this time. The roughing time for one tooth was:

$$18 \div 10 = 1.8 \text{ minutes}$$

and the finishing time

$$18 \div 5 = 3.6 \text{ minutes.}$$

This made the total time only 5.4 minutes or less than a fifth of the time required by the rack-cutting machine. Including the flanges and allowing for two cuts at equal rates of feed, a milling cutter would require a feed of 5 inches a minute to equal the above performance. It appears that the above description is sufficient to show that the planer is by no means a "makeshift" for cutting rack teeth; indeed, its output compares so favorably with the usual method that it may possibly make the latter appear to be the "makeshift."



Tools used for cutting Rack Teeth on a Planer

Some time ago the writer came across a price list of mild steel machine-cut racks, and among other items listed were 7-, 8- and 10-pitch racks made from 1⅛-inch square, drawn-steel bars; the price quoted for such racks was 30 cents a foot. Now on the face of it, this price seems extraordinarily low, but a little figuring will show that, using the proper equipment, a fair profit is possible even with the very low price quoted. The stock used is drawn steel bar costing, roughly, 10 cents a foot. No machining is done on the blanks, except cutting them from the bar. If we allow the rather large margin of 2 cents a foot for cutting off, the total cost of the blanks, ready for cutting, will be 12 cents a foot. This leaves 18 cents a foot to cover cutting the teeth, overhead charges, wages and profits. If we base our estimate on the 10-pitch size, it means that there are:

$$12 \times \frac{10}{\pi} = \frac{120}{3.1416} = 38.2$$

teeth to cut for 18 cents, which works out roughly at 0.5 cent per tooth. How, then, can this work be done at such a low figure and a profit be made on it?

The method suggested by the writer would be by means of a special planing machine to take work up to about 36 inches wide, 18 inches high and 48 inches long. This machine would require an arrangement for automatically feeding, returning and spacing the tool-head, and also a pump to supply lubricating fluid to the tools. The table should have a suitable vise-like fixture for carrying the blanks; this fixture could be arranged so that blanks might be set over the entire length of the stroke of the machine. At three or four places in this length, it would probably be necessary to have supplementary jaws bolted to the base of the fixture to minimize, as far as possible, the tendency for the blanks to lift. The tools would be similar to the ones shown in the illustration, but on such a fine pitch as 10, there would be at least two pairs of tools operating on two spaces simultaneously. A brief description of these tools may not be out of place. The front tool is really for roughing, and is arranged so that it only cuts on the end, while the rear tool, which is for finishing, clears the bottom by one or two thousandths, and therefore only cuts on the sides. This enables fairly heavy cuts to be taken. The writer has used this arrangement for all kinds of grooving in steel with very satisfactory results, and has no hesitation in recommending it for this class of work.

To return now to our calculation, we will assume that twenty blanks are mounted on the machine at once. Allowing for the width of the supplementary jaws, this will require a stroke of about 36 inches. Assuming a cutting speed of 45 feet per minute and a return of 90 feet per minute, the number of strokes per minute will be

$$\frac{1}{3/45 + 3/90} = 10$$

If we allow for a feed of 0.01 inch per stroke, the number of strokes required to cut a 10-pitch space would be:

$$0.216 \div 0.01 = 21.6.$$

Some idle strokes will take place during the returning and the indexing period, so we will increase this to 25 strokes; 25 strokes at 10 strokes a minute means that it will take 2.5 minutes to completely finish 40 teeth; this makes the rate of production 960 teeth an hour. The cost of production is 0.5 cent a tooth which gives $4.80 as the value of one hour's work. It will be conceded that this sum allows a reasonable margin for overhead expenses, wages and other incidental items, leaving a fair profit after all these charges have been met. In addition, it shows what is possible with a machine designed along the lines suggested.

The writer would like the author of the article "Planing Steel Racks for Frog and Switch Planers," which appeared in the September number of MACHINERY, to explain how they managed to make the ⅝-inch roughing tool stand up under a feed of 0.04 inch per stroke in forged steel. So far as our experience goes, this is an abnormal feed for a grooving cut. The writer would also like to draw his attention to the double tool arrangement shown in the illustration which would, in his opinion, not only do the work with less strain on the machine but would probably enable them to do in two cuts what is now taking four. The finishing tool in any case ought to be arranged so that it does not cut on all three sides. This will considerably reduce the tendency to chatter without being in any way detrimental to either the strength or the running qualities of the finished rack. There is no reason why the depth of the spaces made by the roughing cuts should not be even 1/64 inch deeper than standard. This is unnecessary, however, as all that is required is for the finishing tool to clear the bottom of the space when taking the last cut.

* * *

SKETCHING OF MECHANISM IN DESIGNING

BY FORD W. HARRIS[*]

The usual method of designing mechanism is to let the designer lay it out himself or a competent draftsman do it under his supervision. The technique of mechanical drawing is well understood and very little can be said at this late day about the special methods that have been developed for making accurate and economical layouts. It is sufficient to say that a good layout is an accurate drawing which shows the essentials of the device to be detailed without going into all the details and without attempting to produce anything ornamental. It is a drawing reduced to its lowest terms. Most inventors start with such a layout, generally made for them by a draftsman.

The writer has to date placed about fifty patent applications in the Patent Office, and about thirty patents have issued, nearly all of which are for mechanisms, and perhaps a brief description of his methods of inventing a mechanism may be of interest. They have been developed during sixteen years practical experience on such work, during which time the general methods outlined have been applied to work varying from a ladle tilt in a steel mill to a regulating mechanism of an arc lamp. It is probable that they do not differ greatly from those used by other men in the same work, but the writer does not remember ever seeing such methods described and, although he has been associated with a number of inventors, he does not remember many who have developed the system quite as fully as he has. The completeness of this development is due to one fundamental belief that may as well be expressed as a starter.

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[*] Address: 615 Delta Bldg., Los Angeles, Cal.

This belief is that no man calling himself a designer should ask another to draw something that the designer has not satisfied himself in advance is possible and very likely to be practical. This is at variance with the practice of many designers who make a very rough sketch or do what is worse, describe what they have in mind and let the draftsman worry it out. This is very economical of the designer's time as it leaves him free to carry on other work, but it is wasteful of the draftsman's time, and generally results in inferior designs. It is the writer's opinion that the designer should personally carry his work to such a point that the draftsman can go ahead and complete the work with very little help or attention from the designer, and further, it has been demonstrated that if the designer will so handle his work the result will be a considerable saving in cost, considering both the designer's and the draftsman's time.

To do this the designer must roughly lay out the work himself and satisfy himself that what he has in mind will go together. This can be done by the usual drawing office methods, but such methods are too accurate and slow for the purpose in mind. What is desired is a collection of sketches and a description or specification that the draftsman can take and go ahead on, without having to lay out a half-a-dozen schemes before he finds an acceptable one. Of course, designs are generally the work of a number of men, but the original inventor will find that if he digests his schemes pretty well before he starts to get others working on them he will generally carry them pretty near to perfection, and the time of the others will be saved.

It may be necessary to spend a lot of time and hard thought to do this, but very little that is good in engineering comes easy. It will be found that the excellence of any design is a direct function of the time and hard work that has been put upon it. It is not possible to dispense with the draftsman's layout and such a layout will probably disclose difficulties that the sketches will not discover, but such difficulties will be very much smaller in number and of a very much less important character than when the draftsman starts out with only a very hazy idea of what is wanted and the designer has even less accurately defined notions. It is merely a practical application of the old principle that whatever is worth doing at all is worth doing well.

If the design is a hard one it is very unlikely that a satisfactory solution can be found without several trials. If these are made on the drawing-board it will take a lot of time, while by using the sketch method the impracticability of the simple solutions will be quickly apparent and they can at once be discarded without serious expense or what is often of more importance—serious delay.

A man who is going to dig in hard with his brain should have as little strain on his body as possible, and it is a pretty hard job physically to bend over a drawing-board. It is preferable to do the work at an ordinary desk in an ordinary swivel chair which is about as comfortable a position as can be devised. This at once eliminates big sketches, and it is desirable to make them standard letter size which is generally regarded as 8½ by 11 inches. Secondly, it is desirable to use a cheap grade of stationery; the writer uses cheap white typewriter paper for the preliminary work, and tracing linen for the final result. The paper sketches are finally thrown away. The final result is valuable, and it is desirable to save it as it is of value in patent litigation so that the very best is none too good. Intermediately a few sheets of tracing paper will come in handy, but such paper is perishable, tearing easily, and a thin bond paper is much better.

Many designers use ruled cross-section paper, which has two objections: First, it is expensive, and second, after the sketch is made it is better to put in a few main dimensions and not have cross-section lines to confuse the lines of the sketch. It is preferable to make an underlay sheet on tracing linen and use ordinary paper, laying the cross-sectioned underlay under the white paper, and thus have the cross-sectioned lines to make the sketch by but not have them on the sketch itself. Do not use a fine cross-section; the writer finds that half-inch squares give excellent results. Quarter-inch squares are also good, and two sheets one ruled in halves and the other in quarter-inch squares will serve to lay out almost any sort of a small mechanism.

The first thing necessary is a sketch of the fundamentals to give a rough idea of the best arrangement of parts. This the writer ordinarily makes on a poor grade of paper and does not bother about the underlay. All that is needed is a qualitative idea of the mechanism without much regard to size of parts, interferences or details of construction. It is not always easy to draw this first sketch, and one can spend much time in groping around for an inspiration. The best way to do, then, is to seek for inspiration from similar mechanism. We are all of us moving by slow steps and he is indeed a conceited man who will not admit that much of the fine work he puts out was borrowed from the long procession of similar designs that have gone before. It is a good principle to take your own wherever you find it, and if some one has seen it first so much the more credit it is to them. This is, of course, to be modified by considerations of general principles of business and common honesty, but in general there is no such thing as an ownership of mechanical combinations, or at best only a limited ownership for the term of a patent.

After having produced a rough sketch that looks meritorious, it is advisable to make a sketch showing the principal parts to scale within the limits of free-hand sketching. Here is where the underlay and the thin bond paper come in handy. A small pine board and a celluloid angle with a few thumb-tacks are all the drawing instruments needed, and with the underlay sheets and these accessories quite presentable sketches may be made. Pin the bond paper down to the board with the underlay under it and draw in the principal parts with a soft pencil without bothering about one part cutting off the view of another. That is, lay in every piece as if it were the only piece on the sheet and do not bother about dotting or omitting lines that would not appear on a true view of the mechanism.

Before going very far, the designer will begin to wonder what is going to happen when some of the parts assume another position than that in which he is drawing them. The best way to find out is to take a scrap of tracing paper or linen and make the part on this separate piece. This scrap can then be slid around and its action noted. It may be desirable to preserve a record of such positions and a separate sheet of bond paper may be started to show the relation of the mechanism at various points, a separate sheet being generally used to show each position. No attempt should be made to show fastenings.

After a lot of juggling the design begins to breathe or it doesn't. If it doesn't it is generally best to make a fresh start, preserving the papers and the scraps pending the failure or success of this start. After several trials a layout will be evolved that seems to be satisfactory. It is now in order to make the final sketches from the several sheets and scraps that have accumulated. Take a sheet of tracing linen and a soft pencil and trace in free-hand from the scraps the various parts with due regard for their position, dotting important hidden lines and omitting unimportant ones. This final sketch is made only partly for the information of the draftsman. Its chief value is to show whether the work will stand the test of an assembly sketch. Very often it will not and the designer will have to make a fresh start or modify his sketch to avoid the difficulty.

When the designer is through he should have some pencil sketches on letter size tracing linen that fully express the work that he has done. Very often he will do in a few hours what would take as many days to accomplish working cut-and-try with a draftsman, and the chances are that he will have applied himself so that the quality of the work is much better.

* * *

"Fighting one's way to the top," says one of our contemporaries, is an expression that carries too much of the spirit of warfare and antagonism for an age when it is more and more being recognized that cooperation and work for the common good is the primary requirement. Why not then say "working" instead of "fighting?"

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

GENERATING THE SKEW BEVEL GEAR

The January number of MACHINERY contained an article entitled "A Practical Form of Tooth for Skew Bevel Gears," by George M. Bartlett, which was very interesting to me. I believe that Mr. Bartlett is the first to publish anything regarding the fact of the generating rack for skew bevel gears being a *right helicoid.* I have held essentially the theory which Mr. Bartlett so ably advances, for a number of years, and have recently succeeded in actually cutting a pair of such gears by the theoretically correct generating process; this proves that Mr. Bartlett's theory is correct, except in regard to what he says about "under-cutting."

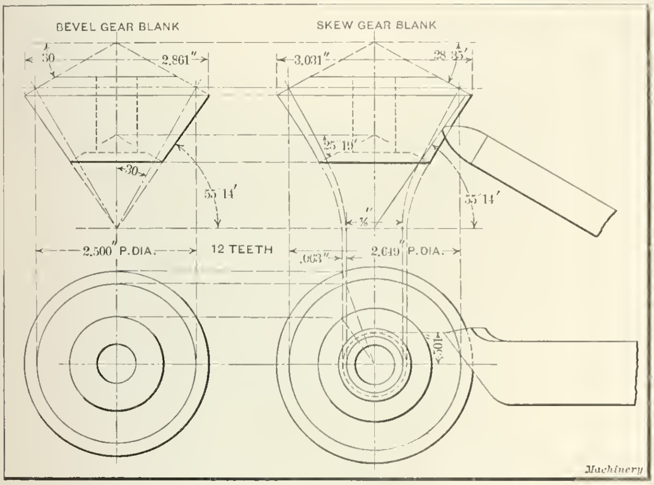


Fig. 1. Turning the Blanks for Skew Bevel Gears and Regular Bevel Gears

Owing to the lengthwise sliding or slip—if it may be so called—I expected that the tooth outline of the skew gear would differ from that of the corresponding bevel gear, and to bring out its peculiar features as clearly as possible I have made a pair of gears which extend as near to the gorge circle of the hypoid as could be conveniently cut with my present facilities. The dimensions of these gears were as follows:

Largest pitch diameter = 2.649 inches.
Angle of asymptote = 30 degrees.
Number of teeth = 12.
Width of gear face = 1.25 inch.
Diameter of gorge circle = 0.875 inch.

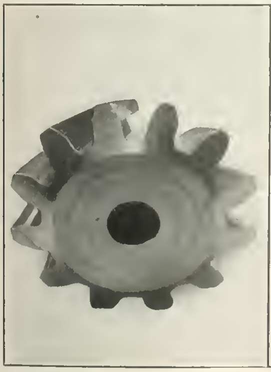


Fig. 2. The First Skew Bevel Gear produced by the Generating Process

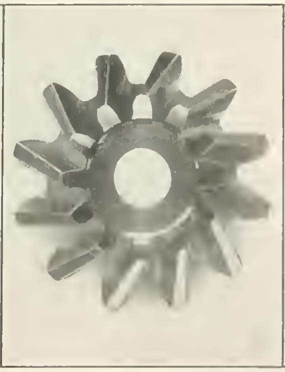


Fig. 3. Front View of Gear shown in Fig. 2; compare the Tooth Outlines

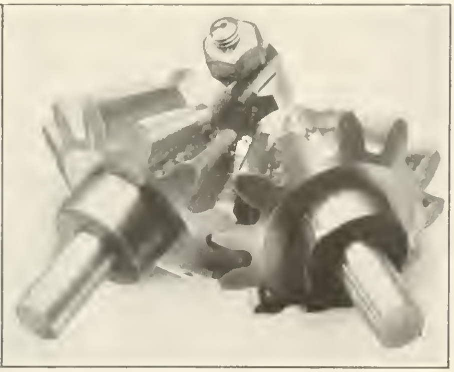


Fig. 4. A Pair of Uhlmann Skew Bevel Gears in Mesh

From this data the pitch of the imaginary helicoidal rack figures out 4.761 inches.

The hypoid form of the blanks was turned with the tool simply set half an inch above the center, and with the compound rest set to the same angle at which it would have been set for turning the corresponding bevel gear blank. The method of turning the blanks will be readily understood by reference to Fig. 1. Figs. 2 and 3 show the first gear after cutting the teeth. Although a pressure angle of 20 degrees was used, there is not only a considerable under-cutting—which is all on one side of the tooth—but the tool also cut away material on the same side of the tooth at the top; the effect on the opposite side of the tooth is just the reverse so that it will be apparent that the tooth outline is decidedly unsymmetrical. Reference to Figs. 2 and 3 will show the reader the amount by which the tooth outline differs from a symmetrical form. From the study which I have made of this subject, I believe that this deviation from a symmetrical tooth outline will be most pronounced at some point near the gorge circle, that beyond the gorge circle these conditions reverse so that excessive under-cutting will then appear on the opposite side of the tooth.

In the case of the gears shown mounted on studs in Fig. 4 this excessive under-cutting has been avoided by changing the pressure angle on one side to 25 degrees, but with the apparatus which is now at my disposal, I could only do this by simultaneously changing the pressure angle on the other side to 15 degrees. This produced a somewhat "leaning tooth," but what under-cutting there is on each side is only trifling in its amount.

Skew bevel gears find application in various kinds of machines, but nearly all of these gears are now cast from patterns, while even the best of cut gears of this type which the trade can so far supply, are far from being good approximations, but the present method of generating teeth should afford a means of producing skew bevel gears which, in point of accuracy, and consequently smooth action, would be equal to generated bevel gears. Where the distance between the shafts is great enough to make the gorge circle very large, it will usually be possible to use other forms of gears; but when this distance is only great enough to allow the shafts to pass each other, thus requiring the gorge circle to be small, as is frequently the case, skew bevel gears are the only form of transmission which will answer the purpose.

Philadelphia, Pa. MAX UHLMANN

DO BELTS RUN TO THE HIGH SIDE?

The writer has been much amused at the different ideas which have been published on the subject "Do belts run toward the high side of the pulley" when the shafts are out of parallel. It is certain that a belt behaves in approximately the same manner for all of us, and the varied experiences which have been reported arise from the confusion in the use of common mechanical terms. In the article in the January number of MACHINERY it was shown by George P. Pearce that the belt runs off on the low side of the pulley. This is undoubtedly true, but in so doing it is running *toward the high side* when it runs off the pulley on the *low side*. The writer uses the diagram which appeared in connection with Mr. Pearce's article to prove the accuracy of this statement. In this sketch the belt is shown running toward the high side of the pulley, but this action causes it to leave the pulley on the low side.

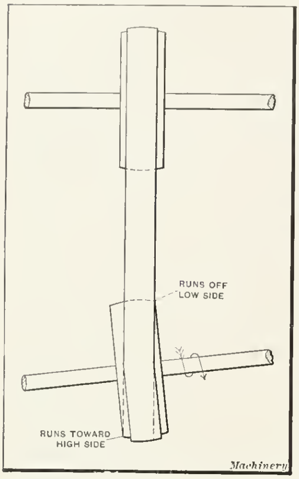


Diagram showing how a Belt runs off the Pulley when Shafts are out of Alignment

Troy, Ohio HENRY J. BECK

"SPECIALISTS WHO DO NOT SPECIALIZE IN PRICES"

The editorial in the February number of MACHINERY entitled "Specialists Who Do Not Specialize in Prices" was read with interest by the writer, who for several years past has been associated with a firm specializing in ball bearing manufacture, and as it is difficult to believe that this was written by one who had made a thorough study of conditions relating to ball or roller bearing manufacture, some discussion relating to this subject may be of interest.

No exception can be taken to the editorial statement that a number of machine tool builders are making their own bearings economically, and in many cases these are giving good satisfaction, but they are not made on standard machine tools with a few special jigs and fixtures as you state. In order to compete successfully with a specialist, it is necessary to have as complete an outfit of machinery, though on a smaller scale, and when initial investment is considered it is seldom that bearings are made in a machine manufacturing establishment as cheaply as they can be purchased, providing they are similar to regular standard stock produced by the manufacturer of anti-friction bearings.

The writer is connected with the machine tool branch of the engineering service department of one of the leading ball bearing manufacturers (New Departure Mfg. Co.), and it is my belief that statements made in editorials are not based on actual experience. In nearly every case where we have been unable to quote satisfactory prices, the machine manufacturer wished small lots of special bearings that in many cases were proportioned so poorly and with so little regard for ball bearing engineering principles that we would not make them even if we had jobbing facilities available.

When manufacturing thousands of ball bearings per day the proposition of introducing the undesirable element of special work of a jobbing nature is not pleasing, so prices are always made sufficiently high to pay for tools, special fixtures and inconvenience entailed by loss of regular production capacity. A few special orders of bearings that differed from the standard stock product would introduce complications that would not be realized by one not familiar with anti-friction bearing manufacture. In our plant, for instance, all bearings are inspected thirty-one times before shipment. The confusion produced by introducing a small special lot of bearings differing from the product can be multiplied by every manufacturing process they must go through, and the seriousness of this in a plant where orders are always ahead of capacity can be easily understood by considering the thirty-one inspections alone. On such bearings we believe the prices asked are justified.

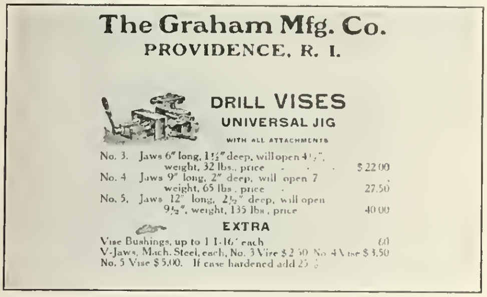
When one considers the wide range of standard sizes and types of ball bearings available, it is difficult to understand why the machine tool manufacturer must use special designs. The firm with whom the writer is associated manufactures nearly two hundred distinct sizes of bearings, these being divided into three standard types. The bores range from approximately ⅜ inch to nearly 4½ inches, the outer diameters from 1 inch to 9 inches. Ball sizes ranging from 3/16 inch to 1 1/2 inch may be obtained, and carrying capacities range from 160 pounds to 15,000 pounds at 600 revolutions per minute. A machine tool manufacturer who cannot make a selection of bearings that will fit his requirements from such an assortment is certainly hard to please, and the only way he can be satisfied is undoubtedly by building the bearings he thinks he needs to suit himself.

The machine tool manufacturer is seldom a gainer by doing this, however, because the building of practical ball bearings is essentially the work of specialists. Some manufacturers deceive themselves to the extent of believing that their product is equal to that manufactured by a specializing manufacturer, but this is seldom true. The writer has carefully examined many such samples submitted for quotations and has never found one equal in design or finish to those produced by specialists. Balls were found to have soft spots, to have entirely decarbonized surfaces, to show a coarse fracture and lack strength when broken, and to vary from sphericity or adherence to standard size by 0.001 inch and even 0.002 inch. The finish on many home-made balls and races showed the grinding marks plainly, and the only balls that were found properly treated were the products of specialists, because they showed characteristic fractures that easily classified them. Cones were found with races of poor curvature and improperly treated. Some of the cones submitted had a raceway with a curve made on a radius equal to ball diameter so the ball could not possibly have a true rolling motion. Others had straight angular raceways that are deficient in carrying capacity. Most cones did not have sufficient metal under the balls, and it was seldom that the bores were not ground bell-mouth and to some irregular size, if ground at all.

Cups were made of pressed steel in many cases, with merely a cyanide hardening and with polished raceways that were finished by some rough lapping process instead of the correct curve generating grinder. The metals were seldom suited for the work, and were usually very carelessly treated. Some cups had a three-point contact and were used with a two-point contact cone so the balls were subjected to a spinning and rubbing action all the time they were in use, and in fact some of the bearings received were so tight that more power would be required to turn a shaft mounted in them than would be needed on plain journals with indifferent lubrication. Some of the pressed steel cups were out of round 0.004 inch or 0.005 inch, and cones were out of round and distorted by hardening fully as much. The lapping process used to polish the raceway did not make the raceway true, as the lap followed the cone or cup contour, whereas the proper type of grinder would have generated a raceway of proper curvature. Most of the bearings submitted used small balls and were of the full type without separators. Some had apparently been run long enough to have banded and scored the balls, and most of them were of the type that fell apart as soon as handled, the balls scattering to all points of the compass. Roller bearings were also examined carefully, and in all cases the workmanship was even more crude and the finish poorer than was found in the ball bearings. These were the bearings machine makers were making in many instances and thinking that they were saving money because they cost less than the product of specialists.

Ball bearing manufacturers have been through the mill, and the difficulties that machine tool manufacturers who make their own bearings are just being confronted with have been overcome years ago. If a manufacturer is satisfied with a cheap product he certainly can compete with specialists, but he can not produce goods of equal quality at the same cost.

Consider the balls used in good annular bearings. These are not allowed to vary from standard size more than 0.0001 inch in any one bearing and are absolute spheres to that close limit. The heat-treatment has been carefully determined by exhaustive laboratory tests, and balls are hardened by the aid of delicate instruments and under the supervision of competent metallurgical engineers. The surface finish is so fine that grinding marks are not visible even under the usual magnifying glasses and show up only when examined under a microscope. The machine tool manufacturer cannot produce balls of this kind to compete with the specialist. Even if he has part of the costly general equipment he is not justified in securing the services of the expert metallurgists available to the specialist, and he surely cannot use the patented, special machinery employed by them in ball manufacture.


The Graham Mfg. Co.
PROVIDENCE, R. I.

DRILL VISES
UNIVERSAL JIG
WITH ALL ATTACHMENTS

No. 3. Jaws 6" long, 1½" deep, will open 4½", weight, 32 lbs., price . . . $22.00
No. 4 Jaws 9" long, 2" deep, will open 7", weight, 65 lbs., price . 27.50
No. 5. Jaws 12" long, 2½" deep, will open 9½", weight, 135 lbs., price 40.00

EXTRA
Vise Bushings, up to 1 1-16" each .60
V-Jaws, Mach. Steel, each, No. 3 Vise $2.50 No. 4 Vise $3.50
No. 5 Vise $5.00. If case hardened add 25%

Fig. 1. Drill Vise Card from File kept for the Graham Mfg. Co.

The writer of the editorial in question says standard machine tools and a few special jigs and fixtures are all that are needed to produce ball bearings commercially. A visit to any anti-friction bearing manufacturing establishment will soon dispel this idea. In the plant the writer is most familiar with, hundreds of standard machines are used, but these are roughing out the work and seldom finishing. The accurate work on cups and cones is being done on special machinery developed by the engineers who are specializing on ball bearing manufacturing solely and whose entire time is spent in experimentation and research work that means a constant refinement in processes of manufacture, making for economical production. The machine tool maker could not afford to maintain this staff of specialists; he could not use the special machinery, which is patented in most instances, and he certainly does not have the data resulting from the research of men specializing in ball bearing production to guide him.

When these facts are considered it will be apparent that either quality or correct design must suffer when anti-friction bearings are made by general manufacturers. The writer can demonstrate very clearly that any manufacturer who can use the standard product of ball or roller bearing producers is no more justified in making his own anti-friction bearings than he is in making his own taps, dies, twist drills, gear cutters, micrometers, scales, emery wheels or any of the many other standard parts he can purchase more cheaply from a specialist. If he needs special drills or cutters and only in small quantities, he must make them himself, and that is the only time he is justified in so doing.

No matter what the quantities are, so long as the product is standard and in course of regular manufacture, no machine tool manufacturer, no matter how well equipped he is, can compete with the specialist and produce goods of equal finish, quality and general excellence at the same cost.

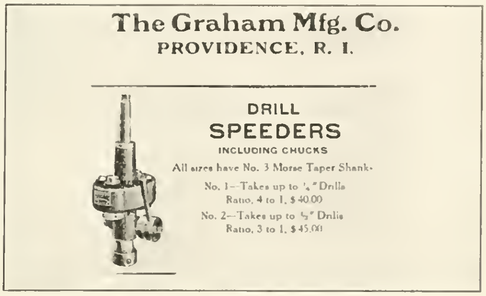
In answer to the editorial writer's query about the cost of selling ball bearings, the writer wishes to state that the cost of selling ball bearings, owing to the large number generally sold to a customer, is much less than that of most machine tools and shop appliances. These have been ordered in lots of 200,000 and 300,000 from the firm with whom the writer is associated, by automobile manufacturers, and even machine tool manufacturers, who have just started using these bearings in quantities order in lots of several thousand. The high cost of special bearings is not due to selling cost, but because it is impossible for a ball bearing manufacturer to become a general jobber without ceasing to be a specialist.

Bristol, Conn. VICTOR W. PAGE

[The editorial in question did not state that machine tool builders were making balls, and it was not the intention to convey the meaning that they were doing more than making the bearings. Motorcycle builders, however, are making the rollers as well as the bearings.—EDITOR.]

MACHINERY AND TOOLS DATA CARDS

In getting out a buyers' directory, the Patterson Tool & Supply Co., Dayton, Ohio, has adopted the use of standard 3- by 5-inch index cards on which are pasted slips bearing the name of the buyer, and a list of tools and other factory supplies. These cards can be readily filed and give information concerning the class of supplies for which the customer is likely to be in the market. It appears that many manufacturers could get up cards of this kind at a very small expense and send them not only to dealers but to manufacturers. Such cards should be of sufficient value to prevent them from being consigned to the waste-basket.


The Graham Mfg. Co.
PROVIDENCE, R. I.

DRILL
SPEEDERS
INCLUDING CHUCKS
All sizes have No. 3 Morse Taper Shank.
No. 1—Takes up to ¼" Drills
Ratio, 4 to 1, $40.00
No. 2—Takes up to ½" Drills
Ratio, 3 to 1, $45.00

Fig. 2. Drill Speeder Card from File of the Same Company

Dayton, Ohio THE PATTERSON TOOL & SUPPLY CO.

SUGGESTIONS ON TOOLING FOR INTERCHANGEABLE MANUFACTURE

In the December, 1912, issue of MACHINERY, "A. L. B. Co." asks about the best method of procedure in tooling for interchangeable manufacture. As the editor very correctly answers, there is no general agreement among manufacturing experts in this regard. However, it seems to the writer that one general statement could be made which would apply to every concern undertaking interchangeable manufacture, *i. e.*, such matters should be "threshed out" and decided in the drafting and tool-designing departments of the company interested. The writer is assuming that any company engaging in interchangeable manufacture has at least one competent draftsman, who, by conference with the shop superintendent and heads of departments, would be capable of collecting and developing all the good ideas relating to the tooling and manufacture of any machine taken under consideration. All machinery manufacturing experts agree that time and expense are not lost when devoted to thoroughly working out such matters on the drawing-board.

Granting that the reader is not averse to considering the part the drafting-room should play in tooling for interchangeable manufacture, let us investigate a few facts which have come to the writer's notice in such cases. It very often happens that a machine is made or built—"thrown together" is a better expression—for a number of years before a company will manufacture it so that the parts are entirely interchangeable. Then a designer is called in and the machine is properly "laid out" and detailed. More often, the various details of the machine are "measured up," and detail drawings are made from the parts themselves. In the writer's opinion, this method is always a mistake. In one such case, a machine had been built for a year or more without making any provision for having the parts interchangeable. It was decided to provide a complete equipment of jigs, fixtures, gages, etc. A draftsman measured the parts, and was instructed to make drawings of them just as they were. The result was a most magnificent collection of odd shapes, fancy dimensions, foolish limits, and mongrel threads, tapers, etc. This was partly due to the draftsman's inexperience, but it was chiefly the result of the method that he followed in doing the work. Then came taps, reamers, and other small tools that were of no standard design, necessitating the production of special small tools as long as the machine was manufactured. Jigs and fixtures made from the pieces, or from the drawings of the separate details, turned out work that failed to "match." A number of these tools had to be discarded, some of them costing several hundred dollars.

When it was necessary to make tools for a similar machine, an entirely different system was adopted, resulting in a highly efficient means of tooling. When this machine was considered to some extent standardized, detail drawings were made from the original assembly, which had been corrected to date. These were checked, and turned over to men familiar with the functions of the machine and the requirements of manufacture, for the assignment of limits. And this matter of limits, as is well known by every man in the mechanical field, is a subject of the utmost importance in interchangeable manufacture. The use of mechanically and mathematically correct limit gages is often the means of swinging a manufacturing proposition from a losing to a paying basis. With the assignment of correct limits to the various machine parts, and a careful checking of the detail drawings; one feels safe in proceeding to design jigs and other tools from these drawings themselves.

Another means of checking the detail drawings, if one is so inclined, is to have a draftsman make an assembly drawing of the machine in question, using dimensions as given on the detail sheets. This serves as a final check, except in the case of very close dimensions, and often is a considerable aid in exposing errors which might not otherwise be found until it came to assembling the machine from the finished parts. Where competent draftsmen are employed, and thorough cooperation is required between the drafting, manufacturing, and tool-making departments, the writer maintains that the drafting-room can be of invaluable assistance in the very important matter of tooling for the interchangeable manufacture of any machine.

T. D.

MILLING FIXTURE FOR A GUN PART

The accompanying illustration Fig. 2 shows a milling fixture for milling the gun part shown in Fig. 1. The cross-section at *A* shows the piece after having been milled. The tools used in gun work must produce very accurate work, and, hence, the features of this fixture will undoubtedly be found of interest. The base *A* of the fixture is fastened to the machine table by the usual tongues and by a large bolt *B*. Separate from the base and secured to it by screws *C* is a body casting *D*. This body casting has four V-slots milled in it at an angle of 5 degrees from the horizontal. Castings *E*, of which there are four in the complete fixture, but of which only one is shown in the engraving, contain the locating and clamping devices for the work. These castings slide in the V-slots in the body casting. The work-holder castings *E* can be adjusted independently of each other by screws *F* and check-nuts *G*. The screws *F* bear against the large studs *H* driven into the body casting. It is thus possible to secure exact duplication of the work in each of the four work-holder castings, even if there should be a slight variation in the diameters of the cutters.

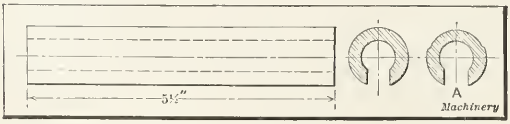


Fig. 1. The Part to be milled

When locating the work, it is laid on the block *J* and the tongue *K* engages the slot in the part to be milled. One end of the work bears against stud *L* and is clamped in position by a quick-acting clamp consisting of a bushing *M* having a slot *N* in it. This bushing is prevented from turning by a set-screw *O*. In the bushing is a plunger *P* which is moved forward by handle *R* to engage the work, and backward when disengaging. In the end of the plunger is a shoulder-pin *S*, the small diameter of which enters the hole in the work and the shoulder *T* of which bears against the end of the piece to be milled.

J. Card

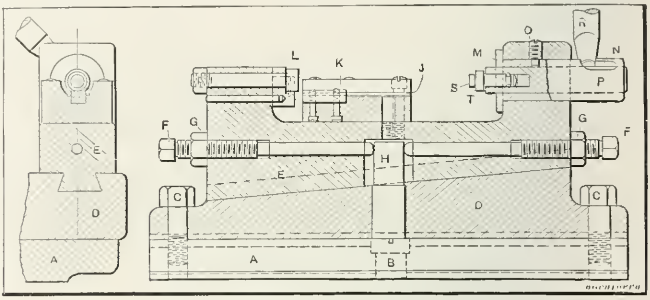


Fig. 2. Fixture in which Part shown in Fig. 1 is milled

UNUSUAL METHOD OF SUPPORTING LATHE SADDLE

An interesting type of 19-inch high-speed lathe was exhibited at the Olympia Exhibition by the Judson-Jackson Co., London, on behalf of Messrs. Schaerer & Co., Karlsruhe, Germany. The interesting feature of this lathe is that the top of the bed is only used to carry the headstock and tailstock; the saddle is not carried on the top surface of the bed in the usual way but slides on vees on the sides of the bed. It is said that having the shears at different heights counteracts the tendency of the saddle to lift. It will be noticed that this arrangement brings the lead-screw above the point of support, instead of being considerably below it, and this design greatly reduces the tendency of the saddle to twist.

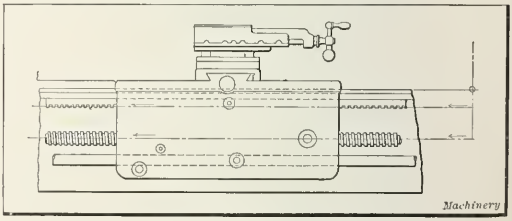


Fig. 1. Usual Method of supporting Lathe Saddle on Bearings at the Top of the Bed

Figs. 1 and 2 illustrate the direction of forces acting on a lathe saddle supported in the customary manner and in the Schaerer construction. Comparing these illustrations, it will be seen that in the usual lathe construction shown in Fig. 1 the pull on the saddle exerted by the lead-screw and the thrust on the tool-rest from the tool unite to give a maximum twisting moment in the saddle, this being due to the fact that the saddle bearing which forms the fulcrum of these forces is between their points of action. In Fig. 2, however, it will be seen that the opposite conditions exist, that is, the saddle bearing or fulcrum of the forces set up is below the lead-screw. Hence, in the later design, the moment due to the thrust of the tool on the rest is opposed and partially neutralized by the moment of the pull of the lead-screw on the saddle. The saddle travels clear of the top surface of the bed and in the larger sizes, such as the 35-inch and 43-inch swing lathes, in addition to these two slides on the sides of the bed, the saddle has an additional slide at the center of the bed. As the slides are underneath the shears, they are protected from chips and dirt, and while the saddle overhangs the gap there is no reduction whatever in the bearing surface. In Fig. 3, the diagram at the right-hand side represents the usual practice in lathe design, while the diagram at the left-hand side shows the Schaerer construction, and this gives the necessary comparison without further comment. J. A. S.

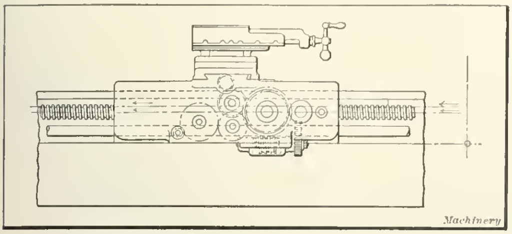


Fig. 2. Schaerer Bed Construction with Saddle Bearings on Side of Bed

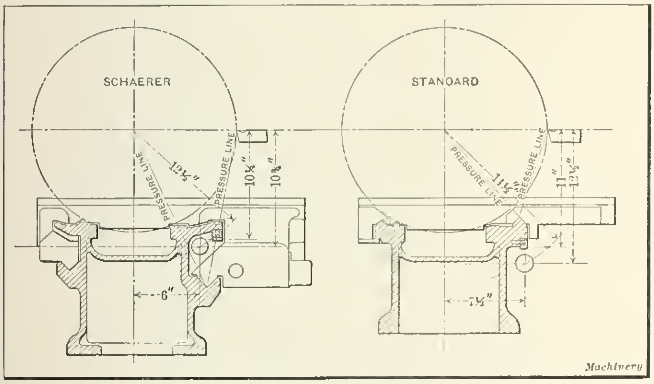


Fig. 3. Cross-section Views of Standard and Schaerer Lathe Beds

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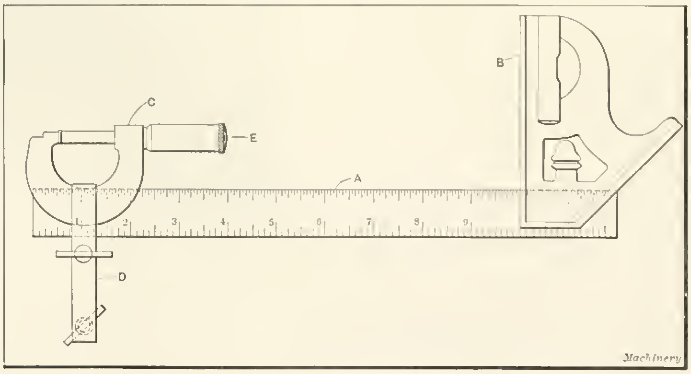
USING A SMALL MICROMETER FOR LARGE WORK

Occasionally a large micrometer is required to measure flat work, and very few machinists are fortunate enough to possess a micrometer larger than the 3-inch size. The illustration shows three tools which are found in almost every machinist's tool case, and the method of combining these tools to afford a means of making measurements to 0.001 inch on work up to six inches in size. It will be seen that the parts *A* and *B* are an ordinary 12-inch scale and combination square. The micrometer *C* is placed at one end of the scale and held firmly in position by the parallel clamp *D*. The stock of the combination square is fixed to the scale in the usual way. The illustration shows the stock placed in position for measuring work between 5 and 6 inches in size. When the micrometer is unscrewed, the thimble *E* approaches the stock *B*. The work to be measured is placed between the thimble and stock and when the thimble comes into engagement with the work, the reading of the micrometer is taken; this reading is subtracted from 6 inches in order to get the dimension of the work to 0.001 inch.



Combination of 1-inch Micrometer and 12-inch Combination Square adapted for making Measurements from One to Six Inches in Thousandths of an Inch

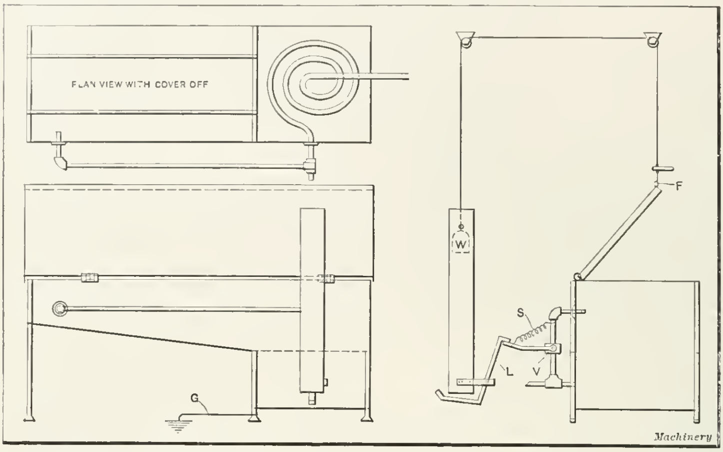
In assembling this tool, a six-inch end gage may be used to locate the stock *B* and the micrometer *C* in the proper relation to each other. It is evident that the same method can be used for measuring work from 1 to 6 inches in diameter. The only additional equipment required is the end gage for locating the micrometer and stock of the combination square in the proper relation to each other. By using a 24-inch scale, the tool would be available for measurements from 1 to 18 inches. A tool of this kind can also be used for obtaining large inside measurements on flat work. For this purpose the micrometer and the stock *B* are reversed so that the dimension is obtained by placing the face of the stock against one side of the work and then unscrewing the thimble of the micrometer until it engages with the opposite side.

Cincinnati, Ohio HENRY FRANZ

A FIREPROOF JAPANNING TANK

The writer has had considerable experience with fires which occur in japanning-rooms due to spontaneous combustion, short circuits, and explosions of gas which rises from the japanning-tanks. In the following is described a fire which recently broke out in the japanning department of a metal working factory. In this department, where articles were being dipped in japan, the general arrangement and condition of the apparatus was nothing to brag about. It consisted of a tank 5 feet square with a rack located near it, on which the baskets of dipped material were placed to drain until it was time for them to be baked. The condition of the brick floor around this apparatus can easily be imagined, when it is known that japanning was carried on day and night. On the day of the fire, the operator had just placed a basket of loose articles on the dripping-rack. Suddenly there was a flash; the japan in the tank caught fire but instead of the flames spreading, they confined themselves to the open tank. The operator, with the use of sand, had the fire under control when the fire department arrived. Regardless of warnings not to turn on a stream, the firemen resorted to the use of a portable chemical extinguisher. As soon as the stream struck the burning japan in the tank there was an outburst of flame and the burning japan was spread over the floor, making a much more stubborn fire.

After the fire, the tanks and racks were inspected and found to be useless; then the writer designed the apparatus shown in the illustration, which not only "does the trick" but affords protection against disastrous fires. This apparatus consists of a galvanized iron tank 15 feet long by 4 feet wide, containing a dipping-tank and dripping-racks. The floor of the portion of the tank containing the dripping-racks is inclined toward the dipping-tank so that the drippings flow back into the tank. In the bottom of the dipping-tank is placed a steam-coil which heats the japan, thus preventing it from settling. The pipe which feeds the steam-coil enters the side of the tank near one end. Another steam-pipe enters near the opposite end, and in case of a fire, this pipe turns a flow of steam into the tank which helps to smother the flames. The tank is thoroughly connected to the ground by a No. 6 copper wire *G* which will carry off any static or frictional charges of electricity that may collect. A hinged lid covers the tank. The handle for raising and lowering the lid is attached to a wire-rope which runs over a sheave, and a fuse-link is placed in the wire rope where it is fastened to the lid of the tank.



Japanning Tank with Provision for automatically extinguishing Fires

Referring to the illustration, the weight *W* rides in a wooden case or runway, the lower end of which contains a latch controlling the lever valve *V* in the steam-pipe. When a fire occurs, the fuse-link *F* melts and allows the lid to drop. At the same time the weight *W* slides down the wooden case or runway and trips the latch *L*; the spring *S* then throws open the lever valve *V* and the steam rushes into the closed tank and smothers the fire which may still be smouldering, owing to the lid admitting some air. The tank is supported by legs at each end. The floor around the tank is covered with a thin coating of loose ashes, which catches any japan that happens to be spilled and allows it to be cleaned up without injury to the floor. Clean ashes may easily be substituted, thus keeping the working space around the tank dry. This apparatus not only makes the operator feel more secure but enables him to turn out more work and work of a better quality.

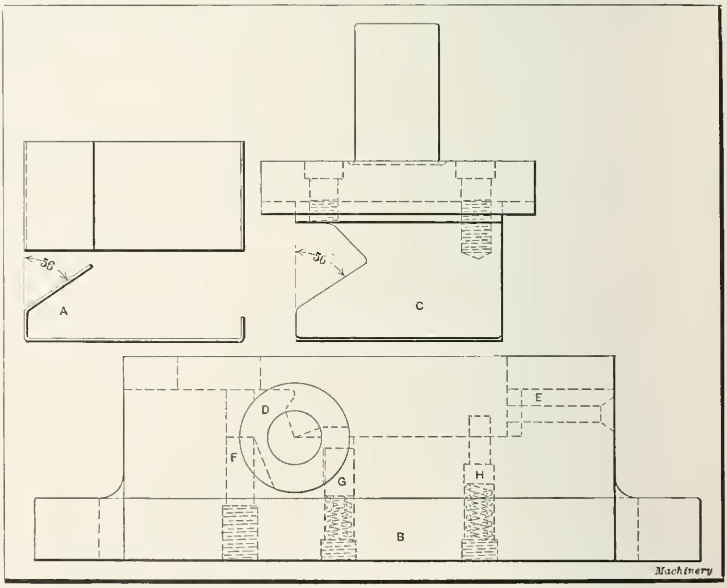
Worcester, Mass. A. P. Broadhead

PUNCH AND DIE FOR BENDING PAST THE VERTICAL LINE

The punch and die illustrated herewith were designed for bending sheet-metal parts to the form shown at *A*. In producing work of this kind, the first operation is to shear off blanks of the required length. The second operation consists of bending these blanks to shape in the die here described. The equipment consists of a cast-iron die-bed *B*, a punch *C* and a rocker-arm *D*. The blank is laid on top of the die and the punch descends to make the 90-degree bend at each end. The bend at one end is made between the the punch and the hardened steel block *E* on the die. The bend at the opposite end is made between the punch and the rocker-arm *D* on the die. The distance between the face of the block *E* and the nose of the rocker-arm is the exact length of the work on the outside.

The principle on which this punch and die operate in making the 56-degree bend is as follows: When the punch descends into the die, it strikes the lower part of the rocker-arm, causing the nose to move to the right and bend the blank over the inclined face of the punch. The movement of the rocker-arm to the right is equal, in amount, to the downward movement of the punch after engaging with the rocker. This causes the metal to be closed in on the side of the punch with the same degree of precision as if the bend were actually made between the punch and a fixed die.

The rocker is provided with ample backing to make it sufficiently rigid. There are two adjustable anvils *F* for the rocker-arm to fall back on, and two spring plungers *G* are situated at the opposite side to provide for the positive return of the rocker to the rear position when it is not engaged with the punch. The punch is the exact shape of the formed piece, the latter being slipped off the punch by hand; a knockout could, of course, be provided to do this operation more rapidly if the quantity of work to be produced warranted it. A spring and plunger *H* are used to eject the stock from the die at the end opposite to the 56-degree bend. This was found necessary because there would be a tendency for the work to be pulled out of shape if some positive means were not provided to insure having it follow the punch out of the die. The punch is made ½ inch wider than the stock, the extra surface taking up the thrust incident to moving the rocker.

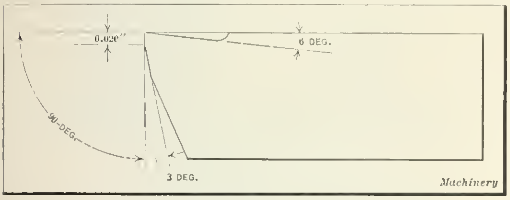


Punch and Die used to form the Sheet-metal Piece A

Toronto, Canada. E. Hawkins

A USEFUL LATHE TOOL

Mechanics who are called upon to use broad "sweep-facing" tools on cast iron, will appreciate the method of grinding outlined in the present article, because it will permit such tools to be used on many jobs where they would otherwise fail. While "boosting" production in a large gas engine factory, the writer had difficulty in sweep-facing flywheels 22 inches in diameter by 3-inch face. An old and badly worn turret lathe was used for this work, and after trying the tool with varying degrees of top rake and clearance—only to find that it would either chatter or refuse to cut in all cases—the writer was about to give up trying to use this style of tool. After letting the matter rest over Sunday, the idea was conceived of grinding the tool to the form shown in the illustration. The cutting edge was first produced with no clearance, and then a three-degree clearance was ground to a point within about 0.020 inch below the cutting edge. The result was highly successful. The tool cut freely and smoothly at a surface speed of 64 feet per minute. The writer has since applied this principle in a number of cases, making the necessary modifications to meet the requirements of individual classes of work, and has found it a sure remedy for chatter. Try it, even where you feel that your tool is working satisfactorily, and you will be both surprised and pleased with the result.



Method of grinding Sweep-facing Tools to eliminate Chatter

Lansing, Mich. ARTHUR NICHOLS

MAKING SMALL ECCENTRICS IN THE LATHE

We had a "hurry call" for one hundred of the special eccentric pieces of the design indicated in Fig. 1. With the exception of the two diameters, the limit of tolerance was 0.007 inch which was decidedly in our favor; as a matter of fact, however, the pieces came far closer to the indicated dimension. A speed lathe with a three-jaw universal chuck was selected to do the work. A cut-off tool and a standard 60-degree circular forming tool were mounted on the hand-operated cross-slide, and a turning tool was put in the toolholder carried in the tailstock spindle; this tool also acted as a stop against which the bar was fed. The plate at the end of each piece was concentric with the bar from which the work was turned and the one-quarter inch stem was turned eccentric, the distance from the center of stem to the center of bar being five-thirty-seconds inch. The eccentric stem was turned by employing a slip piece or clip, which was placed over one of the chuck jaws; this clip was of the proper thickness to give the desired eccentricity.

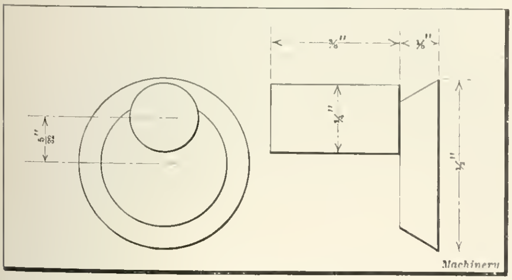


Fig. 1. One of the Eccentrics—Twice the Actual Size

The operations were as follows: 1. Feed the bar to the stop; 2. turn the stem; 3. remove the clip from the chuck jaw and form the angular face of the plate; 4. cut off. The clip was then replaced on the chuck jaw, when the lathe was ready to have the bar fed out to the stop for a second series of operations. It will be observed that it was necessary to stop the machine after the production of each piece. This was not so serious a matter as it might seem, however, because a foot-operated brake was employed to bring the spindle to a standstill as rapidly as possible. This work was finished from cold-rolled steel bars, and very good time was made in producing the one hundred pieces that were called for in our order. There was practically no expense involved for tool making.

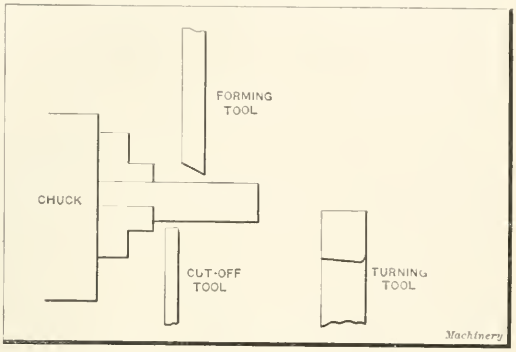


Fig. 2. Lathe and Tools used in turning the Eccentric

Middletown, N. Y. DONALD A. HAMPSON

COMPARATIVE CHIP PRODUCTION OF STELLITE AND STEEL TOOLS

Machine tool builders are at the present time more deeply interested in rapid metal cutting than ever before, and it is generally assumed that we now have our most modern machine tools of sufficient capacity to get the maximum in speeds and feeds from high-speed steel. Some of our most modern machines are supplied with sufficient tool pressure combined with high enough speeds to break down the best grades of high-speed steels produced.

The description of "Stellite," as presented by Mr. Haynes in the February number, is of much interest, but while Mr. Haynes gives us some very interesting accounts of the speeds at which it is possible to run when using this alloy known as "Stellite," it is rather surprising to note that the amount of metal removed per minute is so small.

With ordinary carbon tool steel it is possible to remove more than 2.4 pounds per minute, and with the best grades of high-speed steel we all do many times this. The speed attained by the use of "Stellite" seems very high, but if it were possible to combine this with metal-removing capacity it would be of greater value. Ordinary abrasives can cut at the rate of over 5000 feet per minute, but it has not yet been demonstrated that their metal-removing capacity will equal a cutting tool.

On a recent test of a Lodge & Shipley heavy forge lathe we removed from an 8-inch 0.60 carbon shaft chips at the rate of 20,000 pounds per day of ten hours run. This 20,000 pounds divided by the 600 minutes constituting the ten-hour day would equal 33 1/3 pounds per minute. As a matter of fact we can do better than this and have done better on short runs, and the principal reason for not making longer trials was the unnecessary waste of good material. We can guarantee our heavy forge lathe to remove its own weight in a day's run of ten hours.

It would be interesting to learn just what can be done with this alloy "Stellite" as a metal remover, leaving out the question of high-speed cuts of small chip. Possibly by this time Mr. Haynes has made more extensive experiments and can give us some further data. WILLIAM SCHELLENBACH

Cincinnati, Ohio.

DISTRIBUTION OF CATALOGUES

It was with much interest that I read the letter by Yamatake & Co. in the January number on catalogue distribution in Japan, and with much more interest the editorial comment with regard to the distribution of such matter.

It is generally believed among the trade I think, that the columns of trade papers are dominated by the manufacturers or agents. Yet here the editor takes a stand for the young man and machinist that is to be highly commended, as the practice of giving away catalogues to such is considered as expense without return by many firms in this country who only follow the custom because it is forced on them by more far-sighted concerns.

It has always been a plan of the writer to anticipate the probability of having to work on a machine or special tool, the details of which would likely give trouble, by writing and asking the manufacturer for a catalogue stating the purpose for which it was to be used, and such requests have never been refused. I consider the manufacturers benefited by my interest, yet I am sure there are many others who would join with me in thanking them for their liberality in such matters.

It is a fact that the executive positions of to-day will only too soon be held by a younger generation and such favors will not be lost sight of. A manufacturer like Yamatake & Co. does not hesitate to furnish any firm with such catalogues as they request, yet from my observation of the general use made of such literature, I question whether the distributors receive any more direct advantage than they do in giving them to an interested public.

The writer wishes to praise the public stand the editor has assumed in a matter that might have been settled in a private way. It promotes a better understanding between the reader and advertiser and shows our distant neighbor the liberal spirit that prevails here in regard to such matters.

Brooklyn, N. Y. John F. Winchester

ERASING ON TRACINGS

While the writer feels that more space has now been allotted to the subject of erasing on tracings than his brief remarks in the September issue warranted, he takes the liberty of offering his ideas relative to the arguments set forth by Mr. A. H. Myers in the November issue, and by Mr. Clyde L. Adams in the January issue, trusting that they may prove of further general interest.

Regarding the first mentioned suggestion, namely, the employment of a pencil eraser, the writer concurs, as far as such an eraser is applicable and permissible, which is not by any means *always*. Mr. Myers himself explains this by suggesting the use of both ink and pencil erasers at times. Furthermore, the writer is of the opinion that the use of a pencil eraser will be found to have a greater tendency to discolor the cloth than would the proper handling of an ink eraser, on account of the excessive amount of rubbing that is needed.

Apropos of Mr. Adams' remarks, the writer fails to see their exact significance as applied to a mechanical drawing of regular nature. With a single line or word on a tracing, or in particular instances on a regular drawing, the smearing of ink over the cloth may make it easier to remove, but it seems quite evident that one cannot always, or even frequently, smear the ink without spreading it into some other finished part of a drawing. Thus it would hardly appear concordant to necessitate the erasure of a section or portion of a completed view or part of a notation, letters or figures as the case may be, simply because of a slight error in drawing or marking.

Even though the smearing might accomplish an easier eradication, and this the writer does not find, himself, it would naturally follow that a line is more easily erased without being noticeable, than a square inch or more of surface would be. Regardless of how heavy the line or lines on a drawing may be, the writer has found, through a considerable period of experience, that the correct and careful handling of an ink eraser in connection with an erasing shield when one is necessary, as noted in his original letter in the September issue of Machinery, is the easiest, simplest, quickest and most practical method.

Newark, N. J. L. R. W. Allison

HARDENING SMALL PUNCHES WITHOUT DISTORTION

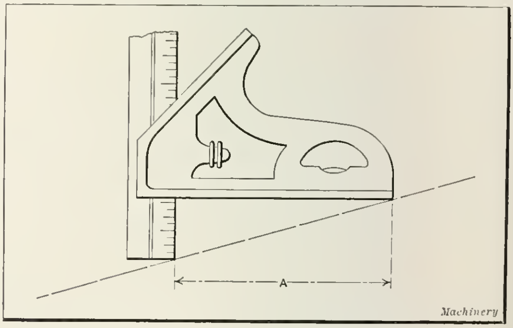
The article in the January issue of Machinery, by M. H. P. A., describing and illustrating a method of straightening small punches after hardening, recalls a method originated and used by the writer for hardening small punches or drills made of straight wire to a degree of perfection which obviates the necessity of straightening. The process consists of rolling the wire, when at the proper heat for hardening, between two flat surfaces, such as a bench plate and a parallel from 2 to 4 inches wide. The operator arranges a bunsen burner as close as possible to the bench block and takes the parallel in the right hand and the wire to be hardened in the left. The wire is left long enough to handle, so that the end to be hardened can be passed back and forth through the flame. When the proper heat has been obtained, the hot end of the wire is quickly placed on about the middle of the bench block, and rolled back and forth with the parallel. If one will take the pains to do this deftly, the result will be surprising, the wire being perfectly hard and straight. Wire up to ⅛ inch in diameter can be hardened in this way, but for wire from 1/8 down to 3/32 inch in diameter it is a help to smear the block with a thin coating of heavy oil or tallow, which assists materially in dissipating the heat.

Springfield, Mass. E. E. Neal

SETTING UP WORK AT AN ANGLE

In the January number of Machinery there was an article on the use of a carpenter's level for setting up work at an angle on a drill press or planer. While this method does not require very much work, every machinist has in his possession a combination square which, without any alteration, can be used for the same purpose with, perhaps, a greater degree of accuracy.

In a 12-inch square, the distance *A* varies with the different makes. For example, we wish to set the work at 14 degrees, 30 minutes, and the distance *A* is 3⅝ inches. The tangent of 14 degrees, 30 minutes is 0.25862; then 3.625 × 0.25862 = 0.93749 = 15/16 inch. Then by setting the scale 15/16 inch below the head, it will give you the required angle. If the work is large and rough, an additional scale or straightedge may be placed between the combination head and the work.



Use of Combination Square to set up Work at any Required Angle

O. T. R.

WINDING A CONICAL SPRING

Instead of winding a conical spring on a tapered arbor grooved to the proper pitch, which is the usual method, I find the following one more advantageous. A cone arbor, preferably one fitted to the lathe spindle like a center, has a slot cut across its nose to accommodate two wires which are wound over the arbor together, much as a boy might wind two strings on his top at once. If a more open spring is desired, three wires might be wound simultaneously, making three springs at a time.

Norwich, Conn. George W. Armstrong

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

RIVETT NO. 6 INTERNAL GRINDER

The illustrations show front and back views of the improved design of Rivett No. 6 internal grinder which has been on the market by the Rivett Lathe & Grinder Co. (Brighton District), Boston, Mass. This machine is particularly designed for internal grinding, and its accuracy makes it especially adapted for tool-room work. Special fixtures have been provided for the machine, however, which equip it for external grinding on work that can be taken between centers, having a maximum distance of 17¾ inches. The base of the machine is a one-piece casting and is designed to hold the driving gears and the reciprocating mechanism used in operating the table. Referring to the front view of the machine, shown in Fig. 1, the change-gear speed box will be seen located on the left-hand side of the column, and the hinged door at the center of the machine gives access to the driving gears and reciprocating mechanism.

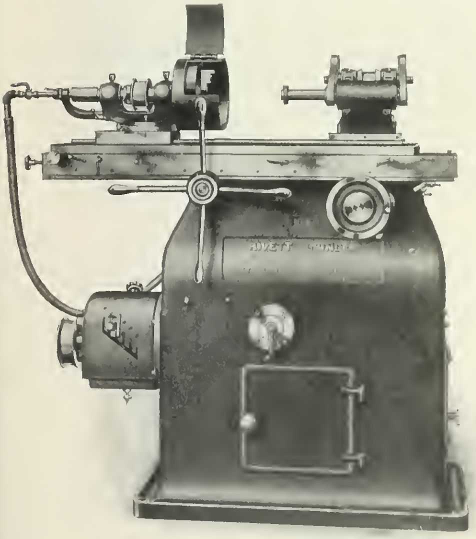


Fig. 1. Front View of Machine showing Gear-box and Operating Levers

The table of the machine is in two sections. The lower section is mounted on the base and slides on broad bearing surfaces, its movement by power being controlled by a reciprocating mechanism which is so designed that as the center of the stroke is approached, the speed of the table is slightly retarded; the speed is similarly accelerated after the central point of the stroke is passed. This speed variation eliminates the tendency of the wheel to take a lighter cut at the center of the work, and at the same time allows a coarser feed to be used. A small handle will be seen near the center of the table which allows the reciprocating mechanism to be disconnected and the table stopped at any time without stopping the machine. The stroke can be varied by thousandths of an inch by turning the crank shown immediately above the door in the column, the maximum stroke being six inches. Six different speeds of table travel are obtained through the gear-box at the left-hand side of the machine; these changes of speed are quickly made by regulating the position of the handle on the gear-box. Another interesting feature of the table design is the provision of a stop which enables the table to be brought forward to the same position which it occupied before releasing the reciprocating mechanism and backing the table away to gage a hole. This insures having the wheel cut to precisely the same depth as before the table and reciprocating mechanism were disconnected. Referring to Fig. 1, the knurled knob on the stop will be seen at the left-hand end of the table; this stop is clamped in any required position by the small handle which is shown near it at the front of the table. The upper section of the table is arranged to swivel five degrees in either direction from the center and is adjusted by screws at the front and back of the table; these screws will be seen in Figs. 1 and 2, closed to the table stop previously referred to. The slide is clamped to the table by turning the small clamp handles, one of which is shown next to the adjusting screw in the front view of the machine, and the other at the opposite end of the table in the same illustration. The table is quickly controlled by hand by means of the pilot wheel at the front of the machine.

Referring to the rear view of the machine shown in Fig. 2, a good idea of the design of the cross-slide will be obtained. The base on which this slide rests is graduated and the slide can be set at any angle up to 90 degrees in either direction from the central position, and clamped by means of a binding nut. The maximum cross-travel is 3½ inches and may be controlled by hand through the use of the wheel seen at the right-hand side of the front of the machine. When power feed is required, the button at the center of this wheel is pulled out and the feed is regulated through two small clamps shown beneath the table at the right-hand side. Variations of feed are obtained by means of a ratchet wheel located directly behind the wheel used in controlling the cross-feed by hand.

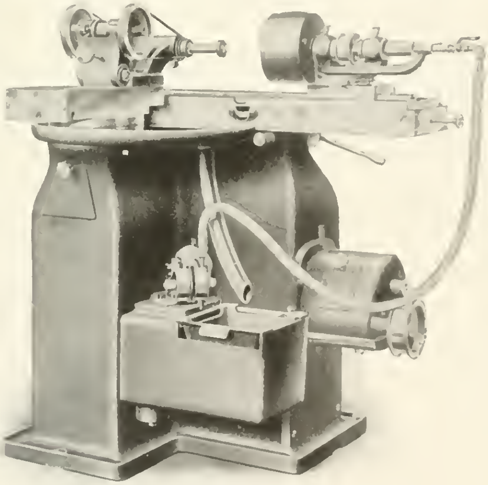


Fig 2 Rear View of Machine showing Cross-slide, Pump and Water Tank

The work head is mounted on a cast-iron plate fitted to the slide, and can be moved any required distance along the slide and clamped in position through the medium of an eccentric lever. It is locked in the neutral position by means of a taper pin. The spindle is made of high-carbon tool steel, hardened and ground, and runs in tool-steel tapered bearings which are also hardened and ground. This form of construction has been found especially suitable for the class of service required of this machine. The high speed at which machines of this type are operated, makes it imperative to have bearings which fit perfectly, and quick means for adjusting the bearings have been provided. The front end of the spindle is ground on the inside to hold split chucks and the rear end is made to fit the draw-in spindle furnished with the machine. The spindle is driven by a cast-iron pulley from a drum on the overhead countershaft and three spindle speeds of 1340, 656 and 189 R. P. M. are provided.

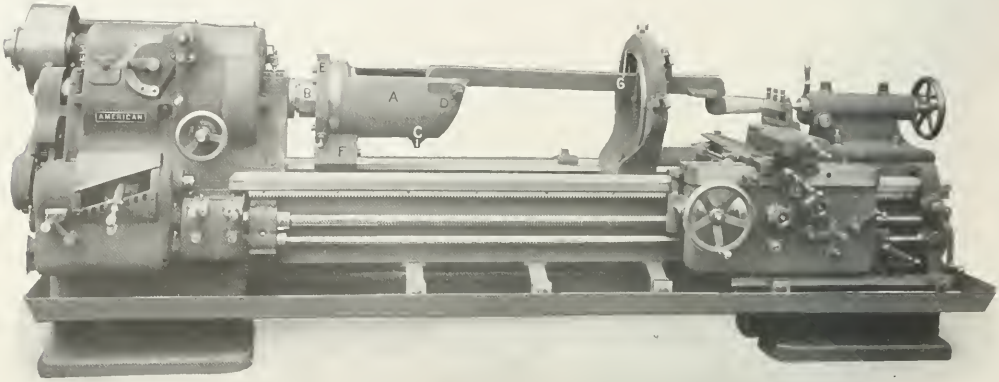


Fig. 1. American High-duty Lathe equipped with Special Fixture for turning Axles after being formed to Shape

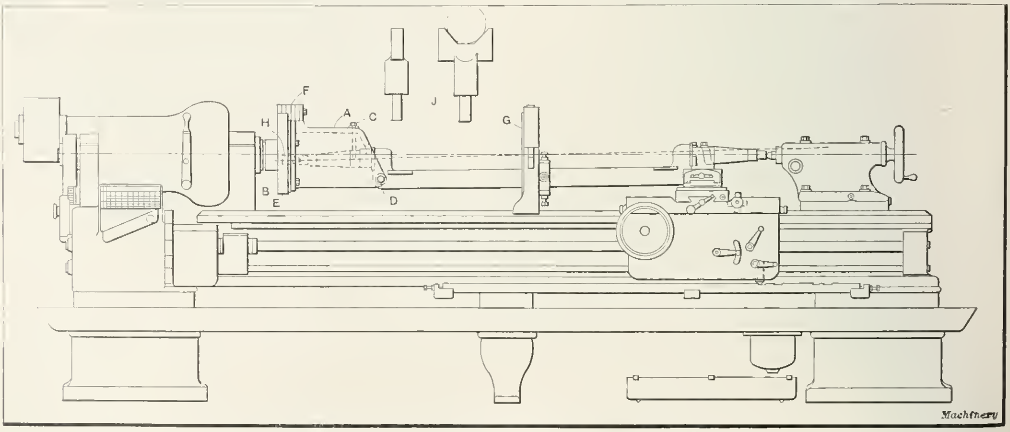


Fig. 2. Axle Turning Lathe, showing Fixture for Axle Turning and Detail of V-block J

The grinding wheel spindle is also designed for operating at high speed and is fitted with the Rivett ball and cone type of bearing enclosed in a cast-iron shell. Adjustment is made by loosening two set-screws at one end and turning the adjusting screw to the right to tighten, or to the left to loosen the bearing by means of a spanner fitting into two holes. When the proper adjustment has been obtained, there should be no shake and the spindle should run freely when twirled between the fingers. The wheel spindles can be quickly changed in the wheel bracket by loosening two thumb screws and the belt tightening screw, after which the spindle can be drawn out at either end. Each of the different spindles is fitted with suitable sized pulleys to provide the required speed. The wheel spindle bracket is made in two sections. The forward section holds the wheel spindle and the rear section is designed to hole the countershaft for driving the spindle. This section may be adjusted by a screw to give the required belt tension. This method of adjusting the belt tension also makes it possible to use an endless belt, which is more satisfactory than a joined belt, where high speeds are required. The bearing caps can be quickly loosened and turned back to remove the countershaft by simply removing two screws. The countershaft is driven by the central pulley and runs in taper bronze bushings, the shaft being of hardened and ground tool steel and provided with means of making rapid adjustments for wear. The driving pulleys are six inches in diameter and flanged on both sides to take a belt ¾ inch wide; three speeds are obtainable through a three-step cone pulley on the overhead countershaft. The overhead countershaft is self-contained, all brackets, shafts and pulleys being assembled on a cast-iron base. This greatly facilitates setting up, insures the proper alignment of the shafts in their bearings and also materially reduces the power necessary to drive the machine The countershaft is designed to operate at 500 R. P. M.

The water tank and pump are shown at the rear of the machine in Fig. 2. The pump is driven by pulleys from an overhead countershaft and the necessary piping attachments are furnished for both internal and external grinding. The flow of water is controlled by a valve placed within easy reach of the operating position. The illustrations show a water guard surrounding the chuck for internal grinding; a guard for external grinding operations can also be provided.

AMERICAN HIGH-DUTY AXLE LATHE

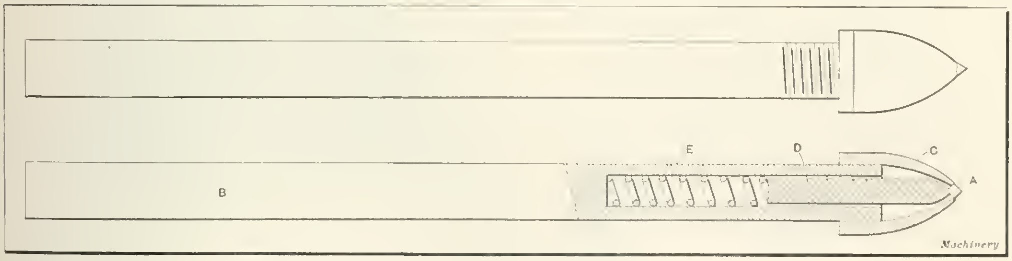
The accompanying illustrations show the new American high-duty axle turning lathe designed and built by the American Tool Works Co., of Cincinnati, Ohio, for the express purpose of machining motor truck axles. The old method of doing this work was obviously unsatisfactory, for the machining had to be done while the axle was straight, after which the forming or shaping was accomplished by means of a die, and this produced inaccuracies in the work. The new method, however, permits the machining of the axle after it has been formed to the required shape, and therefore completely eliminates the distortion of the work produced by the old method. The following description will be confined prinicipally to the fixtures which have been designed especially for handling this work.

The distinguishing and most important feature of this machine is the eccentric chuck *A*, which is held by heavy bolts to a removable plate *B* screwed onto the spindle nose. This chuck, which is made from a steel casting, locates the work to bring the axle bearing in line to be turned. The action of the chuck is very similar to that of the universal chuck used on crankshaft lathes for bringing the crank throws into position for turning. The rough axle is suspended between centers, the chuck-center *H* being placed at the proper angle to throw the end which is to be turned, into position. After the axle has been placed between centers, the adjustable V-block *J*, shown in detail in Fig. 2, is adjusted by means of nut *C* until it holds the axle firmly in position. One of the advantages of this V-block is that it automatically centers the axle and eliminates all tendency for the work to twist. The screws *D*, one bearing on either side of the axle, act as drivers, and are adjusted after the axle has been properly located. Fastened to the band *E* is a counterweight *F*, which is supplied to offset the weight of the eccentric axle.

A rotary steadyrest of steel construction is furnished for steadying the work. The axle is held in the rotor *G* which rotates inside of a steel casing lined with a removable cast-iron ring. This ring is so constructed that in case of wear it can be readily replaced by a new one without any detrimental effect to the rest proper. Efficient means for lubricating this rest are provided, including compression grease cups and babbit and graphite inserts. Longitudinal and diametral stops are supplied for the different turning and shoulder facing operations, and the regular taper attachment used on the lathes built by the American Took Works Co. has been found entirely satisfactory for turning the taper on the ends of the axle. Aside from these features, there is nothing special in the design of this lathe, it being of the well known American high-duty type.

STRONG DIAMOND HOLDER

The illustration shows the Strong diamond holder which has recently been placed upon the market by Montgomery & Co., 105-107 Fulton St., New York City. This tool is designed for use in dressing emery wheels and a cut diamond is used which is shaped with six points, all of which are available for cutting.



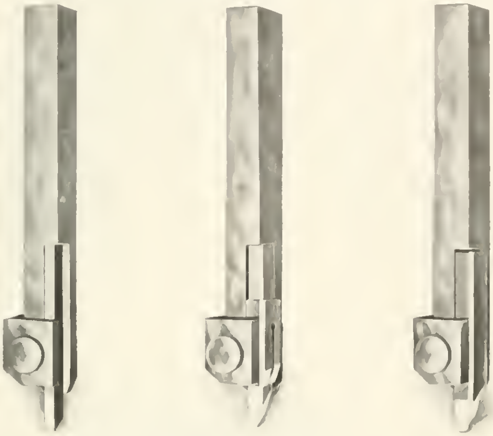
The Strong Diamond Holder for use in dressing Emery Wheels

Referring to the cross-sectional view of the tool, it will be seen that the diamond *A* is held in the shank *B* by means of the threaded cap *C* and copper plug *D*. When the cap is screwed up, the diamond is securely held between the cap and copper plug by the tension of the spring *E*. This design has two important advantages; first, the diamond cannot work out of the tool as long as the cap *C* is left in its original condition; and, second, the diamond can be placed in the tool in any position to bring either of its six points into position for cutting. This adds greatly to the wear of the diamond. The possibility of breaking the diamond is also materially reduced as it cannot be clamped too tight or forced too hard against the work on account of the tension of spring *E*, which will automatically relieve the pressure from the diamond.

CARR PLANER TOOLS

The Carr planer tools illustrated herewith, are a recent product of Henry G. Thompson & Son Co., New Haven, Conn. By referring to the illustration, it will be seen that the tools consist of a holder in which a cutter of high-speed steel is mounted. The holder consists of three parts: the shank, cap and bolt. The socket formed between the holder and cap is dovetail in shape and the side of the cutter is ground to fit into this socket.

The tool shown at the extreme left of the illustration has a cutter mounted in it which is made of narrow stock, and in this case the cutter is not ground dovetail, the shoulder on the cap fitting over the edge of the cutter. In the tool shown at the center of the illustration, the cutter is also made from narrow stock, but in this case an adapter is used to clamp the cutter in the holder; in this tool, it will also be seen that the cutter has been ground away considerably and that an auxiliary block is placed above the cutter to back up the tool. The tool shown at the right-hand side of the illustration is fitted with a cutter of the regular size, and the description given at the beginning of this article applies to this tool.



Carr Planer Tools fitted with Different Styles of Cutters

These tool-holders are made in six different sizes, ranging from ⅝ by 1¼ by 8½ inches to 2⅛ by 2¾ by 22 inches, as the size of the shank. The tools are made either right- or left-hand, as desired, and it will be evident that the cutters can be ground at both ends so that they are adapted for use in either right- or left-hand tools.

STANDARD BACK-GEARED POWER PRESS

The illustrations show front and back views of the No. 6-B back-geared power press which has recently been placed on the market by the Standard Machinery Co., 7 Beverly Place, Providence, R. I. The design of this machine enables power to be transmitted either direct or through the back-gears. In Fig. 1 the machine is shown from the balance wheel side, where it will be seen that there is an adjustable knockout which is actuated by an eccentric rod connected to the slotted disk at the end of the crankshaft. This knockout is used for forcing out swaged material from below and is made adjustable on the crankshaft end. In addition to this, a second knockout has been provided for ram of the press, which is actuated from the special knee put on the frame at the rear; this knockout operates through the slotted hole in the rear of the ram.

Fig. 2 shows a rear view of the press, where the pinion at the extreme end of the shaft is seen to be out of mesh with the driving gear. This is the location of the pinion when the machine is being driven direct through the tight and loose pulleys. An adjustable collar slides along the shaft and is used to retain the pinion in mesh with the gear after pushing it back for the purpose of driving the press through the balance wheel. This machine is designed for blanking, swaging and forming operations and is particularly suitable for use in cases where a quick stroke is required. The instantaneous roller friction clutch used on the machines built by this company has been applied in the design of this press, the diameter of the ring fitting into the driving gear which is 13½ inches. The crankshaft is of forged nickel steel and is of liberal dimensions; the diameter of the wrist pin is 5¼ inches, the bearing being 8 inches long. The driving gear is of gun iron and is 42 inches in diameter; it has an extended hub on which the tight pulley is keyed, and the loose pulley runs on the crankshaft which is turned to four inches in diameter at the end. The pinion is made from a steel forging.

The upper connection is of iron and the lower or ball connection of froged steel, threaded into the upper and provided with effective means of clamping and adjustment. Referring again to the illustration, it will be seen that there are four studs which fit into bronze bushings and are threaded through the rear side of the connection. In order to tighten the upper connection after adjustment, these studs are turned, forcing the bronze bushings against the thread in the steel lower connection. The bottoms of these bronze bushings are threaded at the same time the thread is tapped in the upper connection, thereby having thread fit thread and avoiding bruising the shank of the lower connection. The ball is scraped into the ram and retained by a large bronze shoe. The ram is fitted with a three-inch hole through which the knockout operates, as previously mentioned. For swaging and forming, the machine is generally used with heavy tie-rods, and when large sheets are being blanked, the tie-rods can be removed. The press is designed so that these tie-rods extend from the upper bearing to the outer part of the bed on an angle, so that the maximum working space for the operator is obtained. The press is of the inclinable type and is built with the path of the ram directly below the bearings; this is one of the most important features of the press when it is to be used for swaging or forming, as well as for heavy blanking. The machine is built with the Standard type of brake on the crankshaft. The bed has a thickness of 9 inches below the bolster plate and in addition to the regular 9-inch bolster, 3½- and 4-inch bolsters can be used. The weight of the press is 14,800 pounds and it occupies a floor space of 6 feet by 5 feet 6 inches.

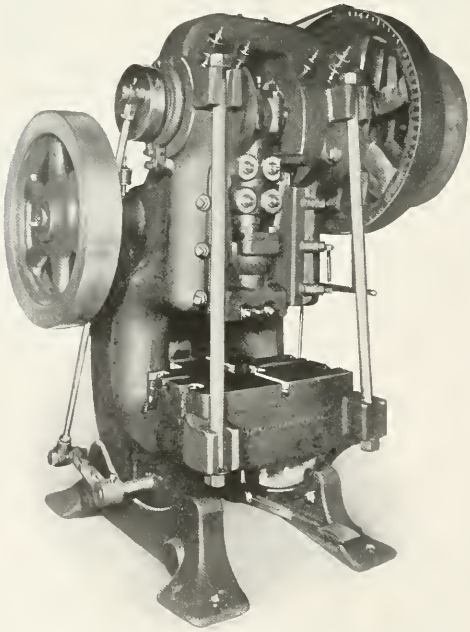


Fig. 1. Front View of Standard No. 6-B Back-geared Power Press

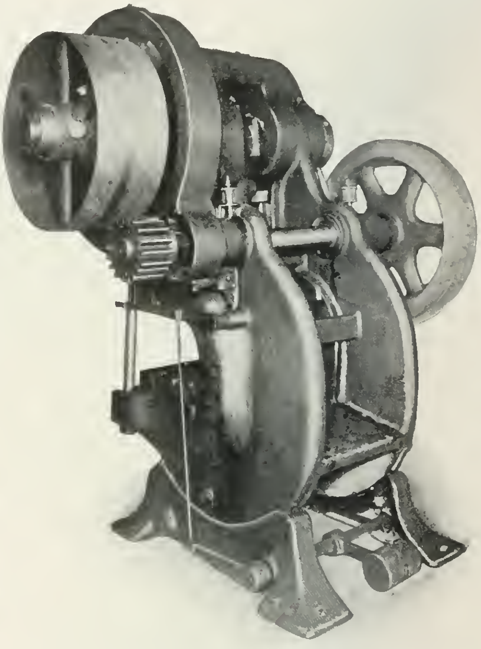
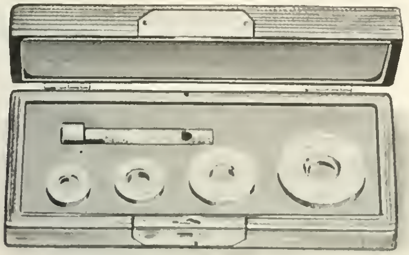


Fig. 2. Rear View of the Press with Back-gears out of Mesh

SLOCOMB DISKS FOR TESTING MICROMETERS

Some purchasers of micrometers have never really considered that it was necessary to test these tools. While there is very little doubt regarding the accuracy of tools made by reputable manufacturers, it is an excellent plan for users of micrometers to have some means of properly testing them at specified intervals. After constant use a micrometer shows some wear and unless this wear is overcome by adjustment, one naturally is not going to get the correct measurements when using the instrument. Where it is customary to test micrometers, it will be found that, in the case of the 1-inch size, the usual method is to run the screw down until the point engages with the anvil and note whether the reading is correct, then run it out to the 1-inch limit, testing it with a 1-inch gage. This, of course, is one way, but there are those who feel that they want to be more particular, and they test the micrometer at 0.250, 0.500, 0.750 and 1.000 inch. This gives a more accurate test throughout the travel of the screw. This method is good, so far as it goes, but it leaves one feature of the micrometer that is particularly important, untested. It is necessary for the travel of the screw to be accurate, and also for the face of the anvil and the face of the screw to be parallel and perpendicular to the axis of the thread. It will be noted that by testing the screw at the four points mentioned above, the thimble and screw would be in the same relative position to the anvil in each case, the opening between the anvil and the screw merely being increased.

In order to make the test properly, the micrometer screw should be turned half way around and tested at that point, which would give the result that was omitted in the first test. By turning the screws half way around it tests the travel of the screw and shows that the face of the anvil and screw are parallel as well as perpendicular to the axis of the thread. The J. T. Slocomb Co., Providence, R. I., is just putting on the market a set of reference disks containing sizes 1/4, 1/2, 9/16, 3/4 and 1 inch, by means of which a 1-inch micrometer may be accurately and properly tested. This set is known as the No. 80 reference disks and should b of value in enabling tool and inspection departments to have their micromters periodically examined and tested for accuracy.



Disks used for testing the Accuracy of Micrometers

REED BENCH AND COLUMN DRILLS

The illustrations show improved types of bench and column drills which have recently been placed upon the market by the Francis G. Reed Co., 43 Hammond St., Worcester, Mass. These machines are constructed along the same general lines as the preceding types of bench and column drills manufactured by this company, but they embody the following improvements. It will be seen that the frames of the new machines are of the box type, while the preceding designs had round columns. The cone pulley at the back of the machine is attached in such a way that it can be adjusted vertically to regulate the belt tension. It will also be seen that the new design of drill is provided with six spindle speeds.

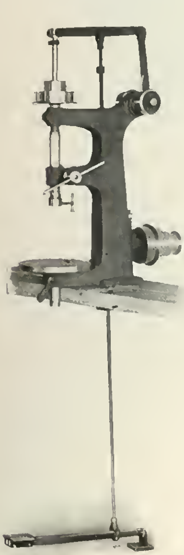


Fig. 1. No. 27 Bench Drill equipped with Lever and Treadle Feed

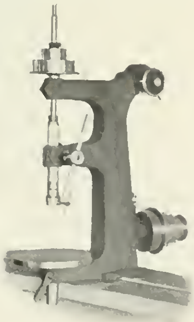
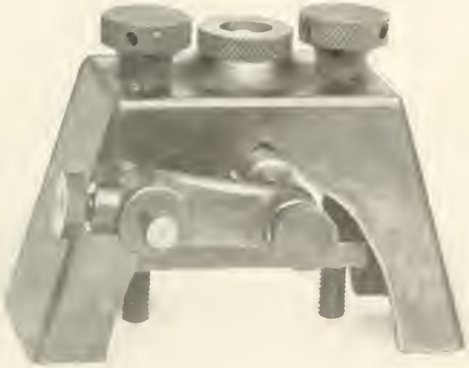


Fig. 2 No. 26 Bench Drill equipped with Lever Feed

In the old style of drills, babbitt bearings were used to line up the table and spindle stud, but in the machines shown in the accompanying illustrations, the bearings are bored to secure the required alignment and no babbitt is used. In machines of both the bench and column type,equipped with lever-feed, ball-bearing thrust collars are used under the quill; and in the machines provided with both lever- and treadle-feed, ball-bearings are used under the quill and at the top of the swivel. The spindle has a bearing for the entire length of the quill and is turned at the end to fit all standard chucks. A two-jaw chuck and a complete countershaft forms part of the regular equipment.



Hill Drill Jig for locating Drilled Holes at Center of Round Work

HILL DRILL JIG

The drill jig shown in the above illustration has been designed and placed upon the market by M. T. Hill Mfg. Co., Worcester, Mass. This jig is intended for drilling round work, and its use enables a hole to be drilled within a limit of 0.002 inch of central. Taper pieces can also be drilled and

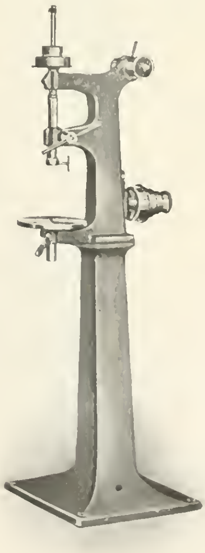


Fig. 3. No. 28 Column Drill equipped with Lever Feed

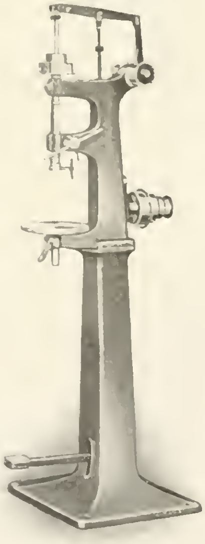


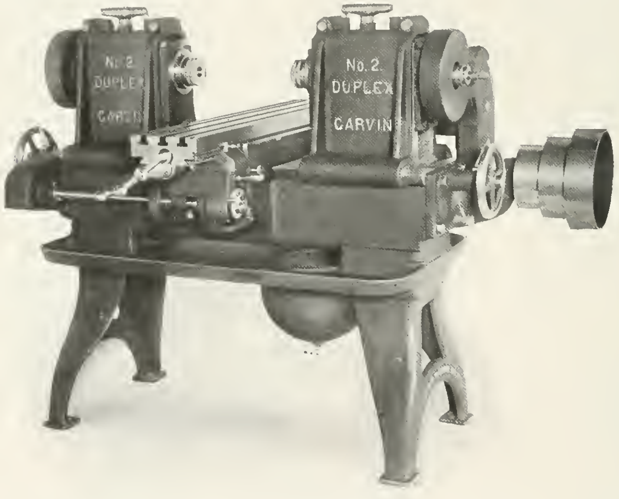
Fig. 4 No. 29. Column Drill equipped with Lever and Treadle Feed

a hole can be drilled close up to a shoulder in a piece of work having two different diameters.

This jig is made in two sizes. The No. 1 jig will take work from ½ inch to 2 inches in size and weighs six pounds. The No. 2 jig will take work from 3/16 inch to 1¼ inch in size, and weighs 1½ pounds. An adjustable stop gage is provided to set the jig for the distance that is required between holes or for the distance between the hole and the end of the work. Standard size slip bushings from 1/4 inch to 1/2 inch in size, varying by sixteenths, are provided for use with this jig; and the same set of bushings will fit both the No. 1 and No. 2 sizes.

GARVIN NO. 2 DUPLEX MILLING MACHINE

The duplex type of milling machine has been developed for use in manufacturing operations which require two sides of a piece to be milled parallel. Machines of this type are particularly adapted for such operations, as they can be worked with speed and accuracy and the perfection of the work is not dependent upon the care and skill used by the mechanic in resetting the work to mill the second surface. As the two surfaces can be milled at the same time, and a second setting of the work is entirely avoided, it will be evident that a great increase of production is obtained.



Garvin No 2 Duplex Miller with Vertical and Horizontal Micrometer Spindle Adjustment

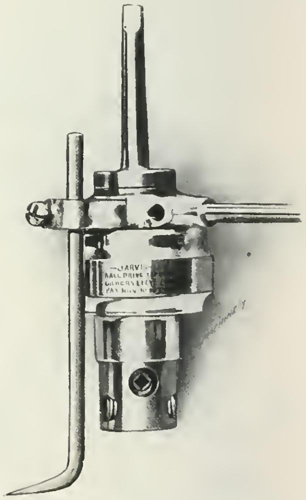
The duplex milling machine shown in the accompanying illustration is a new product of the Garvin Machine Co., Spring and Varick Sts., New York City. This machine is made in four different sizes and is intended for light and medium work. The heads have independent micrometer adjustment to and from each other, and the spindles have independent vertical adjustment by means of micrometer handwheels. It will thus be evident that the cutters can be adjusted to work in any desired position, and corners or ledges be finished by this machine similarly to the flat surfaces. The spindles are tapered and run in solid bronze boxes of the standard design adopted by this company. The drive is transmitted through a train of gears from the driving shaft, which runs along the rear side of the bed. Changes of speed are provided by the cone pulley on the driving shaft which is back-geared 3 to 1. The feed is obtained from the driving shaft by a series of change gears at the left-hand end of the bed; all of these gears are covered and handled from below, giving twelve changes of feed ranging from 1/200 to 1/8 inch, per spindle revolution. The feed-screw is driven direct by a hardened steel worm-wheel and tool-steel worm running in oil.

The table is fitted with an automatic trip and reverse at the right-hand side, and has a quick movement of one inch per turn of the screw, which is operated by a ball-crank. The oil pump and reservoir provide lubrication and extensions are provided to catch the oil dripping from the table. All of the gears are covered and the total weight of the machine is 2465 pounds.

THE JARVIS BALL-DRIVE TAPPING DEVICE

The most important features of the Jarvis ball-drive tapping device, made by the Charles L. Jarvis Co., Gildersleeve, Conn., are the ball-drive, which is used and the application of this drive at a point close to the work. This design adds to the rigidity of the tool without reducing its sensitiveness in any way. The illustration shows the device in position for the tapping operation, and when in this position, the tap is driven at the speed of the drill-press spindle, the drive being transmitted by means of three balls which engage with lugs in the body of the device. When it is desired to reverse the direction of rotation to back out the tap, the spindle of the drill-press is raised. This engages the quick return gears which back the tap out at a higher speed. The drive, in this case, is effected by means of two balls which engages with the stationary gear.

The tapping device can be operated in either a horizontal or vertical position so that it may be used on either a drill-press or speed lathe without the necessity of using a reversing belt. The taper shank screws into the body of the device, and when so desired, this shank may be replaced by a clamping mechanism which is secured to the outside of the spindle of the drill press or lathe. This clamping device screws into the body in the same way as the taper shank, and is tightened on the spindle of the machine by means of two screws which compress the split bushing that fits around the spindle.

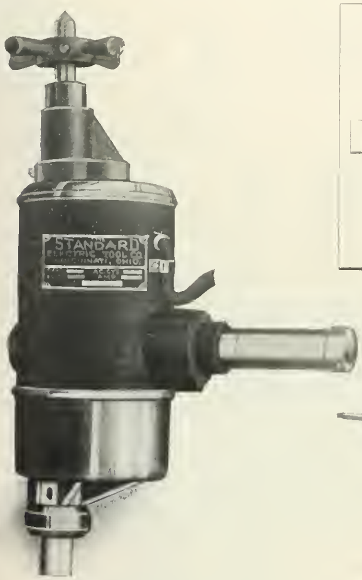


Jarvis Tapping Device with Ball Drive and Quick Geared Return

Special taps are not required for use with this chuck, as the jaws are designed to take the ordinary taps. The tapping device body is made of either steel or aluminum, as desired. The aluminum body has steel bearings and is quite light, making the device very sensitive. This tapping device is made in seven sizes with capacities for tapping holes up to 2 inches in diameter. The capacities of the five larger sizes are 3/8, 5/8, 7/8, 1 1/8, 1 1/2 and 2 inches, respectively.

It will be seen from the illustration that the chuck is provided with two screws for adjusting the jaws. One of these screws actuates the jaws for centering the tap and the other screw controls the floating jaws, which are at right angles to the centering jaws and afford the required grip to hold the tool. In setting a tap in the chuck, the centering jaws are screwed up on the round portion of the shank and the floating jaws are then firmly tightened on the square of the tap. After tightening the floating jaws, the centering jaws are screwed up tight.

It will be seen from the illustration that an adjustable stop is provided which can be set to tap a hole to any required depth. An auxiliary supporting rod is also provided; this rod fits into a socket on the device and a split pin is used to hold the rod in position. The end of this rod bears against the upright of the drill-press or on the ways of the lathe, and serves the purpose of steadying the device while in operation. When the stop is engaged, it releases the ball-drive in the device, and then by pulling up the spindle, the quick-return drive is engaged to back the tap out of the hole.



Standard Portable Electric Drill

STANDARD PORTABLE ELECTRIC DRILLS

The Standard Electric Tool Co., Cincinnati, Ohio, has added to its line high-power direct-current drills of 1/4, 5/16, 3/4 and 7/8 inch in size; these sizes form an addition to the 3/8, 1/2 and 5/8 inch drills of the same type manufactured by this company. These tools are ball bearing throughout and the construction has been designed to provide the necessary rigidity for high-power work. Series motors are employed on these drills, the motors being insulated and impregnated by a special process. All of the gears are generated from chrome-nickel steel and casehardened to give for the necessary wearing qualities; they are supported on both ends and run in grease.

This company has also added to its line of alternating-current drills, tools of the following sizes: 1/4, 5/16, 3/8, 1/2, 3/4 and 7/8 inch. The mechanical construction of these tools is extremely simple and rigid and the electrical connections have been simplified so that the drills have been made practically "fool-proof." The power developed by the motors runs considerably above the rate of capacity, so that the danger of burning them out from overloading is greatly reduced.

MADISON VARIABLE-SPEED COUNTERSHAFT

The illustrations show a variable-speed countershaft which is built in six different sizes by the Madison Machine Co., 310 Carroll St., Madison, Wis. Referring to the illustrations, it will be seen that the countershaft consists of an iron frame carrying two shafts. Two pairs of conical shaped pulleys are mounted on these shafts and a trapezoidal shaped belt runs between them. One of the pulleys of each pair is fixed and the other can be adjusted along the shaft by means of hydraulic pressure from the cylinders on the countershaft. It will be evident that by increasing the space between the pulleys on one shaft, and decreasing the space between the pulleys in the other shaft, the speed ratio will be varied and any desired ratio within the range of the countershaft can be obtained by setting the pulleys in the required positions. The pistons which control the movement of the pulleys are actuated by means of a controller that may be either of the piston type or pneumatic type; where air pressure is available, the pneumatic type is recommended.

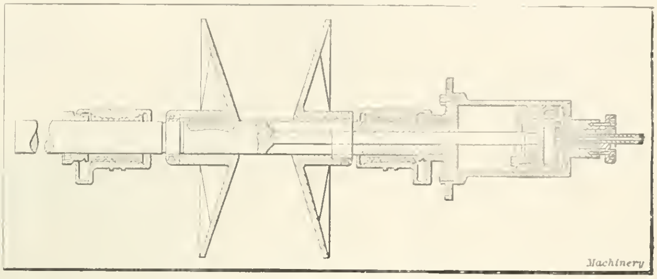


Fig. 1. Cross-sectional View showing Design of Hydraulic Speed-changing Device

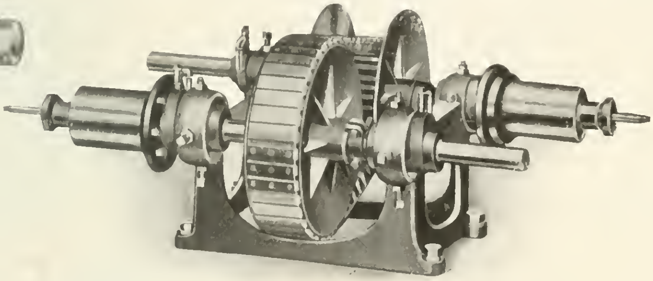
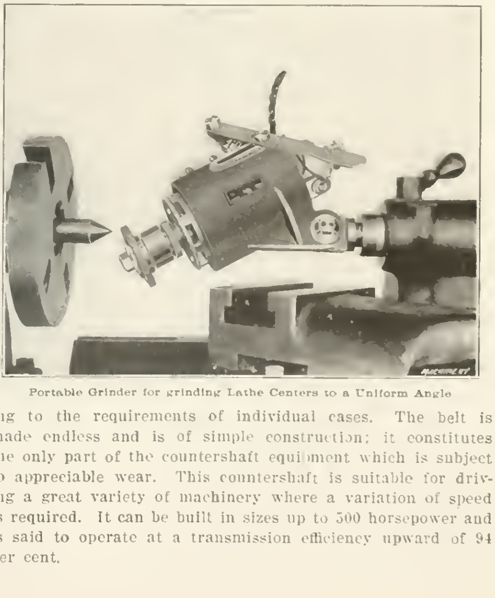


Fig. 2 The Madison Variable-speed Countershaft

This countershaft can be set up in any desired position so that it may be mounted on the floor, wall or ceiling, according to the requirements of individual cases. The belt is made endless and is of simple construction; it constitutes the only part of the countershaft equipment which is subject to appreciable wear. This countershaft is suitable for driving a great variety of machinery where a variation of speed is required. It can be built in sizes up to 500 horsepower and is said to operate at a transmission efficiency upward of 94 per cent.



Portable Grinder for grinding Lathe Centers to a Uniform Angle

SMITH PORTABLE ELECTRIC CENTER GRINDER

A portable electric grinder to be used exclusively for grinding centers is one of the late products of The Smith Electric Tool Co., Cincinnati, Ohio. The illustration gives a very good idea of the general construction of the center grinder. The shank that fits into the tailstock of the lathe has a pin, setting the grinder at 60 degrees; this pin may be changed to set the grinder at any other angle that is required. A desirable feature of grinding centers with this tool is that all centers in a shop can be maintained at a uniform taper, the standard being 60 degrees. This allows the center holes in all the various size arbors to be uniform, thus making the arbors interchangeable on different lathes. This advantage is apparent when it is necessary to shift work from one lathe to another, the bearing end in each center being the same, thereby establishing absolute truth to the periphery of the arbor or work mounted on it.

The operation of grinding centers is so simple that it requires no skill on the part of the operator. With the grinder mounted at the correct angle, it is inserted in the tailstock of the lathe. The adjustment for cut is made by the tailstock screw, no other adjustment being required. For doing accurate work, the great saving of time effected by this tool, as compared with setting up a tool-post grinder for grinding centers, can be readily appreciated.

The motor is of special design, having high efficiency and other features of advantage in grinding. The armature shaft is made of nickel steel, ground and lapped. The phosphor bronze end bearing is adjustable and can be kept in the exact condition for perfect grinding. Grinders are shipped with a blank shank, accurately centered ready to be turned to fit the tailstock of any lathe. When the same grinder is operated on lathes having different size tailstocks, bushings can be used. The grinder can be run from any direct current lamp socket.

FLYNN COMBINATION DRILLING AND BORING CHUCKS

The illustrations show two styles of combination drilling and boring chucks which have recently been placed upon the market by the J. T. Flynn Mfg. Co., Detroit, Mich. The No. 10 chuck shown in Fig. 1, is fitted with universal jaws which are operated by two screws, one of which is intended for adjusting the jaws and tightening them on the shank of the tool, while the other is an auxiliary jaw for securing a firmer grip in cases where a more positive drive is required. Referring to Fig. 2, where a partial sectional view is shown, the design of the chuck will be better understood. Here it will be seen that the jaws are male and female, V in shape, and that they are held against the front of the chuck by means of a nut at the back of the shell. This arrangement is more clearly shown in the illustration of the chuck details, in Fig. 3.

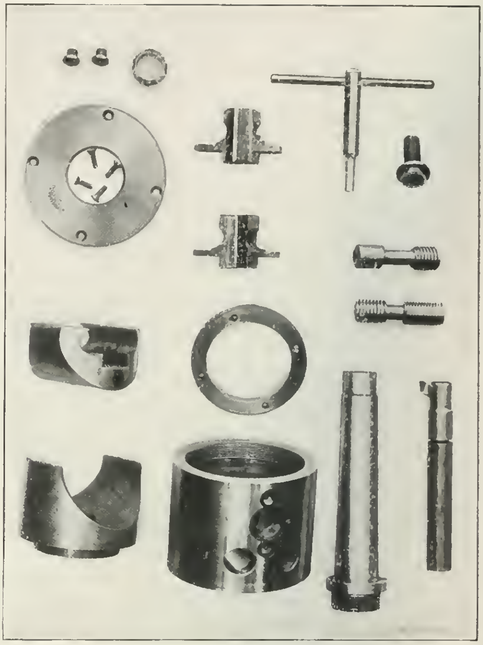


Fig. 3. Parts of the No. 10 Flynn Chuck

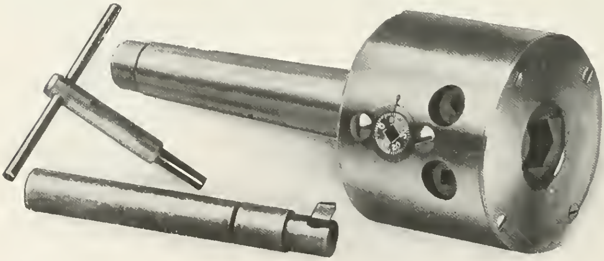


Fig. 1. No. 10 Flynn Chuck fitted with Universal Three-point Contact Jaws

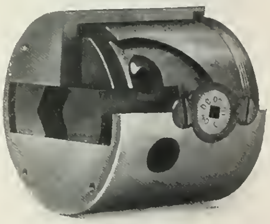


Fig. 2. Partial Sectional View of the No. 10 Flynn Chuck

The screw with a dial head is used for centering the jaws when the chuck is used for drilling, or for setting them at any required distance off center, where a boring bar is mounted in the chuck. The jaws provide a three-point bearing on the shank of the tool 1½ inch in length and afford ample power for drilling and boring operations within the range of the

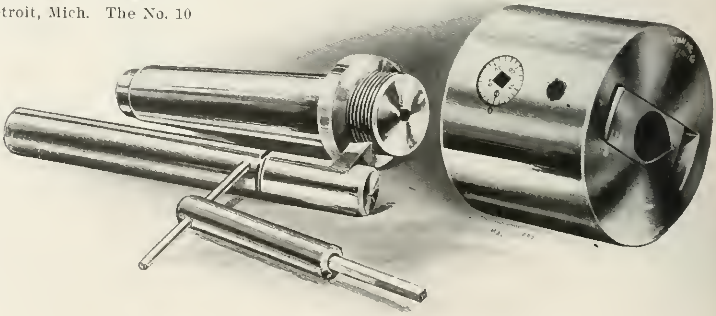


Fig. 4. The No. 8 Flynn Chuck graduated on Face for Different Drill Sizes

chuck. The dial of the adjusting screw is graduated to thousandths and provides for setting the boring bar at the desired distance off center for counterboring, recessing and parallel boring; this adjustment makes the chuck particularly adapted for boring jigs and fixtures. The chuck has an offset of 3/8 inch and will take drills or bars up to 3/4 inch in diameter. The capacity for boring holes ranges up to 4½ inches diameter.

This chuck has a 3/4-inch hole running through it, and by screwing the chuck onto the lathe spindle, instead of using the taper shank, a convenient means is provided for working from long bars or for turning straight or eccentric pins.

Fig. 4 shows another style, known as the No. 8 chuck, which is of practically the same design as the style shown in Fig. 1. This chuck has a solid cross-block with a V in it which acts in conjunction with a second jaw in the chuck. It will be seen that the face of the chuck is graduated for different drill sizes. The dial of the adjusting screw is graduated in thousandths to correspond with the graduations on the face of the chuck and provides for setting the cross-block central for different drill sizes. The same style of chuck is also made in a smaller size, known as the No. 6, which accommodates 3/8-inch boring bars and has a range for boring holes up to 2 inches in diameter.

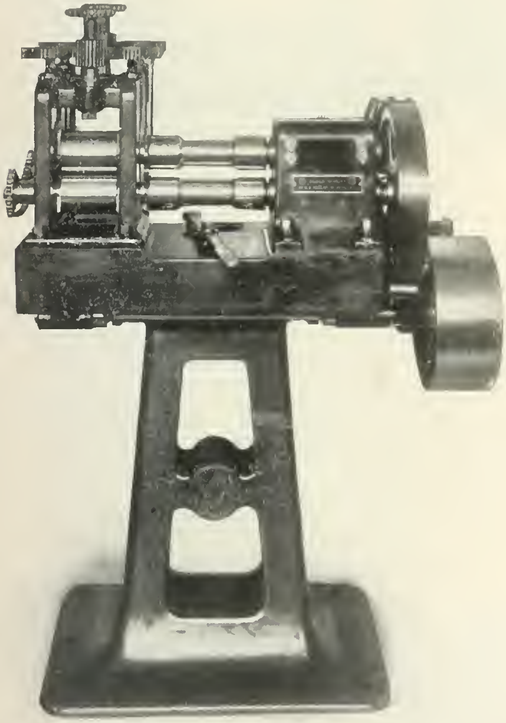


Fig. 1. The Oliver Rolling Mill for forming or embossing Strip Sheet Metal

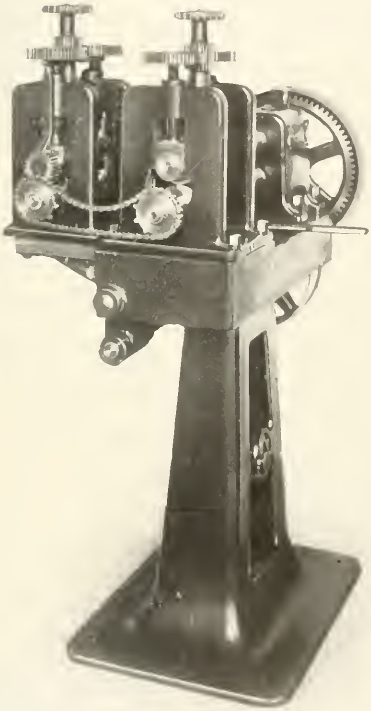


Fig. 2. Side View of Machine showing Chain Drive and Auxiliary Roll Frame

The design of these chucks is simple and compact and particular attention has been paid to the provision of the necessary rigidity and rapidity of adjustment. All parts that are subject to wear have been hardened.

OLIVER EMBOSSING AND FORMING MILL

The work of forming strip sheet metal to any required shape, or of embossing a design upon stock of this kind, is often performed by means of a rolling mill equipped with rolls of the required shape. There are, however, certain limits in the amount to which the metal can be formed in passing through one set of rolls, and when this limit is exceeded, it becomes necessary to pass the work through two or more sets of rolls.

One of the recent products of the W. W. Oliver Mfg. Co., 1500 Niagara St., Buffalo, N. Y., is the rolling mill shown in the accompanying illustrations. This machine consists of the regular No. 4A, triple-geared, power rolling mill manufactured by this company to which a second roll frame has been attatched. The rolls carried by the second frame are driven at the correct speed by a chain from the rolls in the first frame. This machine has been the means of effecting a considerable saving of time in operations where the stock is to be formed to such an extent that two pairs of rolls are necessary.

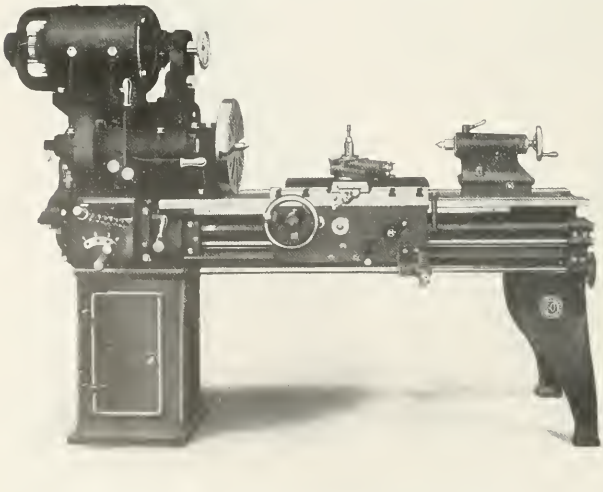
One class of work produced by this machine consists of strips of sheet tin 0.010 inch in thickness which are embossed and crimped by passing through the mill. In this case, the rolls of the No. 4A mill, perform the embossing operation and the auxiliary pair of rolls put the crimp in the work. The stock is fed straight through from the embossing rolls to the crimping rolls without any loss of time, so that the machine operates at a high efficiency.

CONOVER-OVERKAMP MOTOR-DRIVEN LATHE

The Conover-Overkamp Machine & Tool Co., Dayton, Ohio, has brought out a new motor-driven lathe, illustrated herewith, built in 14- and 16-inch sizes. The headstock is ribbed to support the strain of the cut and is cast in two sections. The lower half forms the headstock proper, and the upper half provides a base for the motor, completely covering all running parts and doing away with loose gear guards. The backgears on this lathe are placed in front, instead of being on the back of the headstock, making them accessible to the operator without going around the lathe to throw them in or out. This feature enables these lathes to be placed close to the wall, thus effecting a saving of floor space.

The drive is obtained from the pinion on the motor shaft through an intermediate gear to the friction gear on the lathe spindle. By means of this friction gear on the spindle, the lathe may be started or stopped while the motor is running, thus allowing the motor to retain its normal speed. This friction gear is operated by the horizontal lever on the headstock. The headstock is equipped with other single back gears, or double friction back gears. When equipped with double friction back gears, these gears are operated by the vertical lever on the front of the headstock.

With a 3 to 1 variable-speed, direct current motor, a range of spindle speeds from approximately 13 to 400 R. P. M. may be obtained, allowing ample speed for all classes of work. The motor is controlled through a drum type controller, and is operated by a lever on the apron. The position of this lever is to the right of the operator and working in a vertical position places it in the most convenient and natural position for him to handle. As all working levers on this lathe are at the front, the operator has complete and quick control at all times, saving many unnecessary steps. The dimensions of these lathes are the same as the standard 14- and 16-inch machines built by this company, and the motor-driven type can be furnished with quick change gear, as shown in the illustration, or with an all geared feed or standard belt feed.



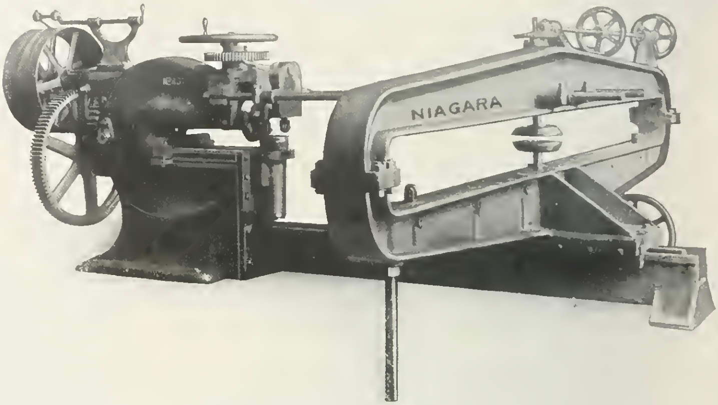
Conover-Overkamp Motor-driven Lathe, built in 14- and 16-inch Sizes

NIAGARA COMBINATION FLANGING MACHINE AND ROTARY SHEAR

The combination flanging machine and rotary shear illustrated herewith is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. As shown, the machine is set up for flanging operations, and to convert it into a rotary shear the flanging rolls are removed and shear blades mounted in their place.

Referring to the illustration, it will be seen that there are two horizontal shafts driven at the rear end by gears. A pair of miter gears connect the lower shaft with a vertical shaft which supports he lower flanging roll; the upper flanging roll is mounted on the upper horizontal shaft. The shaft carrying the upper flanging roll can be raised and lowered by a hand-wheel and the roll can be adjusted laterly to accommodate different thicknesses of stock.

The clamping or circle arm is mounted on the extension of the bed, which is fastened to the main frame, and provision is made to adjust the arm for disks of different diameters. To insure rigidity, the upper part of the clamping arm is tied to the frame by means of two heavy shafts and these shafts serve the further purpose of supporting a hold-down attachment which can be quickly raised and lowered by means of an eccentric lever. In starting a flanging operation, the metal is first cut to a circular shape of the required diameter and is then clamped between the two disks of the circular arm. The upper flanging roll is then gradually brought down and forms the flange over the lower roll. The machine is shown in the illustration equipped with rolls to form a 90 degree angle flange.



Niagara Combination Flanging Machine and Rotary Shear set up for forming 90-degree Angle Flanges

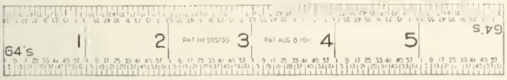
This machine has a capacity for metal as heavy as 1/4 inch in thickness, and it will flange disks from 18 inches to 12 feet in diameter with a maximum height of 2½ inches for the flange. When used as a circular shear, it will cut out disks from 14 inches to 9 feet 2 inches in diameter, from a square blank.

A NEW LUFKIN RULE

Everyone who has used a scale graduated down to 64ths of an inch, knows the difficulty of obtaining accurate measurements, and the eyestrain and loss of time resulting from the fineness of the lines, and the closeness of the lines to one another that is necessary to get 64 lines in an inch. Under the eye, the lines seem to have a tendency to "run together," and because they are so close it is impossible to number each one; therefore, after arriving at the meaurement, it is necesssary to refer back to the last figure and count up the 64ths. It is evident that if the same measurement could be arrived at with the same degree of accuracy with a rule graduated not finer than say 16 lines to the inch, these difficulties would be overcome.

Both of these features are combined in the Allen improved scale, which has just been put on the market by the Lufkin Rule Co., Saginaw, Mich. This is a patented tool which embodies an absolutely new idea in the marking of a machinist's scale. As any even number of the 64th has an equivalent in 32nds and 16ths, one side of this rule is graduated in 32nds and 16ths, and this takes care of all of the even 64ths. The other side of the rule embodies the new idea that takes care of all the odd 64ths. The first graduation mark on one edge of this side is 1/64 inch from the end of the rule and is numbered "1"; the next mark on that edge is 5/64 inch from end of rule, and is numbered "5"; the next

"9"; the next "13," etc., up to the first inch mark. This system of graduation is repeated in each inch. Here there are intervals of 4/64ths, and between 1/64th and 5/64ths would come one odd 64th, *i. e.*, the 3/64th inch mark; between the "5" and "9" graduations would come the 7/64th inch mark, etc. All of these odd 64ths appears on the other edge of this side of the rule; that is, the first graduation mark there is 3/64 inch from the end of the rule, and is numbered "3"; the next is 7/64 inch and numbered "7," etc., in each inch.



Allen Improved Scale which gives Readings to 1-64th inch, with only 16 Graduations to the Inch

Thus the object is accomplished; all of the odd 64ths are here given, and yet there are only 16 lines to the inch. This makes it possible to number each graduation mark, and by marking each second graduation mark slightly longer than the one before and after it, the figures can be put on in two rows, and this allows sufficient room to make them large enough to be easily read. The rule is ¾ inch wide, and furnished in the two thicknesses commonly known as the "tempered" and the "semi-flexible"; it is made in various lengths, but the greatest demand, no doubt, will be for the 6-inch length.

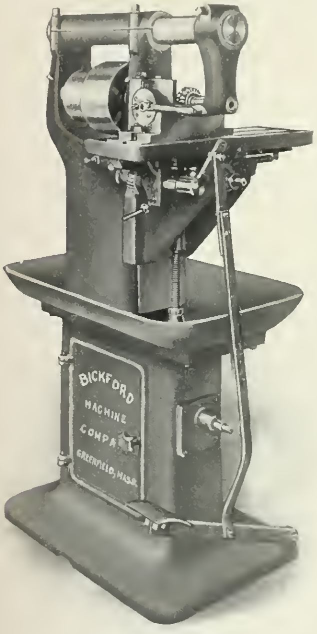


Fig. 1. Bickford No. 1 Plain Milling Machine equipped with Tap Squaring Fixture

BICKFORD TAP SQUARING FIXTURE

In the November, 1910, issue of MACHINERY, the No. 1 plain milling machine manufactured by the Bickford Machine Co., Greenfield, Mass., was illustrated and described. The accompanying illustrations show a recent modification of this machine which has been developed by the Bickford Machine Co., to adapt it for squaring taps. For this purpose the machine has been equipped with a foot treadle to operate the feed, and a chucking device which consists essentially of a steel head arranged to make a quarter revolution in a cast-iron frame. A detail of this chucking device is illustrated in Fig. 2. One of the two handles is screwed firmly into one side of the head and the other is so connected that it operates the chuck which has a tapered nose to fit a corresponding taper in the head. By simply bringing these two handles together the chuck is forced forward into the tapered section of the head and closes firmly upon the work. The chuck may be closed in this manner by bringing the two handles together in either a vertical or horizontal position.

With the work gripped in the chuck in the manner previously described, the treadle is pushed down to feed the work to the cutters which perform the squaring operation. After taking a cut in this way the two handles are swung through a quarter revolution and the treadle is then pushed down to feed the work through the cutters a second time. This completes the squaring operation. This machine will square work from 1/8 to 7/16 inch in diameter and has a capacity from 300 to 400 pieces per hour.

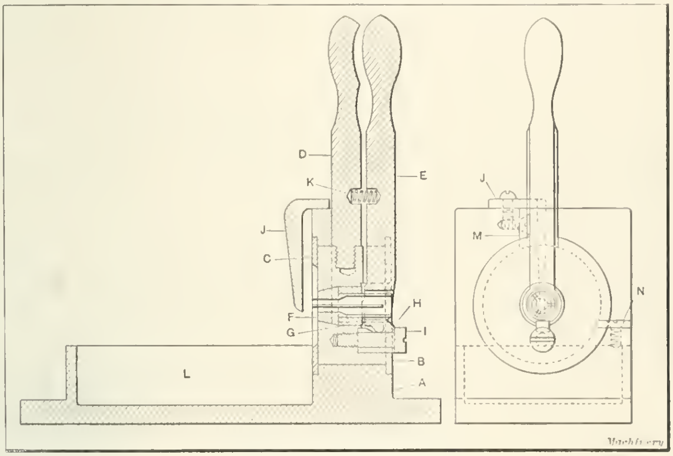


Fig. 2. Chucking Device used for Tap Squaring

CONRADSON TURRET TOOLPOST

The illustrations show a new turret toolpost which has been designed and placed upon the maket by Phoenix Mfg. Co., Eau Claire, Wis. This toolpost is intended for use on a regular engine lathe and for many classes of work, it will give a machine of this type the productive capacity of a turret lathe. This toolpost is not ordinarily recommended for use on work where an intelligent analysis indicates that a turret lathe is necessary, but it has an extremely wide field of application on operations which come between those regularly performed on an engine lathe and a semi-automatic or hand turret lathe.

Referring to the cross-sectional view of the turret toolpost, shown in Fig. 1, it will be seen that this equipment consists of a bracket *A* mounted on the cross-slide of the lathe; this bracket supports the steel bushing *B* in which the turret *C* is free to rotate or to be moved longitudinally for a sufficient distance to disengage the indexing mechanism. The turning tools are carried in toolposts held in bosses on the front of the turret, and the boring tools, of which a great variety may be employed, are held in the split collet sleeve *E*. A reversible boring bar *F* is ordinarily used for holding two interlocking cutters at one end, and this bar has a collet at the opposite end which is used to hold a variety of boring tools, such as those illustrated in Fig. 5. The tool *J* is the cheapest form of tool that can be made, and is used where only two cutting edges are needed. This tool is forged from high-speed steel and is simply flattened out to produce two cutting lips. High-speed steel can be economically used, as the tool can be re-bored any number of times. The tool *K* is of more elaborate design and is intended for boring small holes where more than two cutting edges are needed; this tool provides for roughing and finishing a hole, and can also be fitted with a roughing and finishing thread tool. The bit is made of high-speed steel and the bar of vanadium steel, the bit being screwed into the end of the bar. The collet *E*, Fig. 1, is tightened by means of the differential nut *G* which is turned by means of the capstan *H*. When the turret toolpost is being used for turning operations, the collet is loosened and the bar slid back out of the way, as shown in Fig. 3.

The indexing of the turret is accomplished by means of the teeth *D*, shown in detail in Fig. 2, which are located between the sleeve *B* and turret *C*. There are eight teeth and eight corresponding spaces, and a "ball finder" *J* is provided which automatically registers the turret when it is brought to approximately the indexing position. The turret is then simultaneously indexed and clamped by operating the handle *I*; this draws in the turret and engages its teeth with the spaces on the sleeve *B*. The design of the clamping mechanism takes up all lost motion.

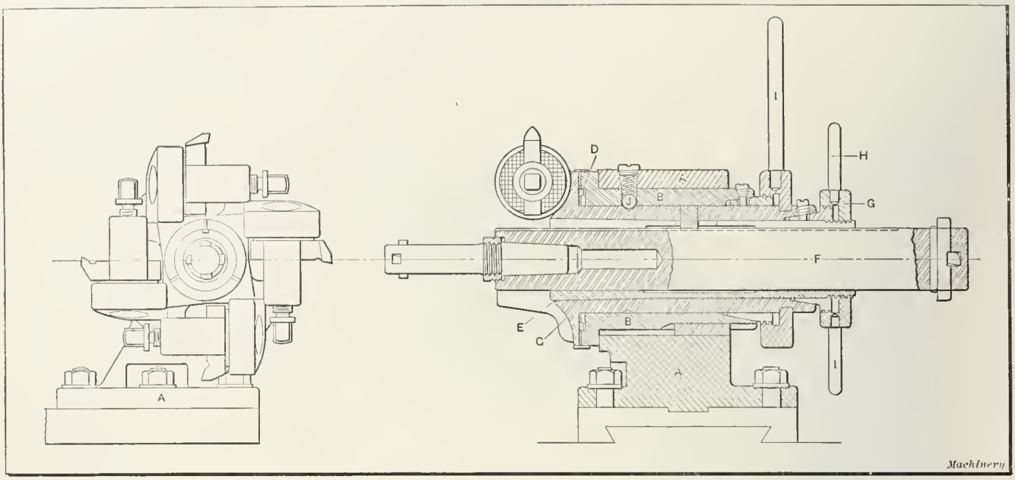


Fig. 1. End and Cross-sectional Views of the Conradson Turret Toolpost

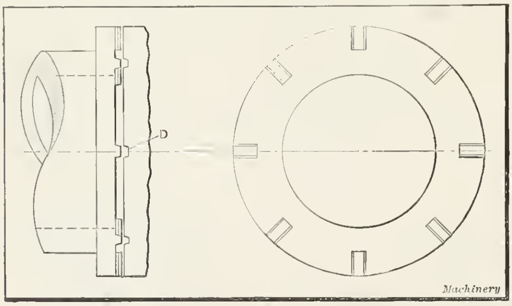


Fig. 2. Detail of the Teeth of the Index Mechanism

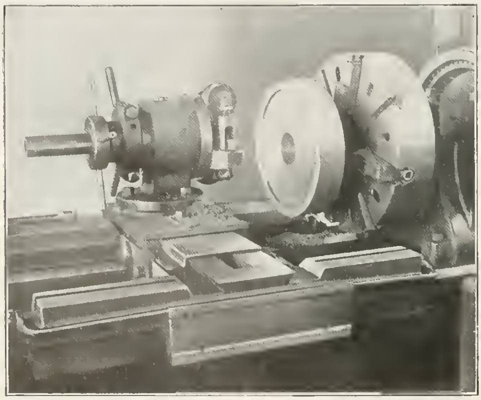


Fig. 3. Turret Toolpost set up on a Lathe for turning Operation

Figs. 3 and 4 show the tool mounted on a lathe ready for the turning and boring operations, respectively, and give a good idea of the class of work for which this turret toolpost is particularly adapted. The work shown in these illustrations is 13½ inches in diameter and parts of this design were completely machined in about twenty-five minutes each. A comparison of this time with the time required to produce such work on an ordinary engine lathe, will emphasize the productive capacity of the tool, and on jobs calling for a small number of pieces the turret toolpost will finish the work in the time required to set up a turret lathe. On those classes of work which this toolpost is best suited, it will keep up with a turret lathe engaged on the same operation. It will be seen from the preceding that this toolpost is particularly adapted to the requirements of shops engaged in manufacturing operations in small lots.

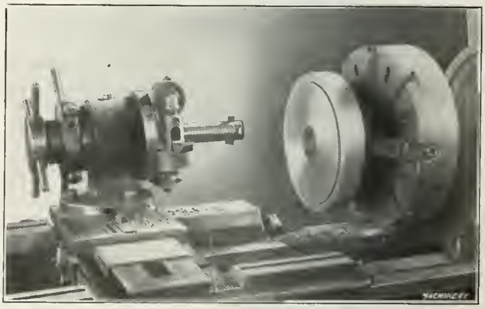


Fig. 4. Turret Toolpost set up on a Lathe for Boring Operation

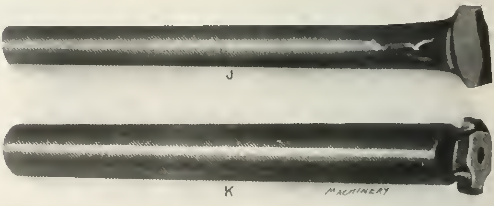


Fig. 5. Two Styles of Boring Tools used in the Turret Toolpost

The tool equipment required for this attachment is extremely simple. It is necessary to have a sufficient number of boring bars to cover the range of the toolpost and about twelve turning tools will cover all ordinary requirements. It is often found particularly convenient to use the reaming and tapping attachment shown in Fig. 6 in connection with this turret toolpost. In using this attachment, the turret is drawn back out of the way, the reamer or tap then being swung down into alignment with the spindle and advanced to the work. The design of this toolpost fits it for the most severe classes of manufacturing operations which come within its range, and this fact will be readily appreciated from the statement of the manufacturer that the toolpost has frequently stalled a 24-inch engine lathe.

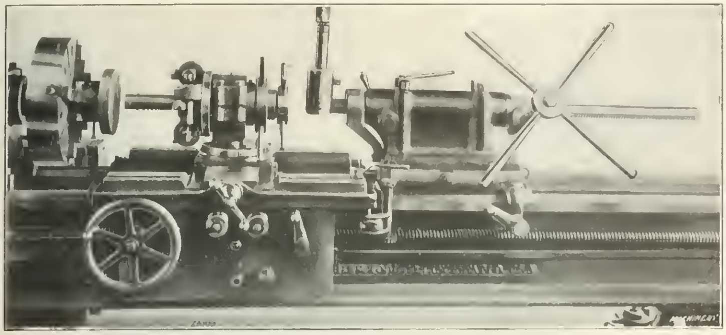
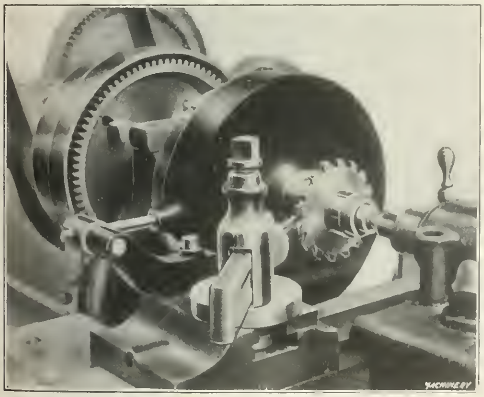


Fig. 6. Tapping and Reaming Fixture used in connection with Turret Toolpost

THE BICKFORD RELIEVING ATTACHMENT

The relieving attachment shown in the accompanying illustration is a recent product of the Bickford Machine Co., Greenfield, Mass. The essential parts consist of a shaft running on eccentric centers and carrying a sleeve upon which the cutter that is to be relieved is mounted, a 64 tooth gear attached to the sleeve and a 60-tooth gear free on the sleeve, and a pinion mounted on an arm carried by the eccentric shaft which meshes with the two gears. The 60-tooth gear is attached to the inside of the gear guard, shown in the illustration, and as this gear cannot revolve around the sleeve upon which the cutter is mounted, the sleeve and cutter are rotated, the motion being the result of the difference in the numbr of teeth on the two gears. The cutter is also carried around in a circle by the eccentric shaft, thus being carried toward and away from the tool as well as up and down.



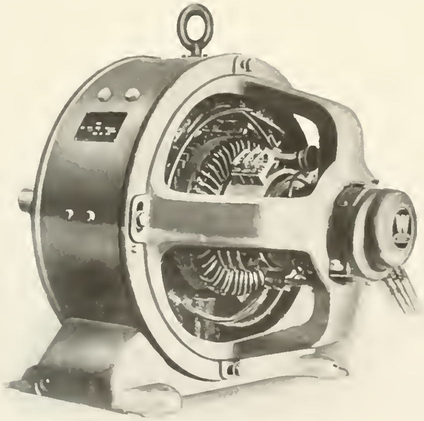
Bickford Attachment for relieving Cutter Teeth

One quarter of the circumference of the idle gear has 18 teeth and the other three quarters have 42 teeth. The result of this unequal spacing of the teeth gives the following result. The cutter which is being relieved revolves in the opposite direction to that in which the lathe is running during the time that the cutter is passing from its point nearest the tool to the lowest point of its travel, and during the balance of the movement of the cutter in its circular path it revolves in the same direction as the lathe. When the cutter has again reached its position nearest the tool, it will have advanced 1/16 of a revolution as the result of one planetary revolution.

This movement makes it possible to run the cutting tool right up to the face of the tooth and the cutter will then revolve backward while it is receding from the tool, instead of moving forward and taking off the end of the tooth. This makes it possible to have teeth which are very wide, and spaces between the teeth which are relatively narrow. A method of adjustment is provided by means of two small screws which will revolve the cutter through the space of one tooth. By this means it is possible to set the tooth in the correct relative position to the tool before starting the cut. Any cutter having 16 teeth, a one-inch hole and a face width of not over 1 1/2 inch may be relieved on this attachment.

WESTINGHOUSE MOTOR FOR DRIVING BENDING ROLLS

A new Westinghouse motor which has just been placed on the market is especially designed for driving bending rolls, raising the cross rails of planers and boring mills, moving the tail-stocks of large lathes, and similar service requiring motors with special torque characteristics. The special feature of this motor is that most of the excitation is due to the series coils. The torque, therefore, increases rapidly as the current input increases, and this is the characteristic that is necessary to adapt the motor for such classes of service as starting a cross-rail or taking a plate through a pair of bending rolls. The shunt field winding, limits the no-load speed to approximately twice the full load speed, so that racing is impossible.



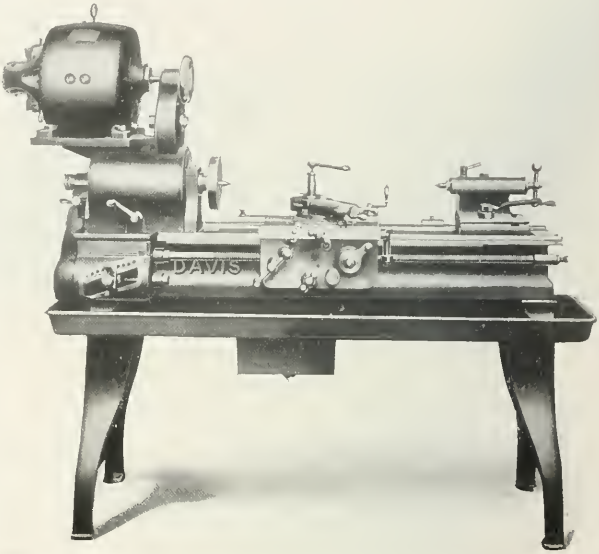
Westinghouse Motor for driving Bending Rolls

Mechanically, these motors are exceptionally strong. The frame is made of rolled steel, the shaft of axle steel, and the bearings are very large and designed to make them dust and oil proof. The commutation is practically sparkless, due to the use of commutating poles and the careful design of the commutator and brushes. The manufacturers state that these motors require very little attention, as the lubrication is automatic and the brushes rarely require renewal. They are made by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in capacities of from 3 to 40 horsepower to operate on 230 volt direct-current circuits.

DAVIS MOTOR-DRIVEN LATHE

The illustration shows the variable-speed motor-drive as applied to lathes of 12- to 16-inch swing manufactured by the W. F. Davis Machine Co., 305 St. Paul St., Rochester, N. Y. Referring to the illustration, it will be seen that the motor is mounted on a substantial plate located above the head-stock and so placed that the weight of the motor is supported without producing any tendency toward vibration.

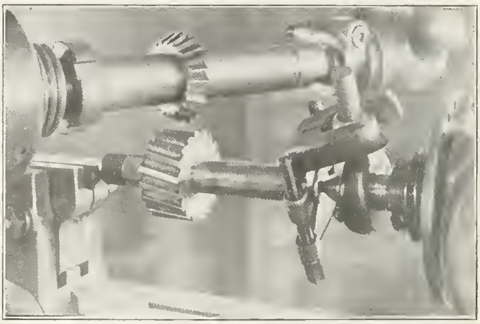
A useful feature of this motor-drive consists of having the armature spindle extended and fitted with a hand-wheel which affords a convenient means of turning the lathe spindle over by hand when setting up or testing the work. The motor is direct-connected to the spindle through an intermediate gear and the drive from the spindle is either direct or through single or double back-gears, which provide two or three mechanical changes. All of the gearing is adequately covered by cast-iron gear guards. The controller can be mounted at any place along the lathe bed, but experience has shown that the best position is either at the head end or in the rear at the back of the tail-stock. The controller is operated by a lever located on the apron, where it is within easy reach of the operator. Any make of variable-speed direct-current motor can be used. On sizes up to 3 H.P., a speed ratio of 3 to 1 giving speeds of from 500 to 1500 R. P. M. is used. The Cutler Hammer No. 78 full reverse drum type controller is used.



Davis Lathe equipped with Variable-speed Motor Drive

"READY" COMPENSATING MILLING MACHINE DOG

In the November, 1912, issue of MACHINERY, the Hill compensating dog for milling taper work was described. The features of this dog were the forked driver mounted on the spindle or faceplate and a dog having a tail with a ball shaped part engaging the fork of the driver. The design of this dog brings the point of application of the forked driver on the ball into approximately the same plane as the end of the piece being indexed. This arrangement eliminates the irregular spacing that occurs in indexing tapered work when an ordinary bent-tail dog is used.



Improved "Ready" Milling Machine Dog for Taper Work

The dog shown herewith is an improved design which is claimed to combine the advantages of the preceding type with the ability to drive work that has to be held on a short arbor with the table swung over at an acute angle, and still allow the dog to clear the overhanging arm. In the preceding design of this dog, the driving fork was clamped to the face plate or spindle of the index head, and the tail carrying the sliding ball was attached to the dog. In the present design, it will be seen that the driving fork is mounted on the dog and reaches back to engage the ball carried on the tail attached to the collar on the spindle. It will also be seen that the driving fork is set at an angle. In this way, the advantages of the old dog are secured and the dog clears with the work on a short arbor and the table set over at an acute angle. Both the dog shown in the illustration and the one previously referred to are products of the Ready Tool Co., 654 Main St., Bridgeport, Conn.

NEW MACHINERY AND TOOLS NOTES

Ball-bearing Shaft Hanger: Gurney Ball Bearing Co., Jamestown, N. Y. A ball-bearing shaft hanger that can be adjusted in all directions and swiveled universally. The yoke swings in a cored-out housing in the hanger and the housing is extended inward around the yoke.

Metal Tool-case: Peck-Hamre Mfg. Co., Berlin, Mass. A machinists' tool-case made entirely of metal and provided with drawers lined with felt. The case can be quickly closed and locked and is especially suitable for resisting hard service.

Cutting-off and Centering Machine: Holton Co., Jackson, Mich. Sixteen collets are provided on this machine for taking round stock varying in size by eighths of an inch. The machine is equipped with a centering device which can be readily attached or detached, or can be left on the machine without interfering with cutting-off operations.

Vertical and Horizontal Rotary Oscillating Surface Grinder: The Springfield Mfg. Co., Bridgeport, Conn. An improved model of the machine of this type peviously manufactured by the above company. The horizontal grinding head is of the previous design but the vertical head is fitted with a counterbalance and quick return hand-feed.

Multiple-spindle Drilling Machine: Moline Tool Co., Moline, Ill. A four-spindle drilling machine with the tables and feeds entirely independent, but with all of the spindles on one drive. This machine is of the double cam feed type regularly built by this company and means are provided for changing the cams to suit different classes of work.

Sensitive Drilling Machine: J. E. Snyder & Son, Worcester, Mass. A 21-inch sliding head, high-speed drilling machine with the spindle driven by bevel gears. The machine is designed to drive drills from $\frac{1}{8}$ to $\frac{7}{8}$ inch in size, and has feeds of 0.003, 0.006 and 0.010 inch per revolution of the spindle.

Three-jaw Clamp: M. A. Haskell & Co., South Braintree, Mass. A convenient clamp for holding irregular shaped pieces of work. The clamp is made of steel and is opened and closed by turning a handle which actuates the clamping screw. The middle jaw can be removed when it is desired to convert the tool into a two-jaw clamp.

Hydraulic Bulldozer: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic bulldozer designed for use in the manufacture of heavy motor-truck axles but adapted to a variety of other forging operations. This machine has three rams connected to a single head, and the number of rams used may be varied according to the power required.

Oxy-acetylene Welding Outfit: F. C. Sanford Mfg. Co., Bridgeport, Conn. The generator of this outfit is designed to operate at low pressure, intermediate or high pressure for small, medium and heavy work, respectively. The changes of pressure are effected by operating a handle, and when the desired pressure is reached the generator requires no further attention.

Eye Protectors: American Spectacle Co., 27 W. 23d St., New York City. Three forms of goggles especially designed for protecting the eyes of workmen engaged in operating chipping hammers or grinding machines. The goggles are also serviceable for those engaged in handling molten metals, electric or oxy-acetylene welding operations and any other service of this class.

Ball-bearing Shaft Hanger: New Departure Mfg. Co., Bristol, Conn. An improved ball-bearing shaft hanger designed especially for use with he annular type of self-aligning ball-bearings manufactured by this company. The frame of the hanger is made of a gray iron casting of box-section, the ends of which are closed by a cap after the shaft is in place. The bearing is carried by a machine retainer ring supported in the hanger frame by four set-screws.

Vertical Planer-type Grinder: Springfield Mfg. Co., Bridgeport, Conn. This is an improved form of the machine of the same type previously manufactured by this company, but is of considerably larger size, having a capacity for grinding work up to 14 feet in length. The important feature of this machine lies in the provision of means to tilt the housings carrying the vertical grinding spindle to enable the machine to grind concave work.

Roller Mandrel: Alert Tool Co., Philadelphia, Pa. A mandrel with a small hardened roller carried in a longitudinal slot milled off center along the face of the shank. This allows the roller to drop below the circumference of the mandrel, and the more strain that is placed on the work, the more securely does this small roller bind and secure it upon the mandrel. To release the work it is only necessary to turn in the opposite direction, thus releasing the grip of the small roller.

Tool-post Turret: Carson & Hartwig, 25 Hackett St., Newark, N. J. This tool is provided with a threaded vertical sleeve which provides vertical adjustment for aligning the turret with the centers of the lathe to which it is applied. The turret is five inches in diameter and has six holes for round shank tools, and has also been provided with means for holding six 5/16-inch square turning tools. The turret is rotated by a lever at the rear and an index pawl locks the turret in either of the six positions.

Automatic Profiler: Charles R. North, 41 Seymour St., Hartford, Conn. This machine has the automatic operating device applied in connection with the two spindles of the machine, the driving drum being placed at the back. A bracket is mounted at the rear of the machine between the driving drum and the profiling head, and this bracket carries a shaft upon which two cams are mounted. The cam nearest the head actuates the cross movement of the head on the rail and the other cam actuates the profiling table at right angles to the rail.

Universal Milling Machine: Oesterlein Machine Co., Cincinnati, Ohio. A 20 by 7½ by 17 inch universal milling machine, the chief features of which are as follows: The cone pulley is of an improved type with larger steps than were formerly employed, and the back-gear is placed inside the column of the machine below the spindle. The arbor is driven with a clutch in front of the spindle, in place of the tongue on the end of the arbor. The column is provided with oil wells for the spindle, and the knee is locked with a taper sliding gib clamped along the whole face of the column and operated by a single lever. Hand-wheels are provided for cross and vertical adjustment and the machine has automatic cross-feed.

Plain Milling Machine: Rockford Milling Machine Co., Rockford, Ill. A plain milling machine equipped with a single drive pulley located at the back of the machine, and driven direct from the lineshaft. The drive is transmitted through a series of change gears mounted inside the column, which affords sixteen spindle speeds ranging from 15 to 360 R. P. M. Fourteen changes of feed are obtained through gears located in the lower part of the column and operated through two levers located on the column below the speed change levers. The speed range is from 1/2 inch to 18 inches per minute. The spindle runs in phosphor-bronze bearings which are easily adjusted, and all other shafts run in Hyatt roller bearings of the high-duty type. The oil pump is located at the back of the machine and driven through gears from the main driving shaft, and works constantly when the machine is in operation. The bottom part of the column forms an oil reservoir through which the oil is pumped in a constant stream to the cutting tools.

Double-spindle Ring-wheel Grinder: Charles H. Besly & Co., Chicago, Ill. A double-spindle, ring-wheel grinding machine, adapted for simultaneously grinding two parallel sides of a piece. The machine is equipped with 18-inch ring-wheels and is of such massive construction as to adapt it for continuous service in severe classes of manufacturing work. The two heads are mountd on V-ways planed on the bed casings; the head at the left-hand side of the machine is bolted in position and the head at the right-hand side of the machine can be moved along the bed and clamped in position to grind work of any desired length within the capacity of the machine. A telescoping dust-hood is hinged at the back to give free access for changing grinding wheels, and has an air-tight connection at the back of the machine for exhausting the grindings removed from the work. The spindle and thrust bearings are lubricated from compression cups, and oil grooves are so placed that the lubrication is forced to the points where it is needed.

* * *

PERSONALS

E. T. Hendee, formerly assistant to the president of Joseph T. Ryerson & Son, Chicago, Ill., has been elected secretary of the company.

Harvey Higgins, Jr., has been appointed advertising manager of the Standard Tool Co., Cleveland, Ohio, succeeding L. F. Hussey, resigned.

Allen Kendall, formerly with the E. B. Van Wagner Mfg. Co., Syracuse, N. Y., is now connected wtih the Buffalo Copper and Brass Rolling Mill, Buffalo, N. Y.

F. B. Jacobs, formerly with the Carborundum Co. of Niagara Falls, N. Y., and an occasional contributor to Machinery, is now with the Abrasive Materials Co. of Philadelphia, in the capacity of traveling salesman.

Melville W. Mix was for the fourth time, re-elected president, at the recent annual meeting of the Manufacturers' Bureau of Indiana. Mr. Mix is president of the Dodge Mfg. Co., Mishawaka, Ind.

R. M. Hawkins, Jr., formerly with the Standard Welding Co., Cleveland, Ohio, has entered the employ of the Hill Clutch Co. of Cleveland as Eastern representative and is connected with its New York sales office located at the Hudson Terminal building, 50 Church St., New York City.

Nathan B. Payne, who has been associated with Manning, Maxwell & Moore, Inc., New York City, for several years, was made manager of sales of the Davis-Bournonville Co., manufacturer of oxy-acetylene welding and cutting apparatus, beginning February 1.

Dr. Edward Goodrich Acheson of the International Acheson Graphite Co., Niargara Falls, N. Y., and one of the foremost inventors and chemists of the time, was recently honored by the Russian government. The Order of St. Ann was conferred on Dr. Acheson at the American Embassy in St. Petersburg, by order of the Czar.

* * *

OBITUARIES

David McNeely Stauffer, a civil engineer of some distinction, died at his home in Yonkers, February 6, aged sixty-seven years. Mr. Stauffer was for twenty-four years, editor of the *Engineering News*, and retired years ago.

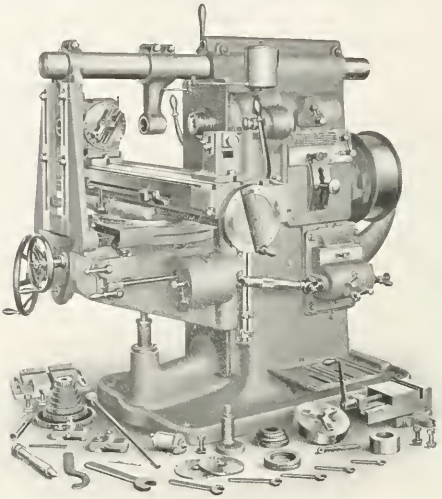
Edward L. Bronson, for several years master mechanic of the Shoe Hardware Co., Waterbury, Conn., died at his home in Waterbury aged fifty-three years. Mr. Bronson was for many years a foreman in the E. J. Manville Machine Co., of Waterbury.

George B. Lamb died February 21 at his home in Waterbury, Conn., aged sixty-four years. Mr. Lamb was vice-president of the Waterbury Farrel Foundry & Machine Co., and was formerly superintendent of its machinery department. He was the inventor of several improvements in hydraulic machinery, etc.

James B. Hammond, president of the Hammond Typewriter Co., and one of the pioneers of typewriter invention, died while on a yachting cruise at St. Augustine, Florida, January 27, aged seventy-four years. The Hammond typewriter, patented in 1884, had as a distinguished feature, a revolving type wheel instead of swinging type bars.

GUSTAF DE LAVAL

The well-known Swedish scientist and inventor, Dr. Gustaf De Laval, died in Stockholm, Sweden, after an unsuccessful operation, February 2. Dr. De Laval was born at Blasenborg, Sweden, in 1845. He was educated at the Royal Technical Institute in Stockholm where he graduated in 1866. He was then employed with the Stora Kopparberg Mining Co., and later, desiring to obtain a more extensive scientific training, he entered the University of Upsala, where for several years he studied physics and mathematics, and received the degree of Doctor of Philosophy. He then again entered the service of the mining company and worked out plans for the erection of a plant for the manufacture of sulphur. Later he



Investigate
Design and Construc
Parts of B. & S.

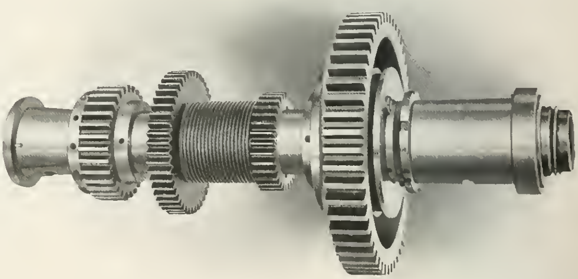
Study the parts and their functions.
requisite for accuracy, efficiency,
You will find they are the features
give you a better understanding of
designing and building machine tools.

Spindle Drive in B. & S. Constant Speed Drive Milling Machines

This is one of the most important features of the constant speed type of machines, for it is essential that a maximum part of the power delivered to the machine be available at the spindle nose. The drive in our machines from the large wide face driving pulley to the spindle is through a direct spur gear train mounted on shafts of large diameter, that are firmly supported at points close to where pressure is applied. The gears are of large diameter, wide faces, and coarse pitches. In this connection we emphasize particularly the large back gears that transmit a very powerful and steady drive to the spindle when slow speeds are being used. All speed changing gears are hardened and the teeth are pointed to afford instant engagement. They are quiet running and highly efficient.

Note the large proportions of the spindle shown below. Observe the long, heavy boxes which are fitted with phosphor bronze. Power is delivered at the front of the spindle at all times, hence, torsion is eliminated.

Write for further information about these machines.

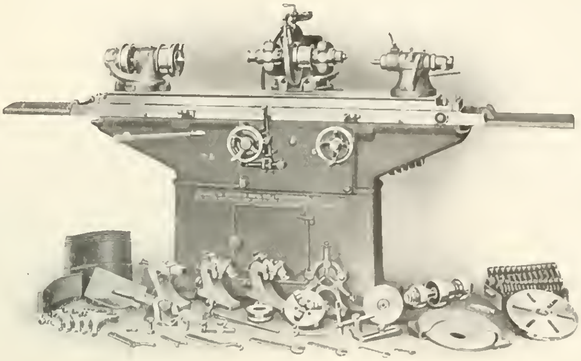


SEND FOR A 1913 GENERAL CATALOG

BROWN & SHARPE MFG. CO.,

Details in
tion of Important
Machine Tools

Pick out those that are
conveniences, and durability.
of our machines. It will also
the B. & S. methods of

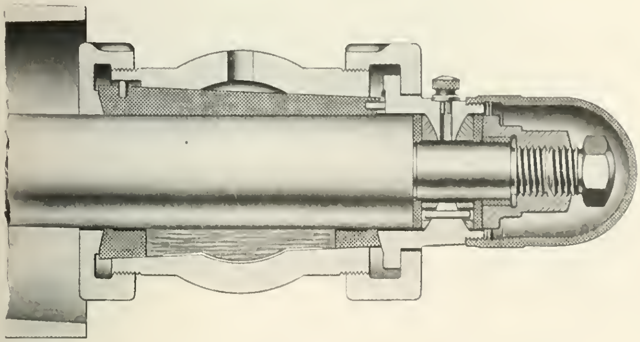


Wheel Spindle in B. & S. Universal and Plain Grinding Machines

B·S

Strength, rigidity, and high efficiency are all required at this point in a grinding machine. The spindle is of ample diameter and is hardened, ground, and lapped. Its manner of support in self-aligning phosphor bronze boxes that, in turn, are firmly mounted in the wheel stand, gives a rigid support for the wheel. Solid walls of metal that form a part of the base of the machine, extend beneath the wheel stand to the floor.

The cut below shows a section through one spindle bearing. The long phosphor bronze bearing and spherical box seat that keeps the bearing in perfect alignment are clearly illustrated. A felt pad, kept saturated with oil from the reservoir of the box, and pressed against the spindle by a spring, furnishes a constant and even lubrication to the bearing. Self-aligning end thrust washers, together with means for taking up end wear clearly show in the cut. Means are also provided for compensating for any wear in the cylindrical bearings.



Ask us for other points about these machines.

HAVE YOU READ PAGE 59

PROVIDENCE, R. I., U. S. A.

entered the service of the Kloster Iron Works, Germany, as mechanical engineer, and shortly afterward made his first two inventions—one relative to a new strainer which was to effect a more perfect separation of air in a Bessemer converter, and the other, a crucible for galvanizing purposes. He experimented on centrifugal machinery and this led to the invention of the centrifugal cream separator which is one of the two great inventions that are most often coupled with his name. The De Laval Separator Co., making the De Laval cream separators, has an extensive plant at Poughkeepsie, N. Y. He also perfected a number of other inventions in connection with a dairy apparatus, one, by means of which the percentage of butter fat in milk could be determined in a simple manner, for the purpose of establishing a uniform method of paying for milk. In the manufacture of the cream separator, he conceived the idea of a steam turbine as an ideal motor for driving the separator, which must itself run at an extremely high speed, and from this primary idea the De Laval steam turbine was developed about 1882. The first commercially practical De Laval turbine was built in 1883. and was used for driving a cream separator to which it was direct-connected. This first turbine, however, was of low efficiency. In 1888 he invented and used the diverging expansion nozzle in which the steam was completely expanded, and by means of which a much higher efficiency could be obtained. The De Laval steam turbine is made in this country by the De Laval Steam Turbine Co., Trenton, N. J. In addition to the invention of the cream separator and the steam turbine, Dr. De Laval worked on inventions of the most varying character, among others, methods for electrically separating the iron in iron ore. Dr. De Laval easily ranked among the great inventors of the age. He was a practical engineer with bold imagination and determination to overcome difficulties, and he probably pointed the way to many of the other inventors who have worked on the development and perfection of different types of the greatest of his inventions—the steam turbine.

JOHN FRITZ

John Fritz, iron and steel maker, having attained the age of ninety-one years, died at his home, South Bethlehem, Pa., on February 13, as the result of a long illness. He was born in Londonderry Township, Chester County, Pa., and his early life was spent on his father's farm in Londonderry, where he received his early education in the country schools of that district. His father combined the pursuits of farming and mill-wrighting, and Mr. Fritz's first mechanical experience was acquired in visitiing the cotton, spinning and weaving mills in the vicinity of his home, where his father was occasionally employed as a millwright. In October, 1838, at the age of fourteen years, Mr. Fritz was apprenticed in general to learn the trades of blacksmithing and general machine work, in a shop in Parksburg, Chester Co., Pa. This shop was engaged in a variety of repair work on industrial and agricultural machinery, and here he obtained a varied knowledge of mechanical matters.

The iron and steel industry was being rapidly developed at this period and Mr. Fritz decided upon this field for his life's work. In 1884, he obtained a position in the mill of Moore & Hooven, Norristown, Pa.; the mill was, at that time, in course of construction and Mr. Fritz was engaged in erecting machinery. Rolling mill equipment at this time was in a crude state, and when the Moore & Hooven mill was placed in operation, a great deal of difficulty was experienced. The gearing used on the mills was particularly troublesome and Mr. Fritz became quite famous for his skill in repairing broken gear-teeth; this was made the subject of a special theatrical performance given in the opera house at South Bethlehem, Pa., on the occasion of Mr. Fritz's seventy-fifth birthday. The plot of the play was centered around the arrest of Mr. Fritz for "practicing dentistry without a license."

When the Moore & Hooven mill was first placed in operation and Mr. Fritz had obtained a general knowledge of the mechanical problems connected with rolling iron, he turned his attention to the studying of the subjects of puddling and rolling, and as his mechanical duties employed him constantly during the day, he devoted his evenings to studying the work of pudding and rolling in the mills. Little by little he picked up the principles of the industry and was placed in charge of the night shift of the Moore & Hooven mill. After remaining in this capacity for six months, he was transferred to the day shift. This was a considerable advancement, as it brought him into close personal touch with Mr. Hooven on all of the more intricate problems connected with the operation of the plant. An example of the accuracy of his observation may be obtained from the following: In the operation of the puddling furnaces, it was observed that a new furnace failed to give satisfactory results, but that after it had been in operation for a considerable length of time it worked much better. There was apparently no reason for this change in efficiency, but a careful study of the subject made by Mr. Fritz revealed the fact that the furnaces were kept in operation until the brick work of the roof was worn away to a thickness of about two inches. He arrived at the conclusion that the change in efficiency was due to the increased height of the furnaces, and acting upon this theory, had furnaces constructed of greater height.

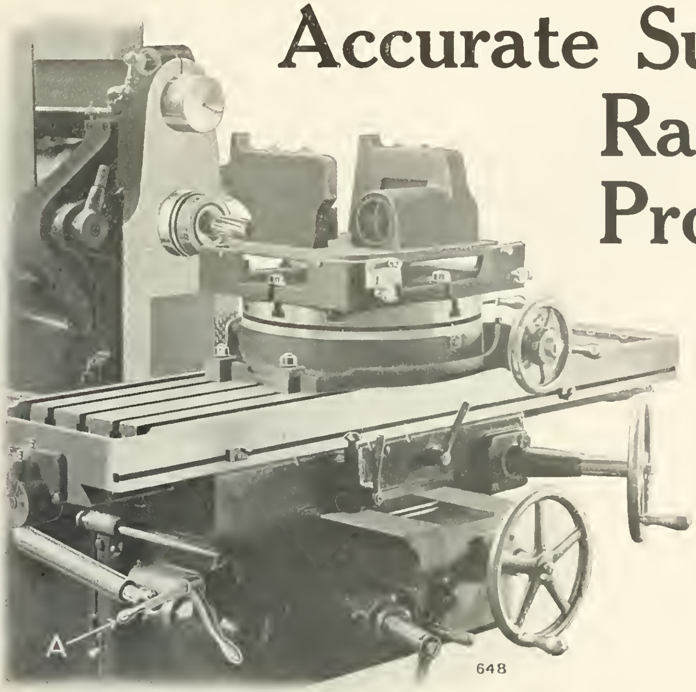
John Fritz

Mr. Fritz worked with a single purpose in view—to obtain a thorough knowledge of the iron and steel industry—and this object frequently led him to make changes which were not financially desirable, in order that he might obtain experience in certain lines of work. An example of this occurred in 1849 when he left the Moore & Hooven Co. to associate himself with Reaves, Abbott & Co., who were building a mill at Safe Harbor. From this period on, Mr. Fritz made a number of changes with the view of securing desirable experience. In 1854, he went to the Cambria Iron Co., Johnstown, Pa., as manager. While engaged in this capacity, he developed the three-high rolling mill which is universally used in steel mills to-day. In July, 1860, he left the Cambria Co. to associate himself with the Bethlehem Iron Co., Bethlehem, Pa., and by 1864, he had become such a prominent figure in the iron industry that he was authorized by the government to organize a plant in the South for rolling rails to replace those torn up by the Confederate armies. Mr. Fritz drew plans for this plant and arranged for the equipment which was necessary, but did not personally superintend its installation or subsequent operation.

In 1864, the Bessemer process for the manufacture of steel was introduced into America, and at once attracted the attention of Mr. Fritz. Many experiments were made, but it appeared that the available ores were unsuitable for the conversion of iron obtained from them, into steel by the Bessemer process, owing to the high percentage of phosphorus which they carried. Mr. Fritz finally regarded this as an insurmountable barrier to the use of the Bessemer process and for some time gave up all thought of the subject. The trouble which was constantly being experienced by railroads with broken rails, however, was finally the cause of the decision of the Bethlehem Steel Co. to erect a plant for the production of Bessemer steel rails, in which four converters were originally installed. Much trouble was experienced when this plant was first placed in operation, but the persistent work, careful study and ingenuity of Mr. Fritz was finally the means of overcoming them, and it is to him that the industry is largely indebted for the perfection of this process as applied to iron smelted from American ores. Following upon the Bessemer process, came the Siemen's open-hearth process for the production of steel, and here again Mr. Fritz was an active figure. His name is also prominently associated with the introduction of the Whitworth process of making steel forgings, and the Schneider-Creusot process for the manufacture of armor plate in America.

Mr. Fritz was a member of the American Society of Mechanical Engineers and was president of that organization during the year 1896. He was made an honorary member of the Iron and Steel Institute of Great Britain in 1893, and was awarded the Bessemer gold medal for his valuable service in the manufacture of iron and steel; in 1909, he was made honorary vice-president of that institution for life. He was one of the original trustees of Lehigh University when the institution was founded in 1866 and remained in that capacity during the greater part of his active career. In 1909, he founded the John Fritz Engineering Laboratory of Lehigh University. Various honorary degrees were awarded to him in commemoration of his work in the iron and steel industry, and on the occasion of his eightieth birthday, the

Accurate Surfaces Rapidly Produced



34 inches per minute feed

You cannot safely mill at this rate without our rear feed control (Lever A).

Flat Within .001″

You can't attain such accuracy with a less rigid machine.

This No. 4 Cincinnati High Power Miller with Cone-Drive is machining the flanges of the casting shown in the detail illustration.

The projecting horns make this an inconvenient piece to handle. The cutter must just clear the projections. The operator controls this by standing at the rear of the table where he can see both cutter and work. With the lever "A" he can instantly stop, start or reverse the feeds.

This piece can be planed. One of our best men, using an expensive planer, formerly did it in 44½ minutes.

Now we mill it as shown above (using our heavy circular milling attachment as an indexing fixture; a less expensive machine and a simple cutter) in 19½ minutes.

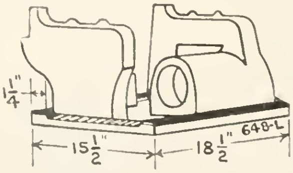
A cut is taken over one of the long flanges at 34″ per minute. The piece is then swiveled half way around and the opposite flange milled.

By swiveling one quarter around he mills the two end flanges. These are merely clearance surfaces and are milled .010″ low.

Finally he finishes the two long flanges. The cutter speed is increased by shifting the countershaft (no belt shift required) and the feed per revolution is reduced to give the proper finish, *leaving the table feed rate the same as before.*

And the two finished surfaces hold six pieces of tissue with even pressure.

To produce such work the machine must have *ample power*, for the cut is heavy; *rigidity*, because the work must be flat; *quick disengagement* of the circular attachment, for it must be swiveled by hand and locked six times for each piece; and *it must provide feed control from that place where the operator must stand.*



Speed 145 rev.
Feed .239″ which is 34″ per min.
Width of cut 1¼″.

Depth of cut 3/16 to 1/4″.
Cubic inches of metal removed per min. 8.
Time 19½ min.

Can't some of your work be handled this way?

LET US MAKE SUGGESTIONS

THE CINCINNATI MILLING MACHINE COMPANY, Cincinnati, O., U. S. A.

John Fritz gold medal was established, which is awarded for valuable service in scientific or industrial work.

A characteristic feature of Mr. Fritz was his ability to coöperate with his associates; he was not below taking the advice of those who occupied humble positions in the different industrial establishments with which he was connected. It is probably due to this willingness to take advice that a portion of his great success was due, and it certainly endeared him to the iron and steel fraternity among the members of which he was popularly known as "Uncle John."

* * *

COMING EVENTS

May 15-16.—Semi-annual meeting of the National Machine Tool Builders' Association at the Hotel Astor, New York City. James H. Herron, secretary, 2041 East Third St., Cleveland, Ohio.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

May 26-29. Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York City.

June 10.—Departure from New York City, of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

June 16-18. Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

October 14-16. Annual convention of the Allied Foundrymen's Associations. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

SOCIETIES, SCHOOLS AND COLLEGES

Williamson Free School of Mechanical Trades, Williamson School P. O., Delaware Co., Pa. Bulletin No. 10 on carpenters' trade course; Bulletin No. 11 on operating engineers' trade course.

Massachusetts Institute of Technology, Boston, Mass. Catalogue for 1912–13, containing the official roster, list of students, statements of the requirements of admission and description of courses of instruction.

University of Vermont and State Agricultural College, Burlington, Vt. Catalogue for 1912–1913, containing also announcements for 1913–1914 and official roster, list of students, conditions of admission, course of instruction, etc.

American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., celebrated its twenty-fifth anniversary with a dinner, on the evening of February 11. Mr. C. J. Mellin, of the American Locomotive Works, Schenectady, N. Y., who was the first president of the society, spoke of its early history and gave a review of its activities during the past twenty-five years. The object of the society is to bring together, in a professional and social way, men of Swedish nationality engaged in the engineering field, and to assist young technical men who have just arrived in the United States in obtaining suitable work, and adding to their experience. The society has now nearly three hundred members, of which about sixty reside in New York and vicinity. In 1908, it acquired the building it now occupies in Brooklyn, where its meetings are held and where it has a library and reading room. Architect N. L. Malmros, president, spoke for the future of the society. The Swedish Minister to the United States, W. A. F. Ekengren, was present as a guest of honor, as was also the Swedish Consul in New York City, M. Clarholm.

NEW BOOKS AND PAMPHLETS

Handbook of Gasoline Automobiles. 187 pages, 7¾ by 5¼ inches. Illustrated. Published by the Automobile Board of Trade, New York City.

The 1913 edition of this publication contains illustrations and specifications of the pleasure and commercial gasoline motor cars built by seventy-four American concerns.

The Gasoline Engine on the Farm. By Xeno W. Putnam. 527 pages, 7½ by 5⅜ inches. 179 illustrations. Published by Norman W. Henley & Son, New York City. Price, $2.50.

This book is a practical treatise on the construction, repair, management and operation of gasoline engines as applied to a great variety of farm implements and machinery.

German on a Trip to Germany. By Max Hirschfelder. 9¼ by 6⅛ inches. Published by Self Educator Publishing Co., Scranton, Pa. Price, 15 cents, per number.

This series constitutes a text for the home study of German. It is to be published in forty installments which will appear monthly, and the first four installments are now available.

The Electron Theory of Magnetism. By Elmer H. Williams, 66 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 62.

The bulletin is a mathematical discussion of the new theory of magnetism, tracing the experimental evidence leading to the development of this theory, defining its present status and pointing out certain phenomena which the theory in its present form fails satisfactorily to explain.

Essentials of Electricity. By W. H. Timbie. 271 pages, 7⅛ by 4⅞ inches. 222 illustrations. Published by John Wiley & Sons, New York City. Price, $1.25 net.

This book was written with the view of providing a text on the subject of direct-current electricity for the use of wire-men and others employed in the electrical trades. The subject of electricity is one of which many mechanical men require a certain amount of knowledge, and the present text should be well suited to meet the requirements of such readers.

Engineers Directory for 1913. 1552 pages, 6¾ by 4⅜ inches. Published by the Crawford Publishing Co., 537 South Dearborn St., Chicago, Ill. Price, $5.

This book is a directory of the plumbing, heating, lighting, power-plant and mill supply industries of the United States. It is intended for the use of jobbers, manufacturers and retailers of supplies used in these industries, and should be of considerable value in promoting sales in these trades and in other work which requires the use of a directory of this kind.

Handbook of English for Engineers. By Wilbur Owen Sypherd. 314 pages, 6¾ by 4⅝ inches. Published by Scott Foresman & Co., Chicago and New York. Price, $1.50.

It is quite generally recognized that the technical schools fail to turn out men who are competent to write satisfactory reports on engineering work. The present text has been developed with the view of affording a textbook on the subject of English especially adapted for use in technical schools. It is also well suited for the use of engineers who wish to improve their style of writing by home study.

Oxy-acetylene Torch Practice. By J. F. Springer. 140 pages, 5 by 7¼ inches. Illustrated. Published by the Richardson Press, 56 Leonard St., New York City. Price $2.50.

The work treats of ordinary welding; preheating for oxy-acetylene welding; restoration of steel; welding copper and aluminum; sheet metal welding; welding tanks, retorts, etc.; welding as a calking process; boiler work; machine welding; metal cutting with the oxy-acetylene flame, oxy-acetylene cutting machines, etc. Oxy-acetylene welding and cutting processes have rapidly acquired commercial importance, and this book should be welcome as a practical treatise on a comparatively new art.

Tafelbätter aus den Figuren der *Zeitschrift des Vereines deutscher Ingenieure*. (Reprinted plates from the Journal of the Society of German Engineers.) Eight plates, 12½ by 19 inches. Heavy paper cover. Published by Verein Deutscher Ingenieure, Charlottenstr. 43, Berlin N. W., Germany. Price, to members of the Society of German Engineers, postpaid, 45 cents; to others, 60 cents.

The *Zeitschrift des Vereines deutscher Ingenieure*—the journal of the Society of German Engineers contains a great many complete assembly and detail drawings of machines built and in successful operation. In response to many requests reproductions of the drawings pertaining to certain special subjects have been reprinted in convenient form so that designers and others can refer to them more easily than by consulting the rather bulky volumes of the journal itself. For this reason, the society has begun to publish a series of collections of plates. The size of the plates is about 12½ by 19 inches, but they are so folded that they can be carried in the pocket, the width when folded being only 5 inches. These reproductions of noteworthy designs should be of particular value to designers. The first two collections in the series relate to locomotives and railway cars, and hoisting and conveying machinery.

Book of Standards. 559 pages, 4 by 6½ inches. Published by the National Tube Co., Pittsburg, Pa. Price, $2.

The 1913 edition of the Book of Standards which was briefly noted in the February number deserves a more extended listing of its contents. The book has been four years in preparation and contains a large amount of original data derived from thousands of experiments made by the company. It is strictly a pipe handbook and should be valuable to the trade. A brief description is given of welding tubes and pipe; methods of manufacture and characteristics; following which are tables on standard black and galvanized pipe; line pipe extra strong and galvanized; standard Boston casing; inserted joint casing; Boston casing—Pacific couplings; California diamond BX casing; oil well tubing; California special external upset tubing; California drive pipe; bedstead tubing; flush joint tubing; Allison vanishing thread tubing; special rotary pipe; air line pipe; locomotive boiler tubes; standard boiler tubes and flues; Matheson joint pipe; Converse lock-joint pipe; Kimberley joint pipe; square pipe; weights of piping per foot; properties of pipe; hydro-static test pressures; illustrations of various forms of pipe joints; standard specifications; locomotive boiler tube tables; wrought-iron pipe bends; valves and fittings; tubular electric line poles; wrought pipe nipples, black and galvanized; pipe band railings; Shelby seamless cylinders; seamless steel specialties; properties of Shelby seamless tubing; strength of tubes; pipes and cylinders under internal fluid pressure; collapsing pressures; pipe columns; mechanical properties of solid and tubular beams; flow of water in pipes with table of loss of head by friction; measurement of flowing water; water power; contents of pipes and cylinders; physical properties of gases; flow of gas in pipes under low and high pressures; properties of saturated steam and superheated steam; flow of steam; properties of air; flow of compressed air, etc. The book is printed on Canterbury bible paper, and while containing 559 pages is only ⅜ inch thick. It is adapted to be carried in the pocket and is completed with a copious index, making reference to the data easy. A valuable feature of the book is a glossary of terms used in the pipe fitting trade.

NEW CATALOGUES AND CIRCULARS

W. E. Caldwell Co., Louisville, Ky. Catalogue No. 1 on friction clutches.

L. S. Starrett Co., Athol, Mass. Circular of Starrett vernier calipers and directions for reading the vernier.

Bristol Co., Waterbury, Conn. Catalogue No. 1200 on Bristol class 11 recording thermometers and accessories.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 124 on pneumatic riveting, chipping, calking and stone hammers.

Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Circular of 13-inch double back-geared lathe with quick change gear attachment.

Potter & Johnston Machine Co., Pawtucket, R. I. Catalogue No. 21 on manufacturing automatic chucking machines 5-A and 6-A models.

Bristol Co., Waterbury, Conn. Condensed catalogue No. 160 of Bristol recording instruments for pressure, temperature, electricity, speed, time, etc.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Pamphlet on "Cling-Surface" treatment for transmisison rope, illustrating installations on which "Cling-Surface" has been used with satisfaction.

Standard Electric Tool Co., Cincinnati Ohio. Bulletins D-8 and D-9 on "Standard" high-power direct current portable electric drills and "Standard" high-power two- and three-phase alternating current portable electric drills, respectively.

Hermann Boker & Co., 101 Duane St., New York City. Catalogue No. 1 on "Novo" high-speed steel, special chrome stetel, steel balls, superior self-hardening steel, special turning and finishing steels, N. C. S. steel, B. N. D. steel, composite steel, German process sheets, oil furnaces, etc. Instructions for hardening "Novo" steel and illustrations of the forging of a lathe tool are included.

Buffum Tool Co., Louisiana, Mo. General catalogue No. 2 on tools, comprising chisels; punches; hammers; handles; carpenters' tools; engineers', machinists,' automobile and motor boat tools; screw drivers; wrenches, pincers, pliers and eelctricians' tools; boilermakers' and structural ironworkers' tools; blacksmith and farriers' tools; plumbers' tools; bricklayers,' plasterers' and stone masons' tools; cement workers' tools; tinners' tools; warehouseman's tools; butcher and packing house tools; garden, farm and lawn tools; household tools and appliances, etc.

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SECTION MODULI OF RECTANGLES—I

D = Depth of Rectangle in Inches

D	Width of Rectangle in Inches = W												
	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
2	0.17	0.21	0.25	0.29	0.33	0.37	0.42	0.46	0.50	0.54	0.58	0.63	0.67
2½	0.26	0.33	0.39	0.45	0.52	0.58	0.65	0.71	0.78	0.84	0.91	0.97	1.04
3	0.38	0.47	0.56	0.65	0.75	0.84	0.94	1.03	1.13	1.22	1.31	1.41	1.50
3½	0.51	0.64	0.76	0.89	1.02	1.15	1.28	1.40	1.53	1.66	1.79	1.92	2.04
4	0.66	0.83	1.00	1.16	1.33	1.50	1.67	1.83	2.00	2.17	2.34	2.50	2.67
4½	0.84	1.05	1.27	1.48	1.69	1.90	2.11	2.32	2.53	2.74	2.95	3.16	3.38
5	1.04	1.30	1.56	1.82	2.08	2.34	2.60	2.86	3.13	3.39	3.65	3.91	4.17
5½	1.26	1.57	1.89	2.20	2.52	2.83	3.15	3.46	3.78	4.10	4.41	4.73	5.05
6	1.5	1.87	2.25	2.62	3.00	3.37	3.75	4.12	4.50	4.88	5.25	5.63	6.00
6½	1.76	2.20	2.64	3.08	3.52	3.96	4.40	4.84	5.28	5.72	6.16	6.60	7.04
7	2.04	2.55	3.06	3.57	4.08	4.59	5.11	5.62	6.13	6.64	7.15	7.66	8.17
7½	2.34	2.93	3.52	4.10	4.69	5.27	5.86	6.45	7.03	7.62	8.20	8.79	9.38
8	2.66	3.33	4.00	4.66	5.33	6.00	6.67	7.33	8.00	8.67	9.34	10.00	10.67
8½	3.01	3.76	4.52	5.27	6.02	6.77	7.53	8.28	9.04	9.79	10.54	11.29	12.04
9	3.37	4.22	5.06	5.90	6.75	7.59	8.44	9.28	10.12	10.97	11.81	12.66	13.50
9½	3.76	4.70	5.64	6.58	7.52	8.46	9.40	10.34	11.28	12.22	13.16	14.10	15.04
10	4.17	5.21	6.25	7.29	8.33	9.38	10.42	11.46	12.50	13.54	14.58	15.62	16.67
10½	4.59	5.74	6.89	8.04	9.19	10.33	11.48	12.63	13.77	14.92	16.07	17.22	18.37
11	5.04	6.30	7.56	8.82	10.08	11.34	12.60	13.86	15.12	16.38	17.64	18.90	20.16
11½	5.51	6.88	8.26	9.64	11.02	12.39	13.77	15.15	16.53	17.91	19.28	20.66	22.04
12	6.00	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00
12½	6.51	8.14	9.76	11.39	13.02	14.65	16.27	17.90	19.52	21.15	22.78	24.41	26.04
13	7.04	8.80	10.56	12.32	14.08	15.84	17.60	19.36	21.12	22.88	24.64	26.40	28.16
13½	7.59	9.49	11.39	13.29	15.19	17.09	18.99	20.89	22.79	24.69	26.59	28.49	30.39
14	8.17	10.21	12.25	14.29	16.33	18.37	20.41	22.46	24.50	26.54	28.58	30.62	32.66
14½	8.76	10.95	13.14	15.33	17.52	19.71	21.90	24.09	26.28	28.47	30.66	32.85	35.04

Contributed by Karl E. Barrett

No. 164, Data Sheet, MACHINERY, March, 1913

SECTION MODULI OF RECTANGLES—II

D = Depth of Rectangle in Inches

D	Width of Rectangle in Inches = W															
	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16	1 7/8	1 15/16	2
2	0.71	0.75	0.79	0.83	0.87	0.92	0.96	1.00	1.04	1.08	1.13	1.17	1.21	1.25	1.29	1.33
2½	1.10	1.17	1.24	1.30	1.37	1.43	1.50	1.56	1.63	1.69	1.76	1.82	1.89	1.95	2.02	2.08
3	1.59	1.69	1.78	1.87	1.97	2.06	2.15	2.25	2.34	2.44	2.54	2.63	2.72	2.82	2.91	3.00
3½	2.17	2.30	2.42	2.55	2.67	2.80	2.93	3.06	3.19	3.32	3.44	3.57	3.69	3.82	3.95	4.08
4	2.83	3.00	3.17	3.33	3.49	3.66	3.83	4.00	4.16	4.33	4.50	4.66	4.83	5.00	5.16	5.33
4½	3.59	3.80	4.01	4.22	4.43	4.64	4.85	5.06	5.27	5.48	5.69	5.90	6.11	6.32	6.53	6.75
5	4.43	4.69	4.95	5.21	5.47	5.73	5.99	6.25	6.51	6.77	7.03	7.29	7.55	7.81	8.07	8.33
5½	5.36	5.67	5.99	6.30	6.62	6.93	7.25	7.56	7.88	8.19	8.51	8.83	9.14	9.45	9.76	10.08
6	6.37	6.75	7.13	7.50	7.88	8.25	8.63	9.00	9.38	9.75	10.12	10.50	10.88	11.26	11.63	12.00
6½	7.48	7.92	8.36	8.80	9.24	9.68	10.12	10.56	11.00	11.44	11.88	12.32	12.76	13.20	13.64	14.08
7	8.67	9.18	9.70	10.21	10.72	11.23	11.74	12.25	12.76	13.27	13.79	14.30	14.81	15.32	15.83	16.34
7½	9.96	10.55	11.14	11.72	12.30	12.88	13.47	14.06	14.64	15.23	15.82	16.41	16.99	17.58	18.17	18.75
8	11.33	12.00	12.67	13.34	14.00	14.67	15.34	16.00	16.67	17.34	18.00	18.67	19.34	20.00	20.67	21.34
8½	12.79	13.54	14.29	15.04	15.80	16.55	17.30	18.06	18.82	19.57	20.32	21.08	21.83	22.58	23.33	24.08
9	14.34	15.18	16.02	16.87	17.71	18.55	19.40	20.25	21.10	21.94	22.79	23.63	24.47	25.31	26.15	27.00
9½	15.98	16.92	17.86	18.80	19.74	20.68	21.62	22.56	23.50	24.44	25.38	26.32	27.26	28.20	29.14	30.08
10	17.71	18.75	19.79	20.83	21.87	22.91	23.95	25.00	26.04	27.08	28.12	29.16	30.20	31.24	32.28	33.33
10½	19.52	20.67	21.82	22.97	24.12	25.27	26.42	27.56	28.71	29.86	31.01	32.16	33.31	34.45	35.60	36.75
11	21.43	22.69	23.95	25.21	26.47	27.73	28.99	30.25	31.51	32.77	34.03	35.29	36.55	37.81	39.07	40.33
11½	23.42	24.80	26.18	27.55	28.93	30.31	31.69	33.06	34.44	35.82	37.20	38.57	39.95	41.33	42.70	44.08
12	25.50	27.00	28.50	30.00	31.50	33.00	34.50	36.00	37.50	39.00	40.50	42.00	43.50	45.00	46.50	48.00
12½	27.67	29.30	30.93	32.55	34.18	35.80	37.43	39.06	40.69	42.32	43.95	45.57	47.20	48.83	50.46	52.08
13	29.93	31.69	33.45	35.21	36.97	38.73	40.49	42.25	44.01	45.77	47.53	49.29	51.05	52.81	54.57	56.33
13½	32.27	34.17	36.07	37.97	39.87	41.77	43.67	45.56	47.46	49.36	51.26	53.16	55.06	56.96	58.86	60.75
14	34.71	36.75	38.79	40.83	42.87	44.91	46.95	49.00	51.04	53.08	55.12	57.17	59.21	61.25	63.29	65.33
14½	37.23	39.42	41.61	43.80	45.99	48.18	50.37	52.56	54.75	56.94	59.13	61.32	63.51	65.70	67.89	70.08

Contributed by Karl E. Barrett

No. 164, Data Sheet, MACHINERY, March, 1913

SECTION MODULI OF RECTANGLES—III

D	Width of Rectangle in Inches — W															
D = Depth of Rectangle in Inches	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8	2 7/16	2 1/2	2 9/16	2 5/8	2 11/16	2 3/4	2 13/16	2 7/8	2 15/16	3
2	1.38	1.42	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.75	1.79	1.83	1.87	1.91	1.95	2.00
2½	2.15	2.21	2.28	2.34	2.41	2.47	2.53	2.60	2.67	2.73	2.80	2.86	2.93	2.99	3.06	3.13
3	3.09	3.19	3.28	3.37	3.46	3.56	3.65	3.75	3.84	3.93	4.03	4.12	4.22	4.32	4.41	4.50
3½	4.21	4.33	4.46	4.59	4.71	4.84	4.97	5.10	5.22	5.35	5.48	5.61	5.74	5.87	6.00	6.13
4	5.50	5.67	5.84	6.00	6.16	6.33	6.50	6.66	6.83	7.00	7.16	7.33	7.50	7.66	7.83	8.00
4½	6.96	7.17	7.38	7.59	7.80	8.01	8.22	8.44	8.65	8.86	9.07	9.28	9.49	9.70	9.91	10.13
5	8.59	8.86	9.12	9.38	9.64	9.90	10.16	10.42	10.68	10.94	11.20	11.46	11.72	11.98	12.24	12.50
5½	10.40	10.72	11.03	11.34	11.66	11.97	12.28	12.60	12.92	13.23	13.54	13.85	14.17	14.49	14.81	15.13
6	12.38	12.75	13.13	13.50	13.87	14.25	14.62	15.00	15.37	15.74	16.12	16.50	16.87	17.24	17.62	18.00
6½	14.52	14.96	15.40	15.84	16.28	16.72	17.16	17.60	18.04	18.48	18.92	19.36	19.80	20.24	20.68	21.13
7	16.85	17.36	17.87	18.38	18.89	19.40	19.91	20.42	20.93	21.44	21.95	22.46	22.97	23.48	23.99	24.50
7½	19.34	19.93	20.51	21.10	21.68	22.26	22.84	23.43	24.02	24.60	25.19	25.78	26.37	26.96	27.54	28.13
8	22.00	22.67	23.33	24.00	24.66	25.33	26.00	26.67	27.34	28.01	28.67	29.33	30.00	30.67	31.33	32.00
8½	24.83	25.58	26.33	27.09	27.85	28.60	29.35	30.10	30.85	31.60	82.35	33.11	33.86	34.62	35.38	36.13
9	27.84	28.68	29.53	30.38	31.22	32.06	32.91	33.75	34.60	35.45	36.29	37.13	37.98	38.82	39.66	40.50
9½	31.02	31.96	32.90	33.84	34.78	35.72	36.66	37.60	38.54	39.48	40.42	41.36	42.30	43.24	44.18	45.13
10	34.37	35.41	36.45	37.50	38.54	39.58	40.62	41.67	42.71	43.75	44.79	45.83	46.87	47.92	48.96	50.00
10½	37.90	39.05	40.20	41.34	42.49	43.64	44.79	45.94	47.09	48.24	49.38	50.53	51.68	52.83	53.98	55.13
11	41.59	42.85	44.11	45.37	46.63	47.90	49.15	50.41	51.67	52.93	54.20	55.46	56.72	57.98	59.24	60.50
11½	45.46	46.84	48.21	49.59	50.97	52.35	53.73	55.10	56.48	57.86	59.24	60.62	61.99	63.37	64.75	66.13
12	49.50	51.00	52.50	54.00	55.50	57.00	58.50	60.00	61.50	63.00	64.50	66.00	67.50	69.00	70.50	72.00
12½	53.71	55.34	56.97	58.59	60.22	61.85	63.48	65.10	66.73	68.36	69.99	71.61	73.24	74.87	76.50	78.13
13	58.09	59.85	61.61	63.38	65.14	66.90	68.66	70.42	72.18	73.94	75.70	77.46	79.22	80.98	82.74	84.50
13½	62.65	64.55	66.45	68.35	70.25	72.15	74.05	75.94	77.83	79.73	81.63	83.53	85.43	87.33	89.23	91.13
14	67.38	69.42	71.46	73.50	75.54	77.58	79.62	81.66	83.71	85.75	87.79	89.83	91.88	93.92	95.96	98.00
14½	72.27	74.46	76.65	78.84	81.03	83.22	85.41	87.60	89.79	91.98	94.17	96.36	98.55	100.74	102.93	105.13

Contributed by Karl E. Barrett

No. 164, Data Sheet, MACHINERY, March, 1913

SECTION MODULI OF RECTANGLES—IV

D	Width of Rectangle in Inches — W															
D = Depth of Rectangle in Inches	3 1/16	3 1/8	3 3/16	3 1/4	3 5/16	3 3/8	3 7/16	3 1/2	3 9/16	3 5/8	3 11/16	3 3/4	3 13/16	3 7/8	3 15/16	4
2	2.04	2.08	2.12	2.17	2.21	2.25	2.29	2.33	2.37	2.41	2.46	2.50	2.54	2.58	2.63	2.67
2½	3.19	3.26	3.32	3.39	3.45	3.52	3.58	3.65	3.71	3.78	3.84	3.91	3.97	4.04	4.10	4.17
3	4.60	4.69	4.78	4.87	4.96	5.06	5.15	5.25	5.35	5.44	5.53	5.63	5.72	5.81	5.90	6.00
3½	6.26	6.38	6.51	6.63	6.76	6.89	7.02	7.15	7.27	7.40	7.53	7.66	7.78	7.91	8.04	8.17
4	8.17	8.33	8.50	8.67	8.83	9.00	9.17	9.33	9.50	9.67	9.83	10.00	10.16	10.33	10.50	10.67
4½	10.34	10.55	10.76	10.97	11.18	11.39	11.60	11.81	12.02	12.23	12.45	12.66	12.87	13.08	13.29	13.50
5	12.76	13.02	13.28	13.54	13.80	14.06	14.32	14.58	14.84	15.10	15.36	15.63	15.89	16.15	16.41	16.67
5½	15.44	15.75	16.07	16.39	16.70	17.01	17.32	17.63	17.95	18.27	18.59	18.91	19.22	19.54	19.85	20.17
6	18.38	18.75	19.13	19.50	19.88	20.25	20.63	21.00	21.37	21.75	22.13	22.50	22.87	23.25	23.62	24.00
6½	21.57	22.01	22.45	22.89	23.33	23.77	24.21	24.65	25.09	25.53	25.97	26.41	26.85	27.29	27.73	28.17
7	25.01	25.52	26.03	26.54	27.05	27.56	28.07	28.58	29.09	29.60	30.11	30.63	31.14	31.65	32.16	32.67
7½	28.71	29.30	29.88	30.47	31.05	31.64	82.22	32.81	33.39	33.98	34.57	35.15	35.74	36.32	86.91	37.50
8	32.67	33.33	34.00	34.67	35.33	36.00	36.67	37.33	38.00	38.67	39.33	40.00	40.67	41.33	42.00	42.67
8½	36.87	37.62	38.37	39.12	39.87	40.63	41.38	42.14	42.90	43.65	44.40	45.16	45.91	46.66	47.41	48.17
9	41.34	42.18	43.02	43.87	44.72	45.57	46.41	47.25	48.09	48.93	49.78	50.63	51.47	52.31	53.15	54.00
9½	46.06	47.00	47.94	48.88	49.82	50.76	51.70	52.65	53.59	54.53	55.47	56.41	57.35	58.30	59.25	60.20
10	51.04	52.08	53.12	54.16	55.21	56.25	57.29	58.33	59.37	60.41	61.46	62.50	63.54	64.58	65.62	66.67
10½	56.27	57.42	58.57	59.72	60.87	62.01	63.16	64.31	65.46	66.61	67.76	68.91	70.05	71.20	72.85	73.50
11	61.76	63.02	64.28	65.54	66.80	68.06	69.32	70.58	71.84	73.10	74.36	75.63	76.89	78.15	79.41	80.67
11½	67.50	68.88	70.26	71.64	73.02	74.40	75.78	77.15	78.52	79.90	81.28	82.66	84.03	85.41	86.79	88.17
12	73.50	75.00	76.50	78.00	79.50	81.00	82.50	84.00	85.50	87.00	88.50	90.00	91.50	93.00	94.50	96.00
12½	79.75	81.38	83.00	84.63	86.26	87.89	89.52	91.15	92.78	94.40	96.03	97.66	99.29	100.92	102.55	104.17
13	86.26	88.02	89.78	91.54	93.30	95.06	96.82	98.58	100.34	102.10	103.86	105.63	107.39	109.15	110.91	112.67
13½	93.02	94.92	96.82	98.72	100.62	102.52	104.42	106.31	108.21	110.11	112.01	113.91	115.81	117.71	119.61	121.50
14	100.04	102.08	104.12	106.16	108.20	110.25	112.29	114.33	116.37	118.41	120.45	122.50	124.54	126.58	128.62	130.67
14½	107.32	109.51	111.70	113.89	116.08	118.27	120.46	122.65	124.84	127.03	129.22	131.41	133.60	135.79	137.98	140.17

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THE PANAMA CANAL

SOME INTERESTING MECHANICAL FEATURES

BY FRANKLIN D. JONES*

THE Panama Canal is a rather difficult subject to treat, because there are so many wonderful features that it is hard to know where to begin. We have been asked a number of times: "What is the most impressive feature of the Canal?" Well, that depends. One man, who lives in the mosquito belt of New Jersey, contended, after visiting Panama, that the construction of the canal was not comparable with the work of extermination wrought by the sanitary engineers. Another pilgrim to the isthmus seemed to almost overlook the canal in his enthusiasm for the "large, airy and comfortable" Y. M. C. A. buildings of the Canal Zone. Then there was the civil engineer who exhausted his stock of adjectives in praise of the dam at Gatun, and no doubt a mechanical or electrical engineer would consider the locks the greatest feature. So the "impressive features" are almost as numerous as the different classes of people who see the canal. Surely, the locks with their ingenious operating and controlling mechanism are not far from first place; but, whatever the verdict, we shall reluctantly pass by the dams and cuts, owing to the limited space, and confine our attention principally to describing some of the more interesting mechanical features. In order to show clearly the relation between the various details that will be referred to, a brief description of the canal will be given first, even at the risk of repeating what may be known to many readers of MACHINERY. Perhaps the general arrangement and operation can best be understood by taking an imaginary trip through the canal, assuming that it has been completed and is ready for business.

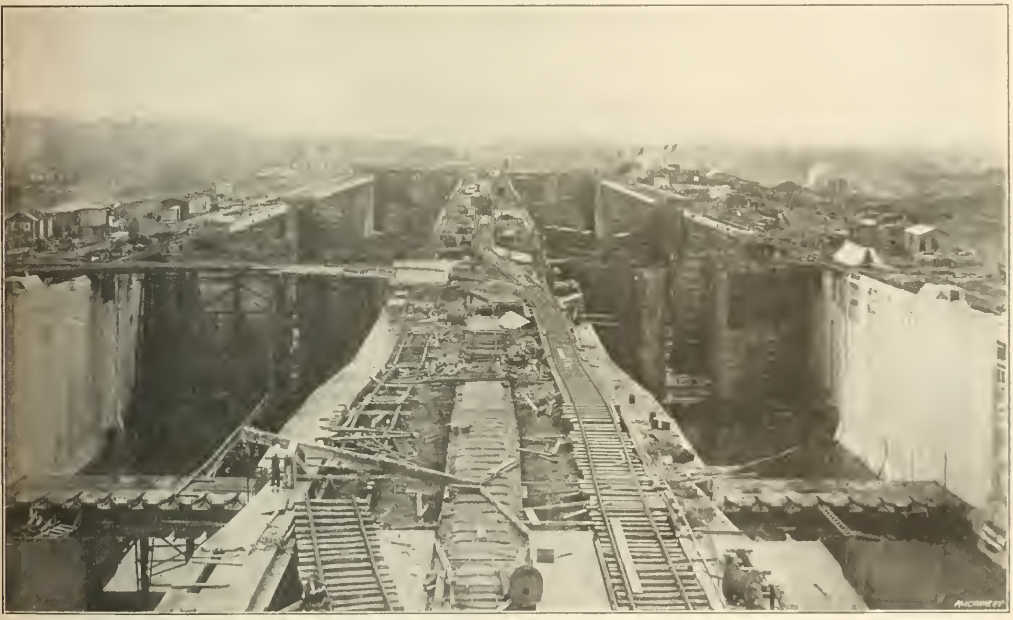

Fig. 1. General View of Upper Locks at Gatun

A Trip through the Canal

In passing from the Caribbean Sea to the Pacific, a ship first enters a sea level channel which extends for a distance of 7 miles to the foot of the locks at Gatun. Here the ship passes through a series or flight of three twin locks (see Fig. 1) and is lifted 85 feet to the level of Gatun Lake. It first enters the forebay of the locks and ties up to a central wall which extends some distance beyond the side walls, to serve as a wharf or mooring wall. The vessel waits here until the electric locomotives, which are to be used for towing all ships through the locks, come down and make fast their hawsers, after which it is towed into the lower lock chamber. The gates are then closed and enough water admitted to raise the vessel one third the total height (or 28⅓ feet) and to the level of the water in the middle lock which is then at low level. The vessel next passes into the middle lock where it is raised to the low level of the upper lock, which it finally enters and is elevated to the level of Gatun Lake. As is generally known, Gatun Lake was formed by building the large Gatun dam, thus impounding the waters of the Chagres River and its tributaries. (See map of the Canal Zone, Fig. 2.) When passing through this lake, the ship may run full speed for a distance of approximately 21 miles or as far as Culebra cut. The length of Culebra cut, which is really an arm of the lake, is nine miles, and after passing it at reduced speed, the vessel enters a lock at Pedro Miguel and is lowered 30⅓ feet (from mean tide) to the level of a small artificial lake. This lake, which has an elevation of 54⅔ feet, is then transversed for a distance of 1½ mile to Miraflores. Here the ship enters two locks in a series, is lowered to sea level, and passes out to the Pacific through a channel about eight miles long. The length of the canal from shore-line to shore-line is about 40 miles, and the entire length from deep water in the Caribbean to deep water in the Pacific, is about 50 miles. The estimated time required for the passage of a medium-sized ship through the entire canal, is from 9½ to 10 hours, and for large vessels, from 10½ to 11 hours, the time depending somewhat upon the size of the ship and its speed. The general direction of the canal is from northwest to southeast, as shown by the map, and not from east to west, as is often supposed. The Pacific entrance near the city of Panama, is about 22½ miles *east* of the Atlantic entrance near Colon.

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Arrangement of the Locks

All of the locks are arranged in pairs (as shown by the general view, Fig. 1) so that vessels can pass through in opposite directions at the same time, one side being used for ships bound for the Pacific and the other side for those going towards the Atlantic. The general construction of these twin locks is shown by the cross-section, Fig. 3. As will be seen, the two lock chambers are separated by a massive central wall. These chambers will be filled and emptied through large culverts located in the side walls at *G* and in the center wall at *D*. These main culverts extend the full length of the lock and connect with the chambers by means of lateral culverts *H* having circular openings *F* through the floor of the lock. The lateral culverts from the center wall alternate with those from the side walls. This arrangement is for distributing the water evenly over the entire area of the lock floor, thus reducing the disturbance when filling or emptying the lock. The main feed culverts are 18 feet in diameter and have an area of 254 square feet, which is about the area of the Hudson River tunnels of the Pennsylvania R. R.

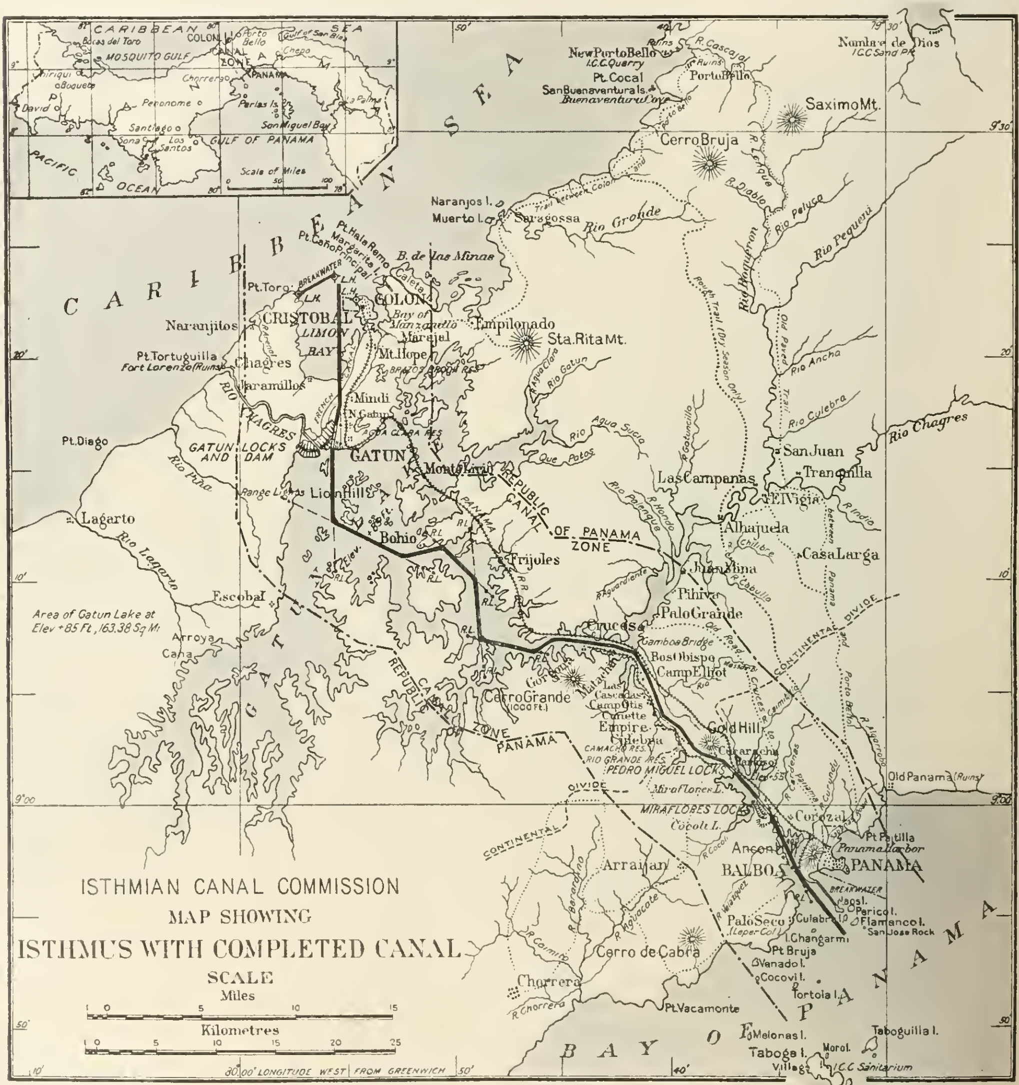


Fig. 2. Map of the Canal Zone. The General Direction of the Canal is Northwest and Southeast, the Pacific End being 22 1-2 miles East of the Atlantic End

The flow of water in and out of the main culverts is controlled by large gate valves located near the gates at the ends of each lock chamber. The center wall culvert *D* is illustrated in Fig. 5, which also shows the chamber for one of the gate valves. The lateral culverts leading from the central wall are all controlled independently by cylindrical valves at *E*, Fig. 3, which makes it possible to feed either chamber from the central culvert. For example, to feed to the right, all the cylindrical valves on the left side would be closed, whereas to feed to the chamber on the left, the valves on the opposite side would be closed. This independent control also makes it possible to transfer the water from one side to the other, by simply opening the cylindrical valves on both sides, which will be done to effect a saving of water, as will be explained later.

In order to fill a lock for elevating a ship, the gate valves at the lower end of the main culverts are closed and those at the upper end are opened. The water then flows from the upper level into the main and lateral culverts and up into the chamber through the holes in the floor, the flow continuing until the water level coincides with that of the lock above. To empty the lock, the order of operation is simply reversed, the valves at the upper end being closed and those at the lower end being opened. The water then flows out through the lateral and main culverts into the lower pool or level. The average time required for filling and emptying a lock chamber will be about fifteen minutes, and the time required for passing a vessel through the six locks of the canal is estimated at three hours. Of this time, 1½ hour will be required at the Gatun and about the same time for the three locks on the Pacific side. It is estimated that the minimum interval between consecutive ships at any lock, will be one hour, giving a maximum of 24 lockages per day, in each direction.

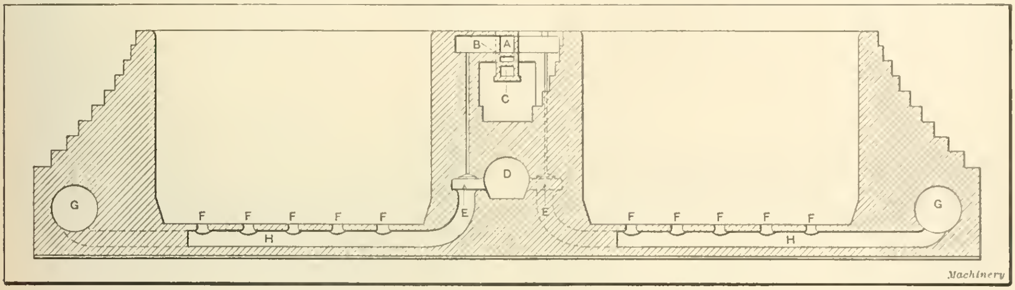


Fig. 3. Cross-section showing Culverts for filling and emptying the Locks

The amount of water that can be saved by transferring it from the chambers of one flight to those on the opposite side, will depend somewhat upon circumstances. It is not probable that a complete saving can be effected, as this would require that at each lockage, one-half the water in the upper lock of a flight be transferred to its twin chamber. This, however, will be possible at the end of every up lockage, when the locks in the downward flight are left empty after use, and those in the upward flight are left full, for when an up-bound ship leaves the upper lock, one-half the water can be transferred to the twin chamber of the downward flight. The up-bound lock would then be left at low level for the next ship, and the downward lock would be left at high level for lowering a ship. While this economy in the use of water is possible, there will be no danger of an inadequate water supply. During eight or nine months of the year, Gatun Lake will be kept full by prevailing rains, so that it will only be necessary to store a surplus for the dry season, which lasts only three or four months. During the rainy season, the lake will be kept at an elevation of 87 feet above mean sea level, at which time the minimum channel depth will be 47 feet. As 40 feet is ample for navigation, there would be a surplus of 7 feet for the dry season. After making allowances for evaporation, leakage and use of water at the hydro-electric power plant, this surplus is greater than would be required, even though the maximum number of ships passed through the canal every day. The normal area of Gatun will be 164 square miles.

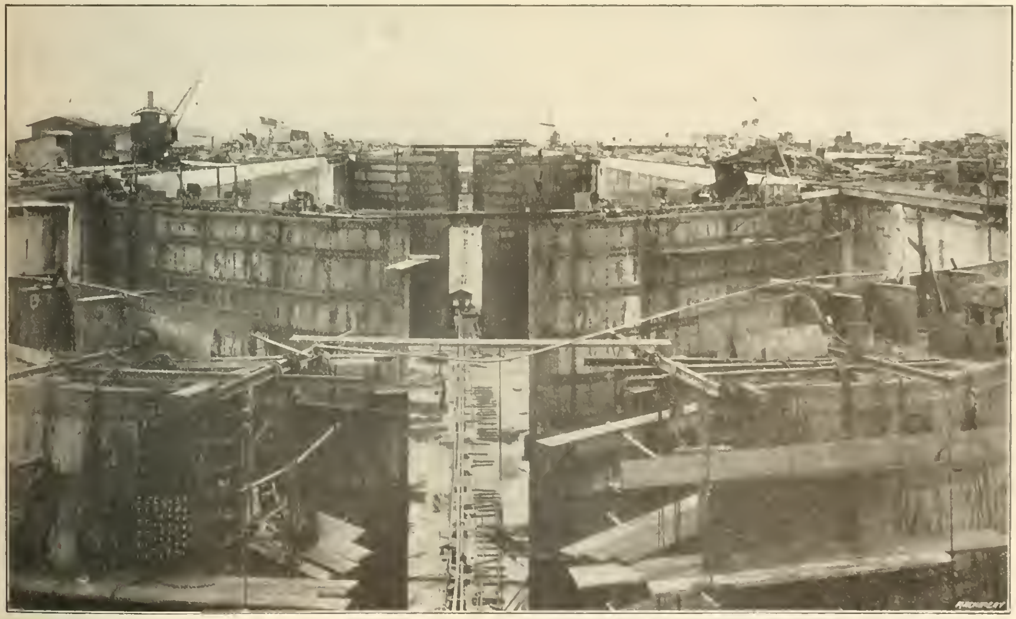


Fig. 4 View of Lock Chamber, showing Guard and Main Gates in Foreground, Intermediate Gate, and Lower Guard Gate in the Distance

Some idea of the size of the locks can be obtained from the following dimensions: Each chamber has a usable length of 1000 feet and a width of 110 feet. The side walls are about 50 feet wide at the floor and from a point 24½ feet above the floor, they are stepped inward to a width of 8 feet at the top. The central wall is 60 feet wide and about 81 feet high. As the sectional view, Fig. 3, shows, this central wall is divided into passages or galleries at the top. The upper passageway *A* is to give access to the valve- and gate-operating mechanisms which are installed in this central wall. The middle gallery *B* contains the electric wires for supplying power to the various motors, and the lower gallery *C* is for drainage.

The Lock Gates

The lock gates are built-up steel structures which have a width of 65 feet, a thickness of 7 feet, and a height varying from 47 to 82 feet. The upper chamber of a flight and the outer end of the lower chamber, are equipped with two sets of gates instead of a single pair, an auxiliary guard gate having been installed to protect the main gate from being rammed, in case a vessel does not stop in time. In addition to the gates at each end, there are intermediate gates which divide the 1000-foot locks into chambers 600 and 400 feet long, in order to save time and economize in the use of water when ships are passing through that are not large enough to require the entire lock. Fig. 4, which is a view of one of the upper chambers at Gatun, shows the guard and main gates in the foreground, the intermediate gate 400 feet away, and the lower guard gate in the distance. Each of the half gates or "leaves," as they are called, weighs from 390 to 730 tons, and most of this weight is supported by an air chamber formed in the lower half and sub-divided by three water-tight bulkheads. By supporting the gates in this way, the bearings upon which they swing, are relieved of excessive stresses. The upper part of the gate is arranged with openings on the up-stream side, through which the water can flow in or out of the gate at the same time that it enters or recedes from the lock. With this arrangement, the weight of the gate is automatically increased as the water rises to a higher level, thus counteracting the increased lifting effect as the air chamber is submerged to a greater depth. Each gate swings on a hemispherical pintle which is secured to the concrete floor near the wall, and connection is made with an anchorage at the top by a vertical pin which forms a hinge.

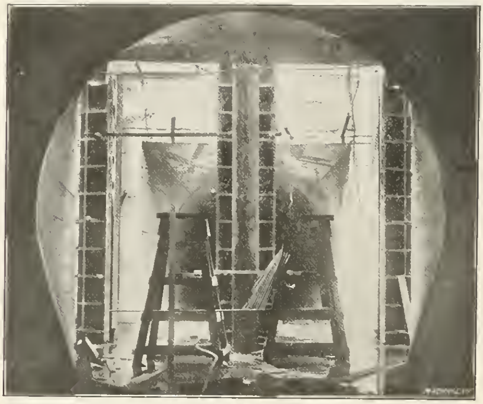


Fig. 5. Center Wall Feed Culvert, showing Chamber for Gate Valve

Gate Operating and Locking Mechanism

The mechanism for opening and closing these massive gates is shown in Figs. 6 and 7, the latter being a diagrammatical plan view. The power is obtained from a 50 H. P. motor *A* which drives through spur and bevel gears, a pinion meshing with the large crank-gear *B*, which is connected to the gate leaf by a rod or pitman *C*. The gear *B* rotates through an arc of 197 degrees, when swinging the gate from the open to the closed position, or *vice versa*. When the gate is open or closed, the crank is approximately on the dead center; hence, a powerful but slow motion is obtained at both extremes of the gate's travel, which is desirable because the resistance to motion is greatest at these points. This increased resistance is caused by the water which, at the point of opening or closing, has a smaller space through which to escape around the edges of the leaf, and therefore tends to pile up and retard the movement of the gate. The connecting-rod or pitman *C*, instead of being rigid, has a spring buffer or shock absorber at *D* that gives a certain amount of flexibility, which is advantageous owing to the inertia of the gates, as it tends to eliminate shock and jar on the mechanism when starting. Moreover, when one leaf comes against the other, the fine adjustment that would be necessary with a rigid connection, is obviated by having a pitman that will yield slightly. When the gates are opened, they enter pockets or depressions formed in the walls. During a test of one of the gate-moving machines, a gate was swung "in the dry" in one minute and 48 seconds, which is 12 seconds less than the estimated time.

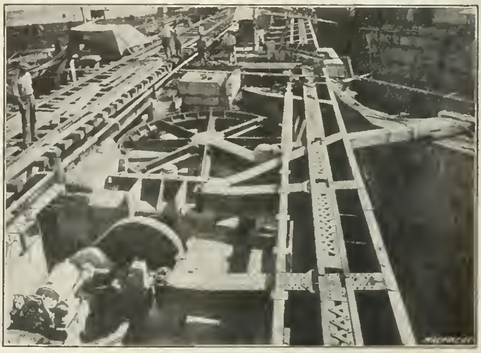


Fig. 6. Mechanism for opening and closing a Lock Gate

In Fig. 8 is shown a locking device which has been designed to hold the gates securely against wave action and, at the same time, force the gates in order to form a perfect miter or joint between the two leaves. A crosshead is mounted at the top of one of the miter posts and it is moved horizontally by screw *B*, which, in turn, is rotated by motor *A* through gears *D*. As the crosshead moves outward, two jaws *E* which are connected to the crosshead by toggle links, are forced to close around a pin, which is so located on the opposite gate that when it is firmly held by jaws *E*, the two gate-sections are properly joined. This is a new device and is to be carefully tested before being extensively applied.

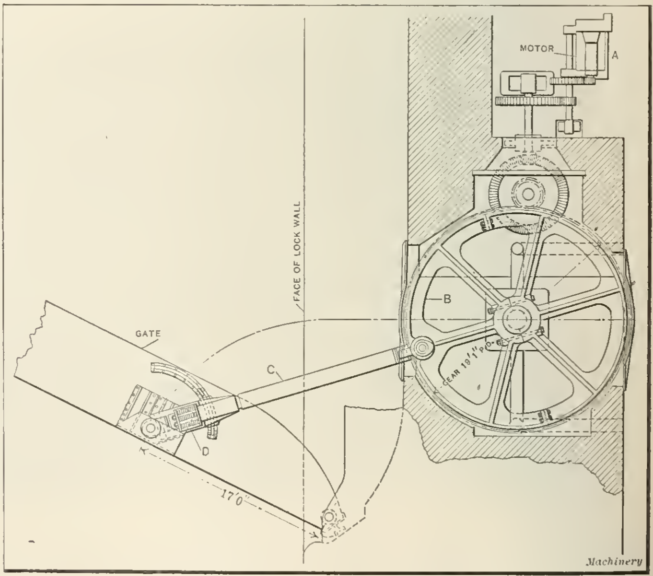


Fig. 7. Plan View of Gate Operating Mechanism

The Protective Chains for the Gates

In addition to the auxiliary or guard gates previously referred to, the locks are equipped with large protective fender chains which are stretched across the chambers some distance in front of the gates. In case a vessel entering a lock should continue to move in toward the gates, instead of stopping in the proper position, it would come against one of these chains instead of ramming the guard gate of the lock, so that a double protection is provided for the main gates. These chains, instead of being rigidly attached are connected with a system of hydraulic cylinders located in both side walls. These hydraulic cylinders, which are illustrated in Fig. 9, are so designed that they allow the chain to yield when it is subjected to a heavy load so that the forward movement of a ship will be checked gradually. The same mechanism is also used for raising or lowering the chains.

Referring to Fig. 9, there is a stationary outer cylinder *A*, into the lower end of which is inserted a movable combination plunger-cylinder *B*, which, in turn, fits over a stationary plunger *C* resting on the bottom of the pit. Two sheaves *D* and D_1 are connected with the plunger-cylinder by means of eye-bars *E* and E_1 and there are two similar sheaves at the top, the upper pair being at right angles to the lower ones. The chain enters the lock wall and is supported by an idler at *G* and, after passing around the sheaves referred to, is securely fastened to one of the beams at the top of the pit. In order to raise the chain, the plunger-cylinder *B* is moved downward by introducing water into the top of the outer cylinder, whereas the chain is lowered by forcing cylinder *B* upward. This upward movement is obtained by admitting water through the stationary plunger *C*. The maximum pressure required for raising or lowering the chain is about sixty pounds per square inch, and the water is supplied by a centrifugal pump. The resistance as the chain pays out, is obtained by means of a resistance valve designed to maintain a constant predetermined stress or pull on the chain. When the chain is struck by a ship the water pressure in the outer cylinder *A* rises, and when it has increased to 750 pounds to the square inch the resistance valve opens and allows enough water to escape to keep the pressure constant until the vessel is stopped. This pressure of 750 pounds corresponds to a stress of 100 gross tons on the chain. The valve for regulating the pressure is a differential piston type and its movement is regulated by an adjustable helical spring. When the pressure in cylinder *A* does not exceed 60 pounds the valve remains seated, but in case the chain is struck by a vessel, thus causing the pressure to rise rapidly, the valve opens as soon as the pressure has increased to 750 pounds. With this ingenious mechanism, a 10,000-ton ship having an initial speed of four knots an hour can be stopped within 73 feet, which is less than the distance between the chain and the gate. When the chains are lowered to permit the passage of a vessel they lie in cross grooves formed in the concrete bottom of the lock. Each of these chains weighs 24,000 pounds and the links are forged from 3-inch stock.

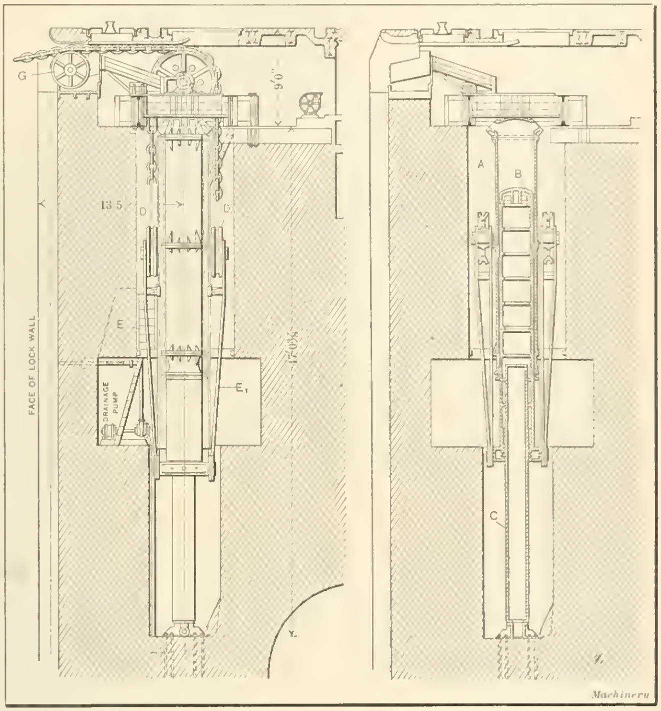


Fig. 9. Hydraulic Cylinders for operating the Massive Fender Chains which are to protect the Gates from being rammed by a Ship

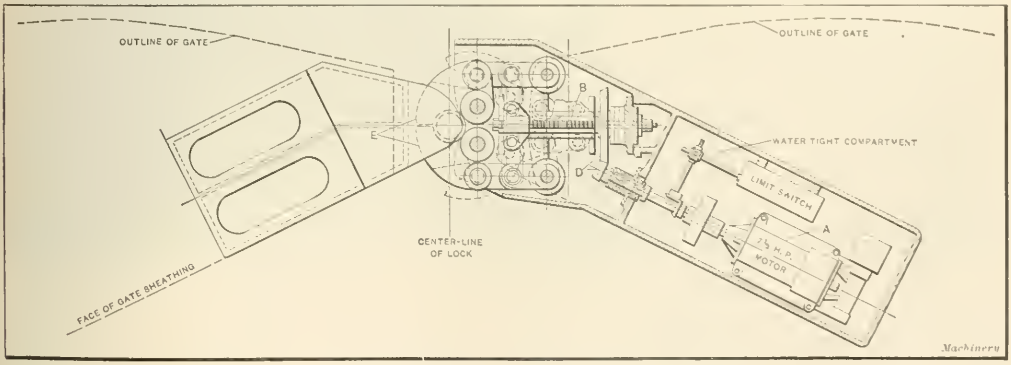


Fig. 8. Gate Locking and Miter Forcing Machine

Electric Towing Locomotives

As previously mentioned, electric locomotives will be used for towing all vessels into and through the locks in order to have a reliable and positive control of a ship's movement. In other canals, where ships enter the locks by their own power, a large percentage of the accidents have been due to the lack of control within the narrow limits of the lock chamber; hence towing locomotives will be used at Panama to obviate accidents of this kind. Ordinarily, four locomotives will be used, although the number will depend somewhat upon the size of the vessel. When four are used there will be two in front and two others behind, those ahead being used for towing and those in the rear for retarding the ship's movement when necessary. With this arrangement a vessel is under control laterally as well as longitudinally.

These locomotives are to operate on tracks laid on the central and side walls, there being two towing tracks for each flight of locks. In addition there is a return track on each side wall and one on the middle wall which is common to both towing tracks on this wall. All of these tracks run continuously the entire length of the lock and for some distance beyond on the approach walls at each end. The towing tracks have a central shrouded rack which is engaged by the driving gears of the locomotive, thus giving a positive and powerful movement. The speed when towing will be two miles an hour. After a ship has been drawn through the locks the locomotives will be switched over upon the return tracks, which are without racks, except upon the steep grades that lead from one lock level to another. The return speed is five miles an hour, except when ascending the steep grades just referred to.

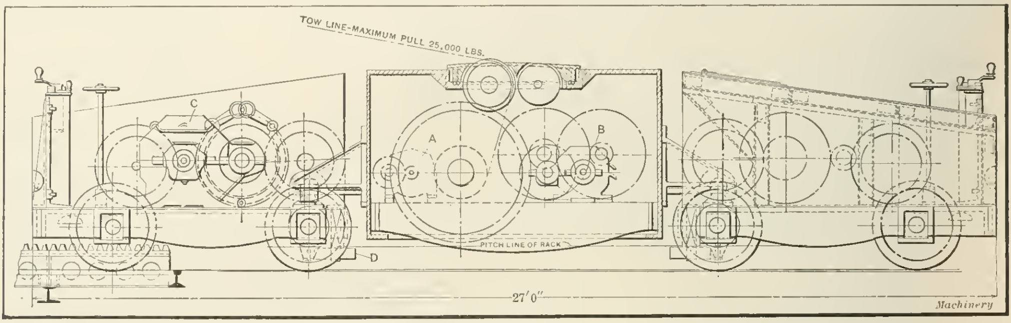


Fig. 10. Side Elevation of Electric Towing Locomotive—All Vessels will be towed through the Locks to avoid Accidents

An elevation view of a towing locomotive is shown in Fig. 10. It consists of three sections connected by universal joints. The front and rear parts are the tractors and the central element is equipped with a slip-drum towing windlass and hawser. Each tractor has a 75 H. P. driving motor with independent control from either end of the locomotive. The motor-driven towing windlass is so arranged that the hawser can be taken in or paid out and a pull exerted without any movement of the locomotive along the track. This feature is especially desirable for arresting a ship's movement or for changing the length of the tow line when, for example, the locomotive ascends to the level of the next lock while the water levels in the two chambers are being equalized and the ship necessarily remains stationary. The maximum pull on the tow line is fixed at 25,000 pounds, and whenever that amount is exceeded the drum slips, so that the locomotive and windlass are protected against excessive strains. The side pull of the towing line is taken by horizontal thrust wheels which bear against the side of the track. The electric current for operating these locomotives is conveyed through conduits at the side of the track. The electrical power for operating all the mechanism of the canal will be generated eventually at a hydro-electric plant located at the spillway of the Gatun Dam. There will also be a reserve station at Miraflores operated by steam. The two stations are to be connected by a transmission line, and current from either can be used.

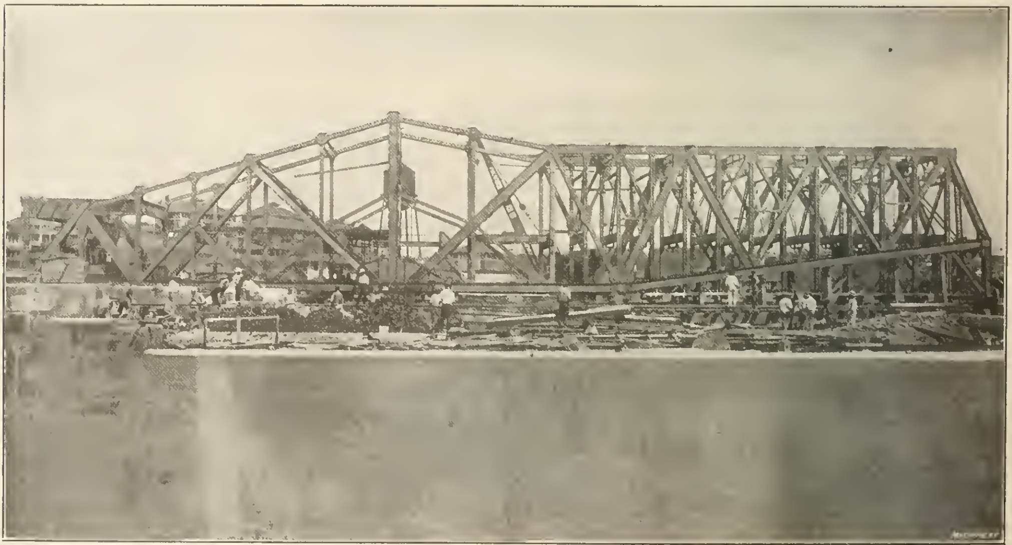


Fig. 11. Side View of Emergency Dam—These Dams are designed to close Upper End of Locks for making Repairs or in Case of Accident to Gates

The Emergency Dams

The emergency dams are one of the most interesting features of the locks. These dams are large bridge-like structures (see Fig. 11), two of which are installed in the forebay at the upper end of each set of locks, there being one dam for the flight of locks on the right side and another for the flight on the left. They are designed to close the upper ends of the locks, either to permit making repairs or in case free communication should be established between the two levels above and below a lock as the result of some unusual and unexpected accident. The emergency dams are arranged somewhat like a swing or center-pivot drawbridge, and, when in their normal position are parallel with the locks. In case it is necessary to use a dam the drawbridge is turned one-fourth a revolution so that it extends across the lock. Twelve equally spaced wicket girders *A* which are held in a horizontal position beneath the bridge, as shown in Fig. 12, are then lowered as indicated in Fig. 13, both of these illustrations representing end views. These girders *A* are pivoted at *B* and the outer ends are lowered by wire cables *C*, which run through sheaves and are operated by motors upon the bridge. When the girders are down the lower ends are supported by cast buttresses fixed in the floor of the lock. A framework is now formed by the twelve girders which have been lowered for supporting the heavy flat roller gates *G* that are used for building up the emergency dam. There are thirty of these gates which, in position, are arranged in five horizontal rows, each containing six gates. The dam is built up in sections and the girders form runways upon which the gates are lowered. At first the six bottom gates forming the lower row are let down, thus shutting off nine feet of water, and then the remaining four rows are lowered in succession. In this way the water, which would be rushing rapidly through the lock in case there were free communication between the upper and lower levels, would be gradually checked. In order to lower the gates readily they are mounted upon flanged wheels which run on heavy rails attached to the front faces of the girders.

After the dam has been formed there will be, of course, some seepage between the different sections, but as the rush of water has been checked, another dam can now be made by sinking a steel caisson above the temporary emergency dam. This floating caisson would be towed by the electric locomotives against an abutment at the upper end of the lock chamber. At this point the caisson, which is equipped with motor-driven pumps, is sunk by filling it with water, thus forming a secure dam. The emergency dam can then be raised, if necessary, for repairing the lock. When raising the gates *G*, preparatory to swinging the bridge back to its parallel position, four of the five rows are drawn up and suspended upon the bridge; then the girders with the lower row of gates still in place are raised to the position shown in Fig. 12.

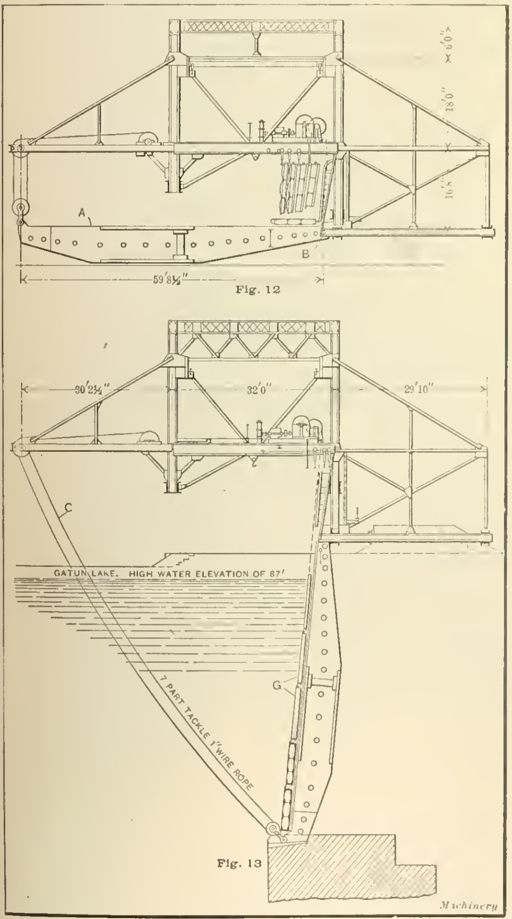

6'0"
18'0"
16'5"
A
B
59'8½"
Fig. 12
30'2½"
32'0"
29'10"
C
GATUN LAKE. HIGH WATER ELEVATION OF 87'
G
7 PART TACKLE 1" WIRE ROPE
Fig. 13
Machinery

Fig. 12. End View of Emergency Dam, with Girders upon which Dam Gates are lowered, in Raised Position. Fig. 13. Girders and Gates lowered to form the Dam

The swing bridge of the emergency dam turns upon a central disk bearing which is interesting from a mechanical viewpoint because of the high pressure to which it is subjected. It consists of an upper casting attached to the bridge, three intermediate disks and a lower casting imbedded in the concrete pier. The disk which bears directly against the upper casting is flat on top and concave underneath, and the lower disk is similar but reversed in position. Between these concave disks which are made of forged chrome-vanadium steel there is a forged manganese-bronze center disk having convex surfaces which fit accurately into the concave disks above and below. These three disks are 43 inches in diameter and are subjected to a unit pressure of 4620 pounds per square inch, which is said to be the highest pressure that has ever been used in a similar location.

Fig. 14. Machine for operating Cylindrical Valve of Lateral Feed Culvert

The bridge is turned by two motors each of which operates a separate pinion engaging a quadrant rack secured to the foundation. The driving end of the bridge contains a heavy concrete counterweight and is equipped with wheels running upon a circular track. There are also wheels and a circular track around the central bearing, but these wheels are about 1/16 inch above the track and are merely intended to steady the structure while it is being turned. Ordinarily the bridge is held in a fixed position by motor-operated wedges located at both ends and in the center. Of course, the emergency dams will rarely if ever be used, except during tests. The floating caisson gates previously referred to will also be used to close the tail-bay of a lock flight whenever the lower guard gates need to be cleaned, painted or repaired, and the caissons will probably be more satisfactory than the dams for closing the upper ends of the locks, except in cases of emergency.

Mechanism for Operating the Culvert Valves

The machinery for operating one of the gate valves which control the flow of water into the main feed culverts, is shown in Fig. 15, which is a side elevation. The top of the valve is seen at *A*. This valve is connected with the raising and lowering mechanism above by valve stem *B* which passes through a stuffing-box in a water-tight bulkhead *C*. The upper end of the valve stem is attached to a crosshead *D*, which is moved vertically by two non-rising screws *E*. These screws are rotated for opening or closing the valve, by a 50 H. P. motor *F*, which transmits its motion through reduction gears. Each screw is suspended from double roller bearings at the upper end and the crosshead is also guided by rollers running upon rails imbedded in the concrete. When the valve *A* is in motion the pressure of the water is transmitted to trains of rollers *G* located on each side. As these rollers should move at half the speed of the gate, their retaining frames are positively raised and lowered by vertical stems *H*, which are connected by chains *J* with the crosshead *D*. The sheaves over which these chains pass are so arranged that rods *H* and the roller trains move at one-half the velocity of the gate valve. These valves can be operated locally, but ordinarily they will be controlled from a central station, as will be described more fully later. There is also auxiliary hand apparatus for closing the valve in case the machinery should fail when the valve is in the raised position.

One of the machines for operating a cylindrical valve, such as are used for the lateral culverts, is illustrated in Fig. 14.

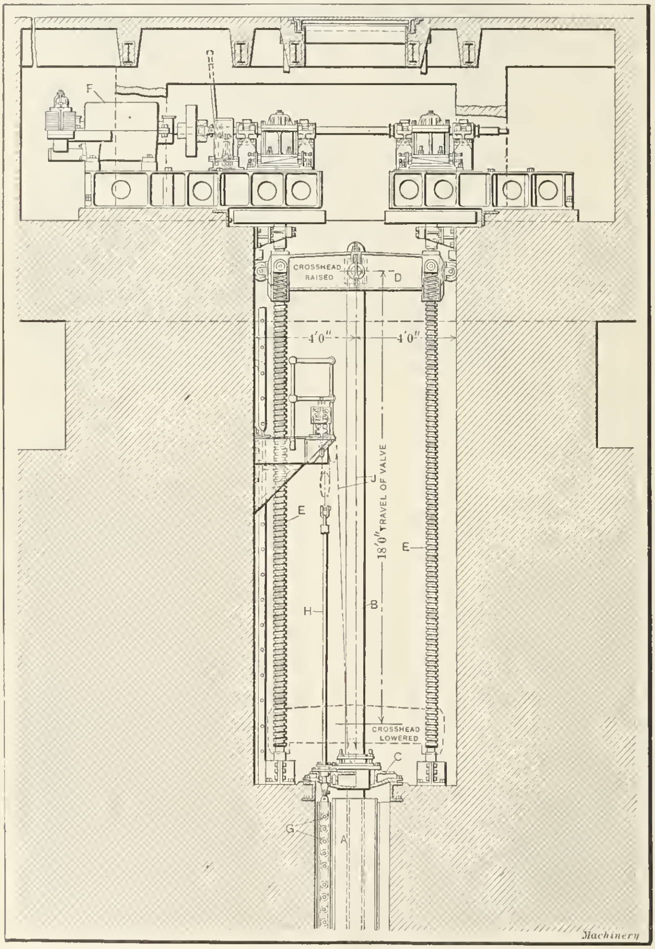


Fig. 15. Machinery for operating Stoney Gate Valves which control Flow of Water to Main Feed Culverts

There will be 120 of these machines in the six twin locks of the canal, there being one for each valve. These machines are located near the top of the center wall in chambers connecting with passage *A*, Fig. 3, whereas the valves *E* are down at the junction of the lateral and main culverts. The movable drum of the valve is connected by a stem rising vertically through a shaft in the masonry, with a tubular extension *A* (see Fig. 16), having a nut *B* which engages a non-rising, revolving screw *C*. This screw is turned through suitable gearing by motor *D*, and the travel of the valve in either direction is stopped at the proper point by a limit switch *E*. One of these valves can be opened or closed in ten seconds, and the large gate valves can be opened or closed in one minute.

Control of the Lock Mechanism

All mechanism that has to do with the actual operation of the locks, such as the culvert valves, gates and fender chains, will be controlled from a tower located on the highest lock in each flight. Owing to the number of gates, valves and chains to be operated, especially at Gatun, there will be many switches in the control tower, but all danger of operating the wrong switch will be avoided by an ingenious interlocking system which makes it impossible to throw the switches, except in the proper order or sequence. As a machinist might tersely explain it, the control will be "fool proof"—a very important feature in view of the fact that these locks are rather high in price and not easily repaired when once put out of commission. In order to pass a large ship through the locks at Gatun, it will be necessary to lower four fender chains, operate six pairs of gates and their locking mechanism, open and close eight pairs of main-culvert gate valves and thirty cylindrical valves. To accomplish all this, at least 98 motors will be set in motion twice during each lockage of a single ship, and this number may be increased to 143 under certain conditions.

The proper control of all these parts will be made easy by a unique "switchboard" located in the control tower. This switch- or control-board will be in the form of a bench or table 32 inches high, and will be in duplicate to conform to the twin locks. On this control-board there will be parts representing the gates, valves, etc., and indicators to show the height of the water in the big locks outside, so the towerman can see at a glance the exact position of the gates or other parts that are under his control. In order to further simplify the operation of the various parts, the switch which controls a certain gate or valve will be mounted on the board opposite that particular gate or valve. Hence, when a vessel is passing through the locks, the operator begins throwing switches at one end and moves along from one switch to another throughout the entire length of the board, the switches being operated successively and in the proper order. As each switch is thrown, the operation of that particular part of the lock is reproduced on the model, thus avoiding all confusion. The length of the board at Gatun is limited to 30 feet and the length of the other boards will be proportional to the length of their respective locks.

The interlocking system will be so perfected that all dangerous combinations in the relative positions of gates, valves, etc., will be impossible. To illustrate, the system will be so arranged that one of the gate valves in the main culvert could not be opened, unless the valves at the other ends of the locks, both up-stream and down-stream, were first closed. This feature limits the operator to the act of equalizing the water levels in adjacent lock chambers and prevents him from allowing water to flow, say from the lake directly to the middle lock, thus eliminating the danger of flooding the lock walls and machinery rooms. The relative positions of the gate valves and gates will also be governed by the interlocks, which will prevent the valves from being opened a lock length above or below a gate that is being opened or closed. Hence, there can be no flow of water while the gates are in motion. The interlocking system for the cylindrical valves of the lateral culverts will be so designed that the valves on one side or the other will always be closed, except when cross filling from one twin chamber to the other, in which case both sets of valves can be opened at the same time by a special procedure. The interlocks will also make it necessary to unlock the miter forcing machine (illustrated in Fig. 8) before the motors of the gate-moving machines can be operated, and they will even prevent such a mistake as leaving a fender chain down when it should be up guarding its gate, so that the locks are to be proof against carelessness and the machine will be the boss. These ingenious protective devices constitute one of the great features of the canal, although they may not be as spectacular and impressive as the cut at Culebra, the wonderful dam at Gatun or the gigantic locks.

* * *

A MACHINERY DEAL

BY A. P. PRESS

They were clearing out a lot of machines from the east wing, and replacing them with up-to-date automatic machinery. The foreman saw there would be a lot of tools to sell, and so he reasoned it out this way:

"They will go cheap as dirt—there are so many of them; and if I can get into the deal there will be some money in it." So he went over to a friend of his, and said:

"Charley, they are going to sell a lot of tools down to the A. B. Co., and while I don't dare to bid on them—in fact, it won't do for me to bid—still I would like to have a finger in the pie, and if you will go over and make a deal with the master mechanic, and buy them, I'll furnish the cash. Then we'll whack up on what we make. You can take them out to your place and store them, and sell them off. We ought to do a pretty good thing."

"All right, Charley. I'm yours."

The next day the foreman was bunching the tools off the way in a corner of the room. Skilton, the master mechanic, came in.

"That's a pretty good bunch of lathes we've got over there."

"Yes, it is, Mr. Skilton."

"What had we better do with them?"

"Well, I don't know, Mr. Skilton; seems to me it would be best to dispose of them. Since we got in the new automatics I can't see that we'll ever have any use for them."

"Well, I guess you're right. Say they are pretty good lathes to go as scrap. Tell you what I think. I would be glad to buy them, but of course it would hardly do. Why don't you buy them? I am willing to furnish the cash. It ought to be easy to dispose of them."

Poor Charley! He turned all colors of the rainbow.

"Well, sir, to tell the truth, I did think of that, and I spoke to a friend of mine, and he said he would be willing to buy them, and so we thought we would make a bid on them."

"Yes," said Mr. Skilton, "but I don't like to be left out in the cold on the deal. I am willing to put in half the cash and share one-third the profits."

A look of relief came over the foreman's face, as he found himself getting out of the hole, even though he lost one-half of his profits.

"All right, Mr. Skilton."

"Well you send your friend up to my office to-morrow, and we will finish up the sale."

Charley went up to the master mechanic's office the next morning, and as he told me afterwards, it was as good as a play.

"There I was buying Skilton's lathes from Skilton, and paying for them with Skilton's money, and while the purchasing agent had to be called in, he was only a side issue."

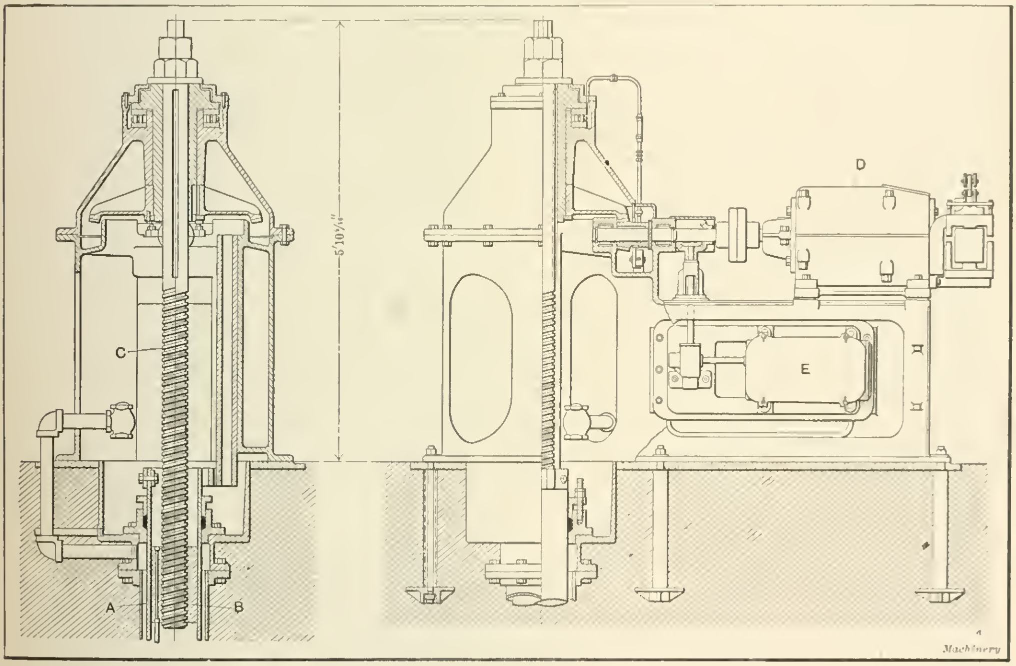


Fig. 16. Side Elevation of Cylindrical Valve Machine illustrated in Fig. 14

To cut the story short, Skilton sold the lathes, and also furnished the cash that he sold them for, and turned them over to Charley, and when I saw Charley last he was trying to unload them. So far he had not made much progress, and so we bought them of him.

We have done a lot of straightening out in our day, but we think this was the crookedest deal in the mechanical line that was legally straight, we ever had anything to do with.

* * *

ACID-RESISTING ALLOY

The following alloy is claimed to possess exceptional qualities with regard to its ability to resist the action of acids: Nickel, 66.6 per cent; chromium, 18 per cent; copper, 8.5 per cent; tungsten, 3.3 per cent; aluminum, 2 per cent; manganese, 1 per cent; titanium, 0.2 per cent; boron, 0.2 per cent, and lithium, 0.2 per cent. This alloy is difficult to cast because it contracts considerably at the point of solidification. It can, however, be drawn into wire and is easy to work.

FREE IMPORT OF MATERIALS FOR SHIPBUILDING

In Section 5 of the Panama Canal Act a provision is contained as follows: "That all materials of foreign production which may be necessary for the construction or repair of vessels built in the United States, and all such materials necessary for the building or repair of their machinery, and all articles necessary for their outfit and equipment may be imported into the United States free of duty under such regulations as the Secretary of the Treasury may prescribe."

In giving effect to this provision, the United States Treasury regulations provide, in part, as follows:

Materials.—The word "materials" is defined as including any imported merchandise suitable for use in the construction or repair of a vessel or of its machinery to be incorporated therein after having undergone a process of manufacture subsequent to importation, or in its condition as imported, provided it has been purchased in the open market and was not constructed or fabricated upon a special order or after a special design. This will include raw materials, such as pig iron and lumber, to be worked up into the finished state in which they will enter into the hull or machinery, rough forgings and castings, but not finished ones, nuts, screws, bolts, steel plates, ship's knees, flooring, and other things which, though completed articles, are useful as parts in the construction of something else.

Articles.—The word "articles" is defined as including only such things as are suitable for use in their condition as imported in the outfit and equipment of a vessel. However, articles will be considered as suitable for use in the condition in which imported, although they are to be fitted, polished, painted, or otherwise improved in condition or fixed in place subsequently.

Outfit and Equipment.—The term "outfit and equipment" is defined as including portable articles necessary or appropriate for the navigation, operation, or maintenance of a vessel, and not permanently incorporated in its hull or machinery, and not constituting consumable supplies. The term includes, therefore, anchors, chains, cables, tackle, boats, repair parts, life-saving apparatus, wireless telegraph apparatus (except the motor generator), nautical instruments, searchlights, signal lights, lamps, furniture, carpets, table linen, tableware, bedding, arms and munitions, and also articles to be used in renewal or replacement of articles of original outfit and equipment.

Machinery, including all the propelling mechanism, and also auxiliary machinery permanently incorporated in the hull of the vessel, such as pumps, steering gear, lighting plants, refrigerating plants, steam winches, hoisting engines, generators, motors, condensers, feed-water heaters, evaporators, switchboards, etc.; provisions, wines, coal, medicines, and other similar consumable articles, and materials intended to be manufactured into articles of outfit or equipment, will not be admitted free of duty under this Act. Neither materials for the construction or repair of vessels or of their machinery, nor articles for outfit and equipment, will be admitted free of duty when imported to be kept in stock for sale.

Materials for construction or repair of vessels, or of their machinery, and articles for outfit and equipment, may be entered for warehouse, and if withdrawn within three years from the date of importation for use in such construction, repair, outfitting, or equipping, will be entitled to enter free of duty upon such withdrawal.

The *Practical Engineer* (London) comments as follows:

> "The 'definitions' of the act leave very little of the act intact. The key to the matter is, however, simple:—(1) Promise free admission on broad general lines subject to 'regulations.' (2) Draft the regulations to include and exclude anything you please. Classifications are no difficulty. If you want to include searchlights and exclude evaporators call the searchlight an 'article' and the evaporator a 'machine,' or *vice versa;* it matters not. Lighting plant can be cut in pieces. If you fear competition in some parts, call the motor a machine to keep it out. The rest of the plant can be called an article to let it in, but, as this will admit switchboards, in which competition cannot be entertained, double back and call the switchboard a machine."

STRENGTH OF WIRE ROPE DRUMS

BY R. H. CREVOISIE*

In the following are given formulas which will be found useful when calculating the strength of wire rope drums. Usually if a drum is designed to be strong enough to resist crushing, it will be strong enough to resist bending also, except in cases of extremely long drums. To be on the safe side, however, the strength should be calculated for both crushing and bending. Let us first consider the calculations to find the crushing stresses. Let

T = tension in one rope, in pounds;
t = thickness of drum in inches at bottom of groove;
P = pitch of scoring, or distance between grooves in inches;
L = span in inches from center to center of bearings;
D = diameter at the bottom of the groove;
d = inside diameter of drum;
W = total load in pounds; .
M_b = bending moment.

We can then calculate the total crushing stresses as follows:

$$\text{Section modulus} = Z = 0.0982\left(D^3 - \frac{d^4}{D}\right);\quad M_b = \frac{WL}{4}$$

$$B = \frac{M_b}{Z};\quad C = \frac{T}{Pt}.$$

$$\text{Combined stress} = \sqrt{B^2 + C^2}$$

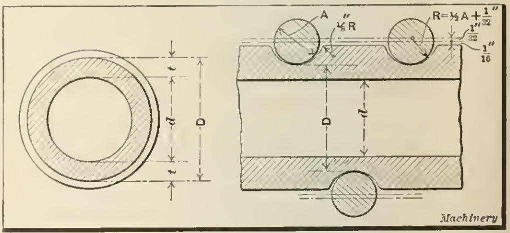
The combined stresses should not exceed 6000 pounds per square inch for cast iron.

To find the strength for bending, let S = safe fiber stress, which should not exceed 3000 pounds per square inch for cast iron.

The diameter of the hole through the drum may then be found from the following formula:

$$d = \sqrt[4]{D^4 - \frac{D \times M_b}{0.0982\,S}} \tag{2}$$

As an example, assume that on a five-ton crane, two 7/16-inch ropes are used; that the pitch of scoring on the drum is ¾ inch; and that the distance from center to center of the bearings on the drum is 6 feet 2 inches. The inside diameter of the drum is 12 inches, and the diameter at the bottom of the grooves, 14 11/16 inches. From the formulas given we find the combined crushing stress:



Notation used in Formulas

$$Z = 0.0982\left(14.69^3 - \frac{12^4}{14.69}\right) = 172.6$$

$$M_b = \frac{10{,}000 \times 74}{4} = 185{,}000$$

$$B = \frac{185{,}000}{172.6} = 1072;\quad C = \frac{5000}{\frac{3}{4} \times 1.34} = 5000$$

Combined stress $= \sqrt{1072^2 + 5000^2} = 5113$ pounds per square inch.

As this is less than the allowable stress of 6000 pounds per square inch, the drum is safe for crushing.

To determine if the drum will withstand bending, use Formula (2), assuming the diameter at the bottom of the grooves to be 14 11/16 inches and solving for the inside diameter:

$$d = \sqrt[4]{14.69^4 - \frac{14.69 \times 185{,}000}{0.0982 \times 3000}} = 13.9 \text{ inches.}$$

Since the inside diameter is only 12 inches instead of 13.8 inches, it follows that the drum is strong enough for the purpose for which it is designed.

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*Address: Wickes Boiler Co., Canton, Ohio.

MACHINE FORGING—1

MACHINES AND METHODS EMPLOYED IN THE MANUFACTURE OF BOLTS, RIVETS, NUTS, MACHINE PARTS, ETC.

BY DOUGLAS T. HAMILTON*

The bolt and nut industry in America started in a very small way in Marion, Conn., in 1818. In that year Mr. Micah Rugg, a country blacksmith, made bolts by the forging process. The first machine used for this purpose was a device known as a heading block, which was operated by a foot treadle and a connecting lever. The connecting lever held the blank while it was being driven down into the impression in the heading block by a hammer. The square iron from which the bolt was made was first rounded so that it could be admitted into the block. At first Mr. Rugg only made bolts to order, and charged at the rate of sixteen cents a piece. This industry developed very slowly until 1839, when Mr. Rugg went into partnership with Martin Barnes, and together they built the first exclusive bolt and nut factory in Marion, Conn. The bolt and nut industry started in England in 1838, the credit for which is given to Mr. Thomas Oliver, of Darlston, Staffordshire. His machine was built on a little different plan from that of Mr. Rugg's, but no doubt was a further development of the first machine. Mr. Oliver's machine was known as the "English Oliver."

As is generally the case with a new industry the methods and machines used were very carefully guarded from the public, and this characteristic seems to have followed this industry down to the present time, judging by the scarcity of available information on the subject. Some idea of the methods which were at first employed to retain all information in the factory in which it was originated, is well brought out by the following instance: In 1842 when the industry was beginning to be generally known, it is stated that a Mr. Clark, who at that time owned a bolt and nut factory in New England, and had devised a special machine for their manufacture, had his forging machine located in a room separated from the furnaces by a thick wall. A hole was cut through this wall, and the man who operated the machine received the heated bars from the furnace through the small hole in the wall. The only person who ever got a glimpse of the machine was the operator. The forge man was not permitted to enter the room.

Machine forging, as we know it to-day, is of wide application, embracing a large number of machines and processes that apply, in a measure, to almost any manufacturing plant. Machine parts hitherto made from castings are now made much more economically by the use of the drop-hammer or forging machine, and give much more satisfactory service. In the following articles the various forging machines and methods employed in the manufacture of bolts, rivets, nuts, machine parts, etc., will be taken up.

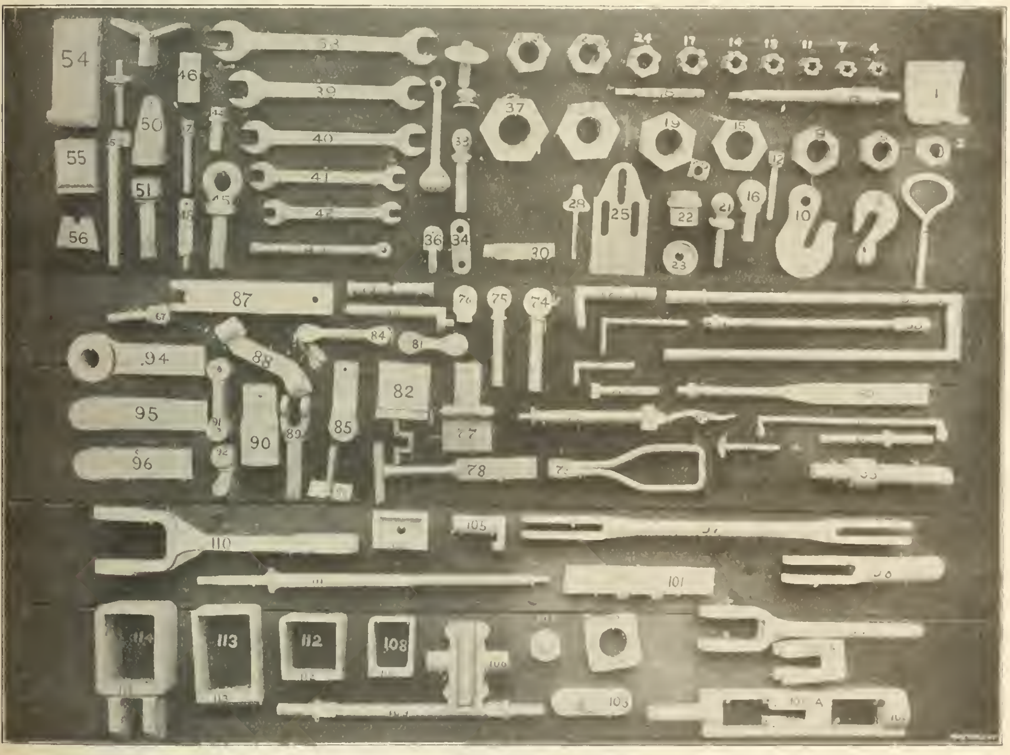

Fig. 1. Examples of Forged Parts produced in the Collinwood Shops of the L. S. & M. S. Railway on Ajax Forging Machines

Types of Machines

Upsetting and heading machines are divided into two general classes, namely, stop-motion and continuous-motion headers. The stop-motion headers have the greatest range, and are primarily used for heading bolts and all sorts of upset forgings. The continuous-motion headers are used only for heading rivets, carriage bolts and short lengths of hexagon and square head machine bolts; they produce these parts at a much faster rate than is possible with a stop-motion header, but their range of work is limited. The universal practice is to shear the bars cold when working a stop-motion header, and only in special cases, where the shank of the headed piece is very short, is the side shear used.

Rivets, etc., made by the continuous-motion header are made by the process known as "off the bar," that is, a bar is heated for a distance of approximately four feet, and is then pushed into the machine where the moving die acts as a shear and cuts off the blank. The latter is immediately gripped against the stationary die, whereupon it is headed and ejected. This whole cycle of movements is accomplished in one revolution of the flywheel.

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* Associate Editor of MACHINERY.

Operation of Plain Bolt and Rivet Machines

Briefly stated, a plain bolt and rivet machine comprises two gripping dies, one movable and the other stationary, and a ram which carries the heading tool. The heated bar is placed in the impression in the stationary gripping die, and against the gage stop; the machine is then operated by pressing down the foot treadle shown immediately in front of the machine in Fig. 2. As already mentioned the stock is generally cut to the desired length before heading, on this type of machine, especially when it is long enough to be conveniently gripped with the tongs; but it can be headed first and afterward cut off to the desired length in the side shear. It is also possible, in some makes of machines, to insert a cutting tool to cut off the blank before heading, when the work is not greater in length than the capacity of the machine.

There are several methods used in making bolts and rivets in a regular forging machine. In Fig. 3 is shown a diagrammatic view of a set of forging dies which have an extremely wide range of application. In this type of dies the head on the bolt is formed by rotating the bar between the gripping dies after each blow of the plunger. For a square-headed bolt, the bar is turned twice through a space of 90 degrees, and is generally given two or more blows in each position. A hexagon-head bolt usually requires at least six blows to complete one bolt, and the shape of the head depends to a large extent on the skill of the operator. The wide range of work, however, which can be handled in dies of this type, make them of almost universal application, especially in a railroad shop.

Fig. 4 shows a set of single-blow rivet dies which are used in a continuous-motion rivet header, and illustrates how these dies are operated in the production of a rivet in one blow. The heated stock is fed in and cut off to the exact length by a shear *A*; it is gripped between dies *B* and *C* while being cut off. The tool *D* held in the ram of the machine then advances, upsetting the head to the shape shown, whereupon the movable die backs out, allowing the formed rivet to drop out and the bar to be inserted to the stop, ready for the next piece. The type of bolt heading tool illustrated in Fig. 5 is known as a double-deck three-blow bolt die; its use and operation will be explained later.

Successive Steps in Heading Bolts

Figs. 6, 7 and 8 show the successive steps followed in the forging of a hexagon-head bolt in the type of bolt forging dies illustrated in Fig. 3. Bar *A* which is heated for a portion of its length, is placed in the impression in the stationary gripping die *B*, as shown in Fig. 6, and is gaged to length by the lifting stop *C*. The machine is then operated, and the movable die *D* closes in on the bar, gripping it rigidly. The stop now rises and as the ram of the machine advances, the plunger *E* upsets the end of the bolt, the blocks *F* and *G* forming a flat on each side of the upset end. The operator keeps his foot on the treadle, and as the movable die backs out, he rotates the rod one-third turn. This operation is repeated until the head has been correctly formed. The operator now removes his foot from the treadle, stopping the operation of the machine, when the dies remain in the open position, allowing him to remove the completed bolt as shown in Fig. 7. This view shows the stop down, ready for the rod to be inserted again with the dies open, while Fig. 8 shows the dies open and the plunger on its return stroke.

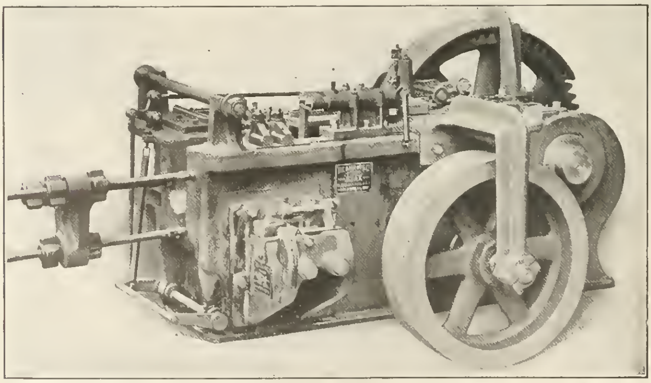


Fig. 2. Ajax Bolt Heading Machine suitable for all Types of Machine Bolts and Upset Forgings

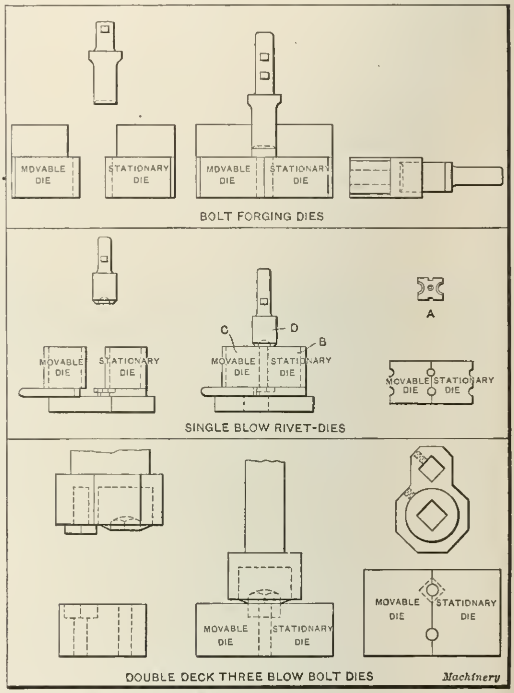


Fig. 3. Plain Type of Bolt Forging Dies—of Universal Application. Fig. 4. Single-blow Rivet Dies. Fig. 5. Double-deck Three-blow Bolt Dies

Fig. 9 shows how the furnace and forging machine are arranged for making bolts and machine forgings. The bars in this case are long enough to be gripped with the tongs, so they are cut off to the desired length in a power shear before heading. From the power shear the bars are brought to the heating furnace in the truck shown to the right in the illustration, where one end of the bars is heated to the desired temperature. This furnace is heated by oil and is placed as close to the forging machine as possible. The man who attends to the heating of the stock places the rods in a row, and as soon as the end to be headed reaches the proper temperature, he quickly removes the heated bar and passes it to the forging machine operator, who immediately places it between the dies, operates the machine, and forms the head. In this particular example the bolt is 1¼ inch in diameter by 12 inches long, and is formed in three blows in double-deck dies of the type illustrated in Fig 11. The dies and heading tool are kept cold by means of a constant stream of water. As soon as the bolt is headed it is thrown in the truck to the left, which is used for conveying the bolts to the threading machines.

Fig. 10 shows a view looking down into the die space of the "Ajax" bolt header, from which an idea of the relation between the working members can be obtained. The back stop *A* is used for locating the bar in the correct position. This stop is sometimes used instead of the swinging stop *B* in locating the work. This view also shows how the gripping dies are held in the die space; a heel plate fastened to the frame of the machine and to the movable die slide by studs and nuts, carries set-screws which bear down on the die blocks, holding them tightly in the die space.

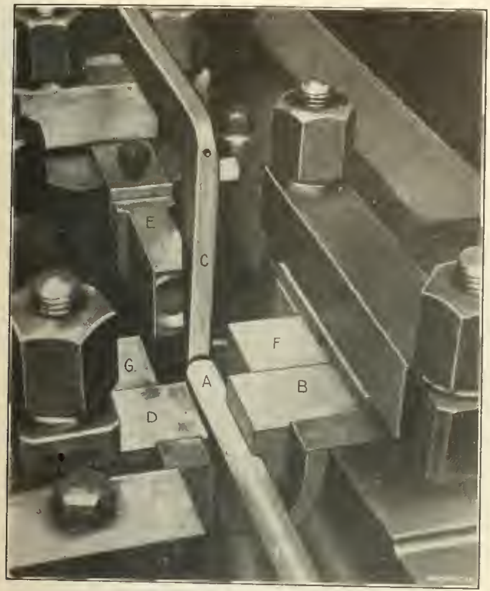


Fig. 6. First Step in the Production of Bolt Heads in Plain Forging Dies of the Type shown in Fig. 3

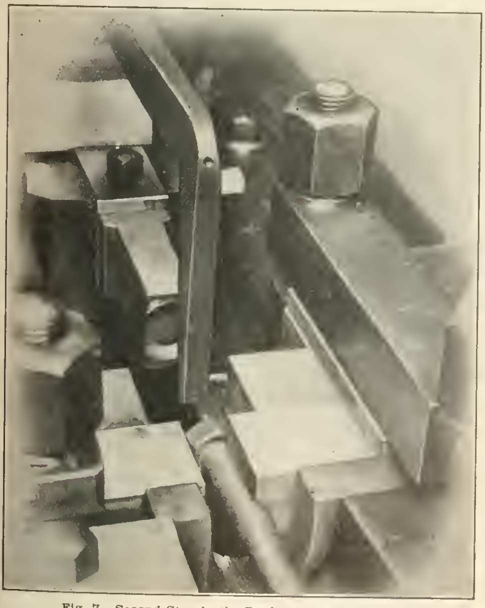


Fig. 7. Second Step in the Production of Bolt Heads

Types of Bolt Header Dies

Fig. 11 shows a type of bolt heading dies known as double-deck three-blow bolt dies, which are used for finishing hexagon-head bolts. The two gripping dies *A* and *B*, as a rule, are made from blocks of tire steel and each gripping die is made from three pieces to facilitate machining. The lower header punch *C* is cupped out to form a hexagon and is held in the heading tool-holder which is attached to the ram of the machine. The upper punch *D* is held in the same manner as the lower heading punch, and forces the bolt into the hexagon impressions in the dies after it has been roughly formed in the lower impressions. This type of die produces a bolt free from fins and burrs, and accurate as regards size and shape. The bolt is given one blow in the lower position and then raised to the upper die impression, where it is generally given two blows.

A combination double-deck gripping die for making square- and hexagon-head bolts is shown in Fig. 12. The construction of these dies is similar to those shown in Fig. 11, with the exception that these dies can be used for making both square- and hexagon-head bolts. The punches for forming the hexagon- and square-head bolts are shown at the right and left, respectively. A general idea of the class of work turned out in a bolt and rivet header may be obtained from Fig. 13.

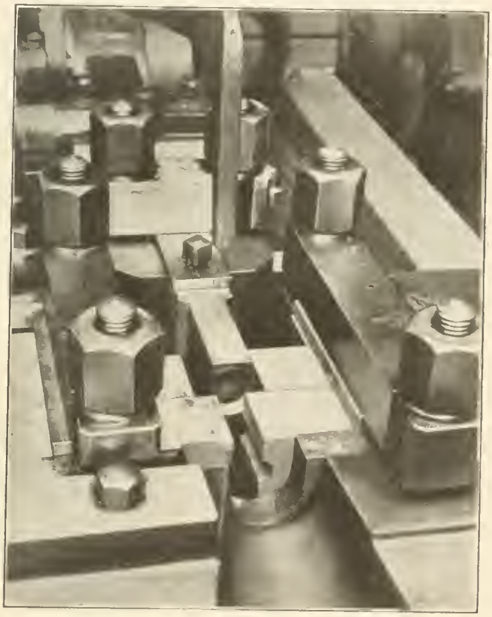


Fig. 8. Third Step in the Production of Bolt Heads

Fig. 9. Heading Bolts in a 2-inch Ajax Forging Machine in the L. S. & M. S. Railway Shops

Construction of National Wedge-grip Bolt and Rivet Header

Fig. 14 shows a view of a two-inch National wedge-grip bolt and rivet header which is used for making bolts, rivets and miscellaneous forgings. There are a number of interesting features connected with this machine, one of which is the wedge-grip and automatic relief mechanism. In operating a bolt and rivet header it is necessary that the work be placed directly in the impression in the gripping dies and not between their opposing faces. Both these dies must come tightly together and are made to do so by the mechanism of the machine, so that any foreign body preventing the correct movement of these dies is bound to cause trouble by breaking the machine.

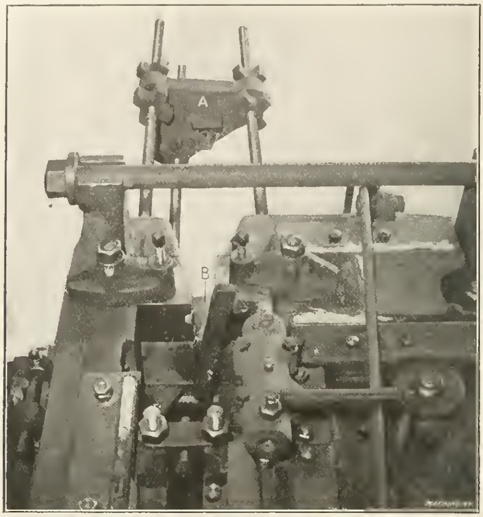


Fig. 10. View looking down into the Die Space of an Ajax Bolt Forging Machine

Various methods have been provided for obviating this difficulty, one of which is the interception of a shearing pin in the movable gripping die slide, which, when the foreign body is placed between the dies, is sheared off without causing any damage to the machine. Another method, which is a special feature of the National wedge-grip header, is a spring relief, which throws the entire gripping mechanism out of action should the stock or any foreign body be caught accidentally between the dies and prevent them closing. The action of this relief is indicated in the diagrams Figs. 15 to 17. In Fig. 15 the gripping dies are shown closed and the relief mechanism does not operate. In Fig. 16, the gripping dies are shown open and the ram is at its extreme backward stroke; while in Fig. 17 the dies are open, but, as can be seen, the ram is at the forward end of the stroke. The latter view shows what happens when a foreign body is caught between the gripping dies and prevents them from closing.

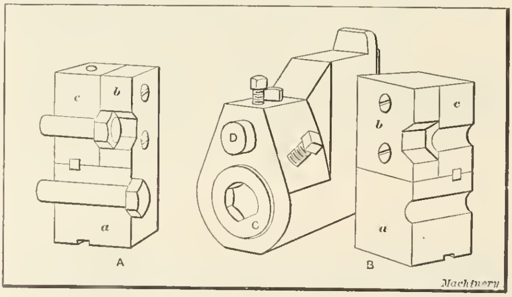


Fig. 11. Type of Double-deck Dies used in producing Bolt Heads without Fins or Burrs in Three Blows

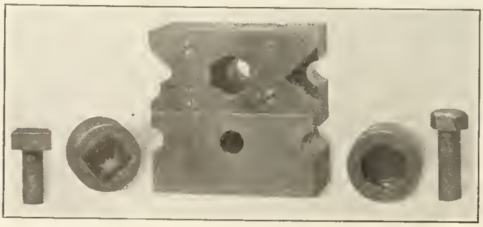


Fig. 12. Combination Square and Hexagon Double-deck Bolt Dies

The relief mechanism consists of a spring plunger *A*, the front end of which is beveled, and which is kept out by a coiled spring. This plunger, as indicated in Fig. 16, presses against the angular projection on the movable gripping slide. Now when a foreign body comes between the gripping dies and prevents them from closing, this spring plunger is forced back and the toggle joint operating the wedge-gripping slide remains stationary, which allows the dies to remain open, but the ram to complete its full forward travel. This relief will operate up to the time the dies are closed, but when the dies are closed, the gripping pressure is positive.

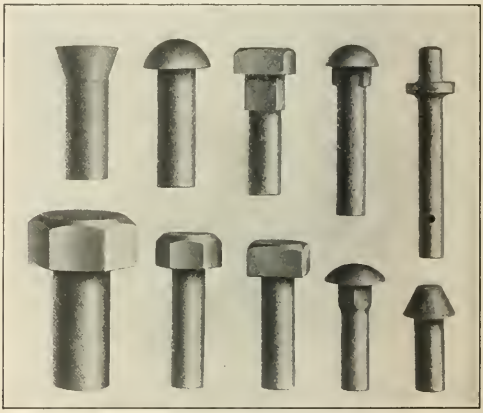


Fig. 13. Some Examples of Work turned out on National Wedge-grip Bolt and Rivet Header

An important feature of this machine is the wedge-grip for the movable slide. This consists of a slide *B* to which the toggle lever is attached, and which is moved back and forth by the latter through the movement of the crankshaft. The forward end of the slide *B* is beveled and forms a solid metal backing when the gripping slide *C* is in the forward or gripping position—when the dies are closed. This means of locking the movable die during the heading operation prevents any rocking or wobbling of the slide and causes an even pressure to be exerted over the entire working surface of the dies. The stationary die *D* and movable die *E* are set so that their working faces merely touch, and the rigidity of the

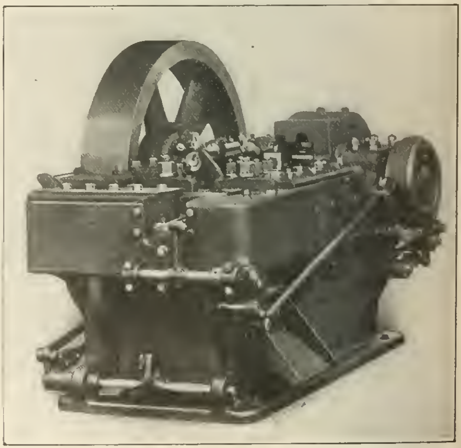


Fig. 14. Two-inch National Wedge-grip Bolt and Rivet Header

grip prevents any spring, so that the work can be produced without fins and burrs. By not having to set the dies ahead, the pounding or battering and premature wearing out of the dies is prevented.

Fig. 18 shows more clearly how the movable and stationary dies are retained in the die space, and how they are backed up by steel liners. This illustration also shows the shape of the sliding wedge and the steel liners that intercept it and the gripping slide. From an inspection of this illustration it will be seen that with this sliding wedge mechanism it is practically impossible for the dies to give or spring when in operation on the work.

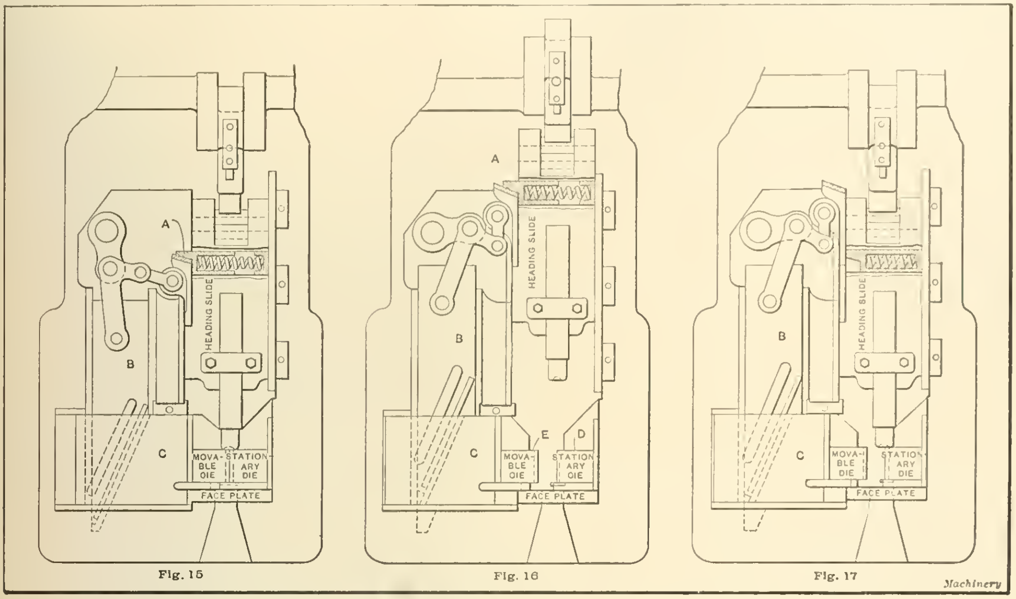


Fig. 15 Fig. 16 Fig. 17

Figs. 15, 16 and 17. Diagrams Illustrating Construction and Operation of National Wedge-grip Bolt and Rivet Headers

* * *

Automatic screw machines which have been in constant use for years become worn in the slides and require readjustment. But readjustment sometimes may be delayed long after a theoretical consideration would require it to be made. The reason is that some cutting oils used deposit a gum which works in between the slides and partially fills the spaces made by wear. Hence it is inadvisable to thoroughly clean an automatic screw machine in all its working parts unless the machine is overhauled and wear is taken up by first scraping and then adjusting. A thorough cleaning removes the accumulated gum and leaves the parts too uneven to be adjusted closely to prevent shake.

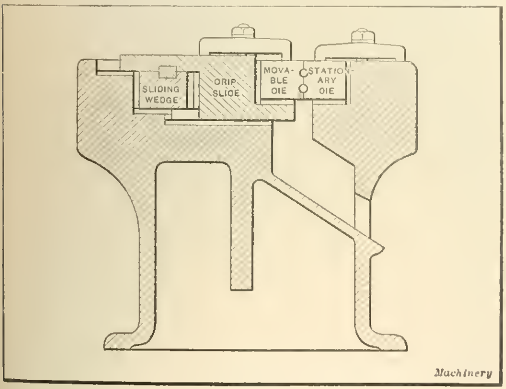
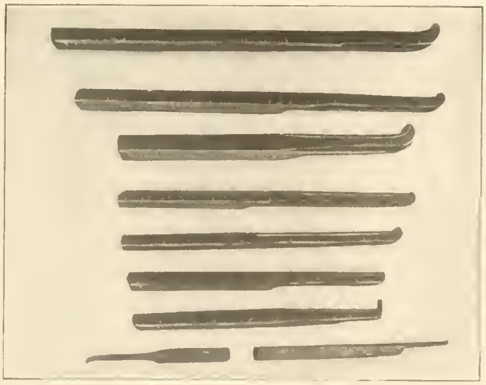


Fig. 18. Section through Die Box of the National Wedge-grip Bolt and Rivet Header

"SORE FINGER" BORING TOOLS

All machinists, of course, are familiar with the type of forged lathe boring tools shown in tthe accompanying illustration, but we wonder how many have heard them called "sore finger" boring tools? The credit for this expressive appellation is given to the late Edwin Reynolds, formerly chief engineer of the Allis-Chalmers Co., Milwaukee, Wis., by Mr. C. M. Conradson of Madison, Wis., who furnished the photograph.

A compilation of the expressive terms used by machinists to designate various machines and tools used in the manufacture and repair of machinery, would be interesting, no doubt, and we shall be glad to have readers from America and abroad send in odd terms used in the shops where they have worked to designate various equipment, especially when they are as pat as the foregoing example.



"Sore Finger" Boring Tools

* * *

With some people the fear of hard times seems to be a chronic disease, but during the last few months we have met some specimens of a new type of "worrier." There are some men who seem to actually fear that we are *not* going to have hard times during the next four years. We are speculating as to whether this is not merely because they are afraid that they will not have the satisfaction of saying, "I told you so."

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APRIL, 1913

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THE MODERN CONCEPTION OF SALESMANSHIP

Someone said long ago, "Anybody can sell anything to a man if he wants it. The real salesman is the man who can sell something to a man that he does not want." Fortunately this conception of the best class of salesmanship is no longer accepted by most high-class business concerns. Experience has taught that little is to be gained by selling something to a man that he does not want, and at the present time the best salesmen are not those who work on that theory, but those who have the ability to understand and analyze the customer's requirements and make him see his own needs, so that the sale means a bargain both to the buyer and seller. The most important thing for a successful growing concern is not merely to make sales, but to create a market, and this can be accomplished by selling to customers who actually want to buy—otherwise there is no likelihood of a second order from the same source. There is a difference between influencing a man to buy something he really needs and merely selling something to him. The salesman who makes men *buy* is a good salesman; the one who merely *sells* may in the long run lose his market.

* * *

SECRET HARDENING AND TEMPERING PROCESSES

That the hardening and tempering of steel tools is still largely a rule-of-thumb process is indicated by the fact that the circulars and other advertising matter of tool manufacturers abound in references to steel being tempered by secret processes. Shear blades are tempered in "our secret solution;" razor blades are hardened by "our secret method;" springs are tempered in "a bath prepared by a secret formula;" an inventor has "a secret process for hardening and tempering milling cutters without scale," and so on. One spring maker pays $5 a pound for a "secret salt" which he uses for a tempering bath. An expert metallurgist ventured the opinion that the chemical constituents were worth about sixteen cents a pound!

In view of the scientific work that has been done to determine exact methods of treatment for various kinds of steel, and the success with which scientific methods are attended, the claims made for secret processes are unworthy of this advanced age. It is of course true that all the vagaries of that complex compound known generally as "steel" have not been mastered by scientific experts, and certain so-called secret methods may be superior to more common methods within certain narrow limits, but that fact does not warrant the users in making the absurd claims for superiority that some do.

* * *

SAFETY IN THE MANUFACTURING INDUSTRIES

One of the gratifying features of the presidential address recently made by Mr. Arthur Williams of the American Museum of Safety in New York, was a report from the General Electric Co. on safeguarding machine tools. The company has made a careful study of this subject and seventy-five to eighty per cent of its 10,000 machine tools now have safety devices, the remainder being fitted out as rapidly as possible. A committee on safety devices has been organized with representatives from each of the principal works, who meet periodically to discuss and adopt standard protective devices. When this committee has agreed on standard devices it becomes the duty of the local committees of each plant to see that they are applied and kept in working condition.

While sentiment and altruistic impulse may play some part in the progress of industrial safety, business policy is the prime moving force. Corporations, large and small, are waking to a realization of the fact that dangerous conditions should not be tolerated in their plants. Systematic study of accidents has shown that simple precautions will eliminate a large percentage of them. Workmen are also beginning to realize more clearly their duty to themselves and their fellows to avoid the causes of accident and to regard and utilize the means provided to prevent them. This is indicated by the great improvement made by such concerns as the United States Steel Corporation, which employs 200,000 workmen, and which has reduced its accident roll forty-five per cent. The Midvale Steel Co. has cut down its accident list sixty-one per cent and the Pennsylvania R. R. Co. has reduced accidents to its 33,000 employes in the shops, sixty-three per cent. It is evident that the efforts of employers to promote safety are appreciated and that the spirit of cooperation has been awakened.

* * *

INTERNAL COMBUSTION ENGINE FUELS

The large number of automobiles and other motors now in use which consume gasoline has tremendously increased the consumption of this fuel during the past ten years. Not many years ago gasoline was an almost useless by-product, disposed of with difficulty by the oil refiners, but as the internal combustion engine became the leading vehicle motor, the demand increased so greatly that kerosene is now the by-product and gasoline the prized product. The high price of gasoline is a serious matter to makers and users of automobiles, and the need of engines that can use kerosene is imperative. The promise of alcohol as a cheap motor fuel has not been realized. The high prices of grains and vegetables from which alcohol can be produced have prevented it, as have also the government restrictions which make the operation of small plants impracticable.

Kerosene is superior to gasoline as regards safety, price and availability, but its high gasifying temperature which makes it comparatively safe to handle, is a detriment as an internal combustion engine fuel. It is true, of course, that internal combustion engines using kerosene have been in use for years; but they are not so flexible nor so easily started as gasoline motors. Various efforts have been made to adapt kerosene as a substitute for gasoline, and it seems probable that the substitution will be accomplished for automobiles in the near future. One plan is to provide two carbureters and two fuel reservoirs, one for kerosene and the other for gasoline, and when the engine is well warmed up to turn on the kerosene supply and shut off the gasoline. Each fuel being led through its own carbureter, no change of adjustment is necessary. In winter it is desirable to heat the kerosene supply, and that is readily accomplished by diverting the exhaust into a heating coil surrounding the kerosene tank.

THE MECHANICAL ENGINEER AND THE PANAMA CANAL

The leading article in this number of MACHINERY describes some of the mechanical engineering problems that have been solved in the carrying out of one of the greatest engineering undertakings of the world. It is interesting to note the part that the mechanical and electrical engineers have played in this great development. In general the visitor approaches Panama with the idea that the Canal is merely a great civil engineering undertaking; but when he sees the work in progress, he cannot fail to realize that tremendous as is the work of the civil engineer, many of the salient features of this wonderful connecting link between the two great oceans are purely mechanical in their character. The huge lock-gates and culvert valves with their operating mechanism, as well as the ingenious interlocking system which makes for absolute safety, are monuments to the skill and inventive ability of mechanical and electrical engineers.

The time has passed when the civil engineer, as such, can alone carry out an engineering work of the magnitude here met with. While he is in complete charge and must have a perspective of the whole work he depends to a very great extent upon other branches of engineering. All the machinery used in the excavation of the canal is the product of the mechanical engineer; and the operation of the canal, when once completed, will largely make use of electrical apparatus. It is doubtful if there is any engineering undertaking that has required the cooperation of so many different branches of engineering as has the Panama Canal, and it is therefore fitting that a mechanical journal such as MACHINERY should give an adequate description of some of the mechanical features of the construction.

* * *

THE NEED OF STANDARDIZATION

The need of standardization and the service which the Engineering Standards Committee of Great Britain has done in the fields of standardization which it has taken up, is well illustrated by the following incident: A few weeks ago a correspondent wrote to us complaining that a table of Whitworth standard pipe threads, as published in one of MACHINERY'S reference books, did not agree with data given in a table published in 1901. Upon investigating the matter and noting the sources from which the published information had been obtained, it was found that the table published in MACHINERY'S reference book on screw threads, which was based upon the practice of one of the most prominent tap manufacturers in the country, did not agree with that of another well-known manufacturer of these tools, and the practice of neither of these manufacturers agreed with the table published in 1901. All three of these tables, however, represented "standards" of manufacturers of high reputation in their field. Of course, neither of the three "standards" agreed with the newly accepted standard of the British Engineering Committee, although its table published in 1901 gave dimensions very close to those now accepted. In another case, a smaller tool manufacturing concern, working to the figures published in the catalogue of one of the leading makers, had a large number of taps rejected because they were not "standard."

It is difficult for an individual firm to procure the adoption of a standard, but an engineering society of established standing could have taken this work up long ago, and the confusion that now exists would have been avoided. In a few years we hope that in the practice referred to the recommendations of the British Engineering Committee will be adopted by all manufacturers; but notwithstanding the fact that the report of this committee was published in 1905, we find the old dimensions given by manufacturers in some of the small-tool catalogues of 1912.

There are scores of other instances where standardization would be a great advantage to both manufacturers and users. The engineering societies still have a great work ahead of them—work that will mean a great deal more to the engineering world than merely coming together at annual meetings and reading papers which are often received with indifferent interest.

ON SUGGESTION SYSTEMS

BY F. W. HARRIS*

It has always seemed to me that the suggestion box idea was a good one but I have been experiencing some trouble with such a scheme, and it may be interesting to see if others have encountered the same difficulty. We started with the assumption that our machinists were working largely with their hands but that there was no reason why they should not have an occasional good idea and several hundred idle brains might just as well be set to work for the benefit of the concern.

We installed boxes and offered prizes for the best suggestions and after several months are now taking stock. It does not seem to us that the results have been profitable. We have managed to get several very good suggestions that have more than paid us for our trouble, but we have apparently sowed the seeds of discord and made several very discontented men who are growling about the unfairness of employers in general and of us in particular. This is causing a loss in efficiency that seems to me to more than balance the gain that we have made. We wanted to encourage our men to think, and to show them that we appreciated their giving us the benefit of their thoughts.

The trouble seems to be that nine-tenths of the suggestions made are of no value and the suggestors will not take a turndown without getting "sore". Bill Jones, working on a lathe, gets an idea in his noddle that the design of a particular part is not right, and he starts spending his evenings improving it. He will not take any one into his confidence as he does not want his ideas stolen, and the result is that after a lot of trouble he turns in a suggestion that is entirely impracticable. Anyone who has had experience with a lot of engineers fighting about design knows how fond one grows of his own notions along such lines, and can appreciate how hard it is to show Bill that his pet scheme is utterly worthless. We tried it and gave it up; if the scheme is good—which happens one time in ten—we use it, but if it isn't we send Bill a very neatly printed note saying that his scheme is a good one but that we cannot use it—because of certain reasons which we cannot explain. We then go on to say that there are many reasons quite aside from lack of merit that compel us to turn down some schemes, such as patents that we dare not infringe, etc., and wind up by asking Bill to try again.

Bill does try again and he gets another slip reading just the same. With only one idea in ten proving worth while there are bound to be a lot of blanks, and every blank is regarded as more or less of an injustice. Then there has been some conflict of ideas; men often discuss their schemes and several times two men have put in the same idea. It has proved a hard matter to find out just who originated it. I have about decided that when you start to hold out promises of rewards for such matters you are more or less bound to stir up a hornet's nest.

Then there is the fellow that has made a suggestion to his boss, and has been turned down. He slipped the same scheme in the box and pretty soon the general foreman asked the foreman about the scheme. The foreman knew right away that the workman had gone over his head and that did not help to make relations pleasant. During our several months' use of the suggestion box a score of schemes have turned up that have been taken up and discussed and discarded after giving as thorough a consideration as practicable. On tracing the matter we have found that these were brought up by the same men who originally started them and who felt that their ideas were not adopted because of some trickery or bias. These incidents not only have caused a lot of extra work but some hard feeling. I personally have about decided that we should discontinue the boxes, but it would be interesting to hear from others who have tried them.

* * *

To find the weight of a casting when the weight of the wooden pattern can be ascertained, multiply the weight of the pattern by 9 if it is made of oak; by 9.7 if it is made of beech; by 12.8 if it is made of birch; by 13.4 if it is made of linden, and by 14 if it is made of pine.

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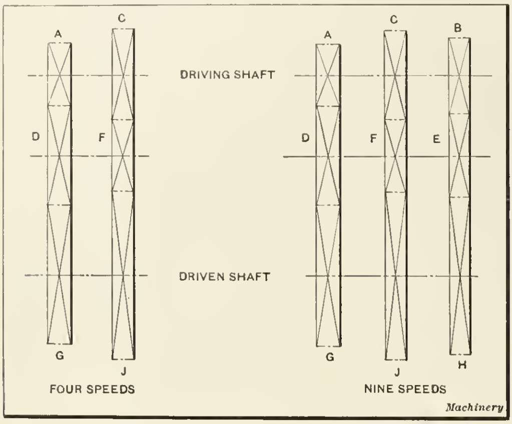
*Address: 615 Delta Bldg., Los Angeles, Cal.

FIGURING OUT GEARS FOR SPEED-BOXES

BY J. J. DENSMAN

Commonly used arrangements of speed-box gears giving four and nine speeds, respectively, are shown in the accompanying illustration. The gears on the driving and driven shafts are sometimes arranged to slide into engagement with those on the intermediate shaft; such gears are also designed to be driven or to drive through friction clutches, tooth clutches or sliding spring keys. In this type of speed-box, it is impossible to select gears so that the speeds of the driven shaft are in strict geometrical progression, although it has been stated that the speeds of certain machine tools in which this type of box is employed are in geometrical progression.



Gear Boxes which give Four and Nine Speed Changes

The writer has not come across any published information relating to the method of figuring out these boxes, and believes that the usual practice is to "cut-and-try" until satisfactory results are finally obtained. This formerly made it necessary for some hours to be spent in working out a box before arriving at a passable result, and there was then an uncertainty as to whether or not the best combination had been found. Consequently, the writer developed the following formulas which have been the means of effecting a great saving of time. These formulas do not lead directly to a complete solution, as there are many combinations of gears which will give the limiting speeds, but they narrow the choice of the dimensions for certain gears between fixed limits.

As a rule, such boxes are driven by a high-speed pulley or by a motor, and the ratio of the driving shaft speed to the minimum driven shaft speed is greater than that of the maximum driven shaft speed to the driving shaft speed. This leads to the selection of gear A on the driving shaft as the gear having the smallest number of teeth. For simplicity in dealing with the formulas, the number of teeth on this gear will be taken as unity. Let

S = speed of driving shaft in R. P. M.
X = maximum speed of driven shaft in R. P. M.
Y = minimum speed of driven shaft in R. P. M.

Then using notation shown in the illustration

$$J \text{ must not exceed } \frac{S}{Y} \tag{1}$$

and must be of such a value that

$$J\left(J^2 + J - \frac{S}{Y}\right) > \frac{S^3}{XY^2} \tag{2}$$

From these relations we obtain limiting values of J.

Then

$$C = \frac{J+1}{\dfrac{S^2}{XYJ} + 1} \tag{3}$$

and

$$F = \frac{YJ\,(C-1)}{S-YJ} \tag{4}$$

Having found values for J, C and F, it is a simple matter to obtain those for D and G from the equations

$$C - A = J - G$$
$$C + F = A + D$$

A good trial value for B in the nine-speed box is

$$B = \frac{J-C}{\sqrt{\dfrac{JG}{C}} - 1} \tag{5}$$

from which we obtain values for E and H.

By deciding on a certain number of teeth for gear A, we obtain numbers of teeth for the rest of the gears from the product of this number and the respective values obtained from the preceding formulas, the results being taken to the nearest integers. After a few trials with various values of J between the limits mentioned—the tendency of the resulting speeds being noted—the best arrangement is quickly obtained with the knowledge that it is the best for the number of teeth assumed for the gear A. By the best arrangement is meant the one whereby the speeds obtained are nearest to a geometrical progression. Some of the formulas may appear a little complicated but with the aid of a slide-rule they are quickly worked out. It might be mentioned that with values of J approaching the high limiting value, the values of F are high, becoming infinite in the limiting case, and are near to unity as the values of J are taken close to the minimum.

It may be of interest to show how these formulas were obtained.

$$X = S\frac{CD}{FG}; \qquad \frac{F}{D} = \frac{SC}{XG} \tag{6}$$

$$Y = S\frac{AF}{DJ}\ (A = \text{unity}); \quad \frac{F}{D} = \frac{YJ}{S} \tag{7}$$

From (6) and (7)

$$\frac{SC}{XG} = \frac{YJ}{S}$$

$$S^2C = XYJG$$

and as

$$G = J - C + 1,\quad S^2C = XYJ^2 - XYJC + XYJ \text{ and}$$

$$C = \frac{J+1}{\dfrac{S^2}{XYJ} + 1} \tag{3}$$

From (7)

$$\frac{F}{D} = \frac{YJ}{S}$$

and as

$$D = C + F - 1$$

$$FS = YJC + YJF - YJ$$

and

$$F\,(S - YJ) = YJ\,(C-1) \tag{4}$$

$$F = \frac{YJ\,(C-1)}{S-YJ}$$

Now for F to be greater than unity it is necessary that

$$S - YJ < YJ\,(C-1)$$

That is

$$S < YJC.$$

Substituting the value of C from (3) and simplifying, we get

$$J\left(J^2 + J - \frac{S}{Y}\right) > \frac{S^3}{XY^2} \tag{2}$$

From (4), S must exceed YJ for F to have a positive value.

$$\text{Therefore } J \text{ must not exceed } \frac{S}{Y}. \tag{1}$$

B is found by assuming $\frac{A}{G}$, $\frac{B}{H}$ and $\frac{C}{J}$ to be in geometrical progression. In using the formulas, it will be found advantageous to work out the values of $\frac{S}{Y}$, $\frac{S^2}{XY}$ and $\frac{S^3}{XY^2}$ separately for use in Equations (1), (3) and (2) respectively, with the different trial values of J, etc.

To illustrate the use of this method of figuring the gears for speed-boxes, we will assume a case in which the following speeds are required:

Driving shaft speed = 300 R. P. M. = S
Maximum driven shaft speed = 720 R. P. M. = X
Minimum driven shaft speed = 63 R. P. M. = Y

Then J cannot exceed $\frac{300}{63} = 4.76$, and a minimum value for J is obtained from $J\left(J^2 + J - 4.76\right) > \frac{300^3}{720 \times 63^2}$. From this data a value of 2.48 is obtained for J.

Commencing with 2.5 as the value for J

$$C = \frac{J + 1}{\frac{S^2}{XYJ} + 1} = \frac{2.5 + 1}{\frac{300^2}{720 \times 63 \times 2.5} + 1} = 1.95$$

$$F = \frac{YJ\,(C - 1)}{S - YJ} = \frac{63 \times 2.5\,(1.95 - 1)}{300 - 63 \times 2.5} = 1.06$$

Values for D and G can now be obtained by inspection.

$D = 2.01$
$G = 1.55$

$$B = \frac{J - C}{\sqrt{\frac{JG}{C} - 1}} = \frac{2.50 - 1.95}{\sqrt{\frac{2.5 \times 1.55}{1.95} - 1}} = 1.34$$

We then obtain values for E and H by inspection

$E = 1.67$ $H = 1.89$

Now assume that the gear A has 20 teeth. The numbers of teeth in the other gears will then be obtained by multiplying the preceding results by 20. Taking the results to the nearest integers we have:

$A = 20$ teeth, $B = 27$ teeth, $C = 39$ teeth, $D = 40$ teeth, $E = 33$ teeth, $F = 21$ teeth, $G = 31$ teeth, $H = 38$ teeth, $J = 50$ teeth.

The available speeds of the third shaft from this set are thus: 63, 103, 130, 194, 213, 234, 317, 484, and 719.

Other values of J may be tried and the most suitable set of speeds decided upon. It will be noticed that higher values for J will make the middle shaft gears larger and larger until they approach infinity for sizes nearing the maximum value of J. For some ranges of speed, values for B have to be modified as the speeds "cross" each other. It seems hardly necessary to mention the advantage of the slide-rule in dealing with these formulas.

* * *

COMBINATION OF NON-COMPETITORS UNDER THE SHERMAN LAW

In handing down the decision of the United States Supreme Court in the case of the Government against the United States Shoe Machinery Co., charged with violation of the Sherman Anti-Trust law, Justice Holmes stated that there can be no greater objection to one corporation manufacturing 70 per cent of three non-competing groups of patented machines collectively used for making a single product, than to three corporations making the same proportion of one group each. The disintegration aimed at by the statute does not extend to reducing all manufacture to isolated units of the lowest degree. As there had been no claim by the Government of unfair competition, the unanimous decision of the court held that on the face of it the combination was simply an effort for greater efficiency. The business of the several groups that combined was assumed to have been legal before the combination, and that being the case, the court states that it is difficult to see why the collective business should be any worse than its component parts. The court thus clearly declares that the Sherman Anti-Trust law does not forbid the mere combining of non-competitors in an industry.

PUNCHING EFFORT*

In punch work, there are a number of influences which affect the effort necessary to punch a certain sized hole through a given thickness. Principal among these are the relative proportions of the punch and die, for if the punch fit the die snugly, not only is there shearing action to be overcome, but in addition, a considerable binding of the punching in the punched plate and die. It has been found that the effort required is materially increased when the fit is snug, this also tending to shorten the life of the punch. If, however, the size of the hole be slightly increased, within certain limits the punching effort will be decreased, and the life of the die lengthened. Practice shows that for plate work, if the die be 1/32 inch larger than the punch, giving 1/64 inch clearance all around, conditions are much improved. However, if this amount be increased too much, the resulting punched hole will be conical in shape, and consequently, it is inadvisable to increase the clearance above the amount stated.

The punch and die are both given clearance to facilitate stripping the punched plate and punching, respectively. In the die, this clearance is given in various ways. In some cases, the inner wall is given a slight batter, the diameter at the cutting edge being as stated, and increasing slightly from this point down. In other cases, the wall directly below the cutting edge is left parallel for possibly ⅛ inch, with the hole enlarged for the remaining part of the die. Similarly, the punch is made either tapering gradually back from the cutting edge, or else receding sharply to a predetermined body size of uniform diameter. In bridge work the latter is more generally used, and is preferred, for the reason that when the cutting edges are dulled, it does not bind like the uniform taper punch.

In the Data Sheet Supplement it is assumed that the punch and die are so proportioned that the shearing effort alone need be considered, neglecting the previously mentioned binding action. In it are tabulated the pressures required to punch 0.25 carbon steel of a tensile strength of 65,000 pounds per square inch. It constitutes a very convenient reference table, making unnecessary much of the routine work usually accompanying such problems.

The effort required to perform this work is found by obtaining the product of the circumference of the hole by the thickness of the plate, which represents the area under shear, and multiplying this by the ultimate shearing strength of the plate. That is

$$P = \pi d t f_s$$

in which

P = punching effort or pressure,
d = diameter of hole,
t = thickness of plate, and
f_s = ultimate strength in shear.

For an example, consider a 1⅛ inch hole in a ¾ inch plate, where the shearing strength of the latter is 50,000 as on the Data Sheet. Then

$$P = 3.1416 \times 1.125 \times 0.75 \times 50,000$$
$$= 132,500 \text{ pounds.}$$

The employment of the table thus saves much work.

Punching, while not the best method of making holes in plates or structural shapes, is in almost universal use, with the possible exception of heavy marine boiler work, in which case it is customary to drill the rivet holes. The drilling process is preferred in that case, as punching has a tendency to crystallize the metal around the hole and weaken it, a condition that might prove fatal in large work which is more subject to this action than thinner plates.

* * *

A committee has been appointed by the British Government to inquire into and report on the conditions necessary for the adequate and suitable lighting of factories and work shops, with special reference to the nature of the work which is carried on and the protection of the eye-sight of the persons employed.

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* With Data Sheet Supplement.

LOCATING THE DRIVING SCREW ON HORIZONTAL BORING MILLS

BY W. G. DUNKLEY*

In a recent article on the location of supporting chains for the spindle slide of horizontal boring machines, the writer discussed the question of the turning moment on the spindle slide in the plane of the upright face under various conditions. It was also mentioned that there may be a turning moment in a plane at right angles to the upright, which would cause a binding action between the slide and upright in this plane. Assuming the same loads as were used in the previous article—a slide weighing 8 tons, and balance weight weighing 4 tons—if the conditions are as shown in Fig. 1, the upward reaction of the screw on the slide and the total pull in the chains will be equal. The resultant of these two forces of 4 tons will be a force of 8 tons acting midway between their points of application along the line D–D, and the turning moment on the slide will be $8d$ ton-inches. A consideration of the illustration will show that it is desirable to reduce the distance d as much as possible. This is done by keeping the center of gravity of the slide as near to the upright as possible and also by bringing the screw out as near as possible to the center of gravity of the slide in this plane. The chains should be secured on the opposite side of the center of gravity from the screw, their location being brought as nearly as possible to meet the conditions in Fig. 2, where the twisting moment on the slide is zero.

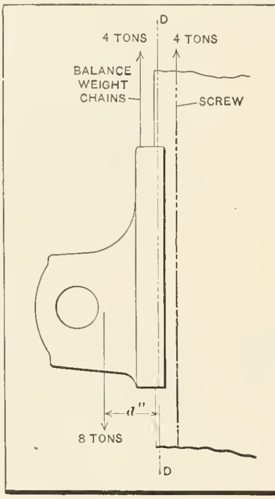

Fig. 1. Location of Resultant of Forces on Slide

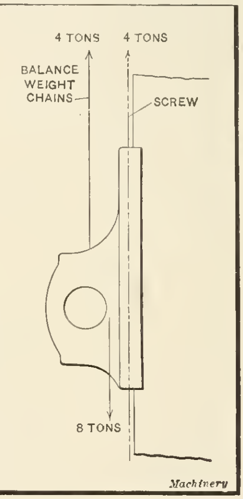

Fig. 2. Conditions which make Twisting Moment Zero

In the article referred to, the writer also pointed out that it was desirable to keep the vertical screw as near as possible to the face of the cut in the plane of the face of the upright, where the machine was engaged on vertical milling. Provided the supporting chains are properly placed with respect to the position of the vertical screw and the center of gravity of the slide, it was shown that this arrangement reduced the turning moment in this plane to a minimum when the slide was stationary. The question now arises, "Does this also apply to the horizontal driving screw in the bed?" It is never safe to assume that because a calculation holds good for one case it will hold good for another case. Bearing this in mind, it will be interesting to look into the influence which the position of the horizontal driving screw in the bed exerts upon the turning moment on the upright. As an example, let us consider the case in which the center of gravity of the load on the bed—consisting of the weight of the upright, spindle slide and balance weight—is located on line C–C in Fig. 3, which passes through the middle of the bed if the bed is equally loaded on the two surfaces. Denoting the load by W tons, the resistance to motion due to frictional forces on the top of the bed will be μW tons, where μ is the coefficient of friction. The resultant of this frictional resistance will come directly beneath the center of gravity, and assuming that the screw is located under the line C–C, which is in the middle of the bed in this case, the force on the screw will be equal to μW in order to just cause the upright to move. The turning moment of the upright will be zero as shown in Fig. 4.

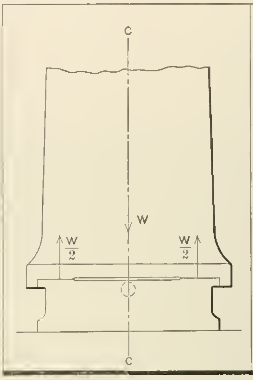

Fig. 3. Distribution of Load on Bed

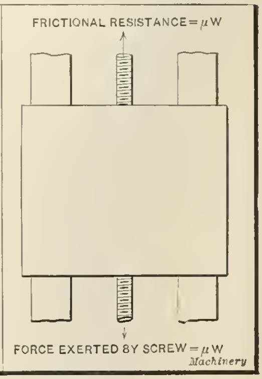

Fig. 4 Amount of Frictional Resistance to Motion

Assuming a case where the machine is milling horizontally and the resistance of the cut is P tons acting at a distance L from the middle of the bed, there will be a turning moment giving rise to the forces Q on the edges of the bed. These forces Q will cause additional frictional resistance μQ along each edge of the bed, as shown in Fig. 5. For these conditions, the screw has to overcome the force P due to the resistance of the cut and the frictional resistance $\mu W + 2\mu Q$. This makes the total force between the screw and upright to just cause motion equal $P + \mu W + 2\mu Q$. Taking moments of the forces parallel to the screw about an axis through the screw, we get a turning moment of

$$PL + \mu Qx - \mu Qx = PL.$$

This moment is balanced by the forces Q from which we find

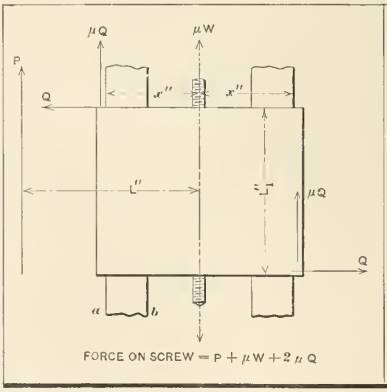

Fig. 5. Frictional Resistance due to Turning Moment

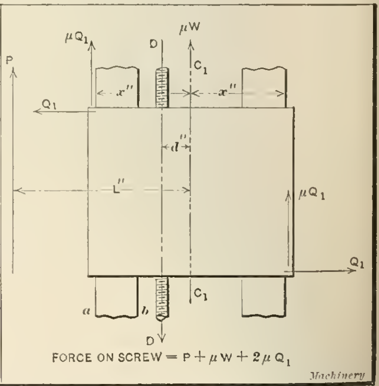

Fig. 6. Effect of varying Position of Driving Screw

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$QL_1 = PL$. The transverse frictional resistances on the top of the bed would reduce the values of the forces Q in this case, but this fact will not affect the deductions arrived at with respect to the position of the screw, as we are not so much concerned with the forces resisting the turning moment as with the forces which tend to augment it. Thus when the screw is under the center of gravity, we have no turning moment on the upright when it is being traversed, but there is a turning moment of PL ton-inches when the machine is engaged in milling.

Let us next consider a case in which the screw is moved a distance d toward the point of application of the force P, as shown in Fig. 6. Taking moments about the middle of the bed, the turning moment of all forces parallel with the screw will be zero when the machine is engaged in milling. This condition is expressed in the following equation:

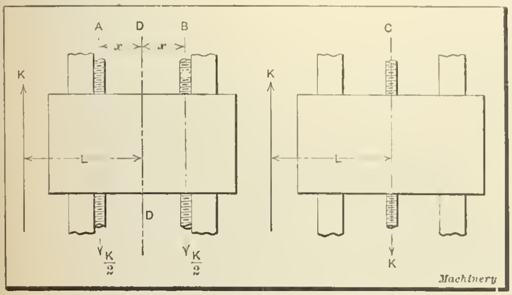

Fig. 7. Turning Moment where Two Driving Screws are used Fig. 8. Turning Moment with One Screw instead of Two

$$PL + \mu Q_1x - \mu Q_1x - (P + \mu W + 2\mu Q\ )\,d = 0$$

from which we find that the value of d which will give a zero turning moment is:

$$d = \frac{Pl}{P + \mu W + 2\mu Q_1}$$

But for such a case, we would have a turning moment equal to

$$(\mu W + 2\mu Q_2)d$$

when the machine is being traversed. In this case, W equals 25 tons, so that the turning moment is considerable, and in determining the best position for the horizontal screw, we have to choose between two evils: shall we arrange to have the turning moment a minimum when the machine is engaged in milling, or when the upright is traversed over the bed? Evidently we cannot secure the advantages of the best location for each individual condition. The best we can do is to have one-half the turning moment in each case by putting the screw somewhere between the lines D-D and C_1 C_1. It is evidently poor designing to put the screw to the right of the lines C_1-C_1, as this brings it further from the point of application of the force P and makes the turning moment greater for both milling and traversing.

The question of the narrow guide does not properly come within the scope of this article but it seems advisable to point out that with the guide which is at a and b as shown in Fig. 5, the only alteration would be that the forces Q would act along a and b instead of in the manner shown. The result in this instance would be an increase in the turning moment due to the forces parallel to the screw which shows a slight disadvantage in this respect for the narrow guide as compared with the broad guide.

It is obvious that no golden rule can be laid down respecting the position of the driving screw of the machine, since it can only be decided from a consideration of the circumstances which govern individual cases. It appears that little improvement in the amount of turning moment can be obtained by using two driving screws instead of one. Referring to Fig. 7, we will assume that the forces on the two driving screws are equal, the force in each case being $\frac{K}{2}$, in which K is the resultant of all resisting forces, its point of application being at a distance L from the line D-D midway between the center of the two screws. Taking moments about D D, the turning moment is $KL + \frac{Kx}{2} - \frac{Kx}{2} = KL$. In Fig. 8, a single driving screw C is substituted for the two screws of the preceding illustration. The force on the screw in this case will be K and the turning moment KL as before, from which it will be seen that, so far as the turning moment is concerned, there seems to be little advantage rising from the use of two screws. Of course, the pressure on each of the two screws is less than where single screws are used, with the result that there is less wear. There may also be other points of advantage which have no direct bearing upon the subject of this article but which might have to be considered when deciding whether two screws or one are best suited for the requirements of the machine that is being designed.

* * *

WINDING PIANO WIRE TENSION SPRINGS*

BY C. R. T.

Most mechanics have their own method of winding springs, but many of these do not comply with the most approved practice. During the writer's experience as a mechanic, he has had occasion to wind practically every type of tension spring, and the information which he has gathered on this subject is presented in tables which appear in the current Data Sheet Supplement. These tables are practically self-explanatory, but it may not be out of place to cite typical examples showing the method of using them:

For this purpose it will be assumed that a mechanic is required to wind three different springs; the first to be wound with 0.035-inch wire and to fit in a 3/4-inch hole; the second to be wound with 0.040-inch wire and to fit in a 3/16-inch hole; the third to be wound with 0.060-inch wire and to be a sliding fit on a 1/2-inch shaft. Reference to the tables will show the proper sizes of mandrels to be as follows: For the first spring, 0.625 inch; the second spring, 0.250 inch; and the third spring, 0.437 inch, 0.011 inch being allowed for play between the spring and shaft in the latter case.

In all cases where the mandrel diameter is in excess of 3/8 inch, the mandrel is mounted in a lathe chuck. Mandrels of less than 3/16-inch diameter are mounted in a drill chuck. In fastening the wire in a lathe chuck one jaw is usually loosened and where the mandrel is driven by a drill chuck, the wire is placed between the jaws and the mandrel. If a long spring is required, a mandrel of corresponding length is used, which is ground to an angle of 60 degrees at the end to fit into a female dead center for support. The wire is placed in a bench lathe boring-tool holder or a V-holder in the toolpost. A piece of brass about 1/8 by 1/2 by 3 inches is placed between the wire and the toolpost screw. A groove 1/32 of an inch deep is filed in this brass to hold the wire in place. The groove is filed in the lengthwise direction of the brass plate and is made of the proper depth for the size of wire from which the springs are being wound. This clamping arrangement is tightened up with the toolpost wrench, just enough tension being put on the wrench to keep the wire from slipping.

When it is required to wind springs of a standard pitch, provision is made for this purpose by means of the lathe gears, the pitch of standard springs being the same as that of standard screws of corresponding diameters. Consequently the customary tables used for screw cutting can also be used for winding springs according to this method.

* * *

Aluminum is being used to some extent for jig and fixture frames. It has the advantage of being only about one third as heavy as cast iron, which is the reason, of course, for using it. Machine operators can readily handle an aluminum jig which would be beyond their strength if made of cast iron. The cost of aluminum jigs is higher than that of cast-iron jigs, but not in proportion to the relative costs per pound. Aluminum weighs, bulk for bulk, only about one-third as much as cast iron, and at the present market price the bulk cost is about the same as cast iron at from seven to eight cents a pound.

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* With Data Sheet Supplement.

MAKING STEEL TYPE*

CUTTING LETTERS IN STEEL BY HAND AND MACHINE

BY CHESTER L. LUCAS†

The general method of making type of type metal (tin, lead and antimony) for printing is well known, but to make type from steel so that it can be set up and used for stamping metal in the same way that printing type is used, is quite another matter. The Schoder & Lombard Engraving Co., 18 Franklin St., New York City, makes quantities of steel type that can be set and locked in chases the same as regular printing type, and some of the methods used in the manufacture should be interesting to those not familiar with this class of work. In making steel type the perfect alignment, even length, uniformity of face, etc., are as necessary as for printing type. Steel, of course, cannot be cast in type form; therefore, the letters must be cut upon the type face starting from the solid steel. This type is made for stamping steel, brass and wooden novelties with makers' names, etc., and also for printing on cloth and other materials where ordinary type would not give long service. For such purposes the type can be set up and used exactly the same as ordinary type. At *A* and *B*, Fig. 1, are shown pieces stamped with this type and in Fig. 1 separate types may be seen at *E*, *F* and *G*.

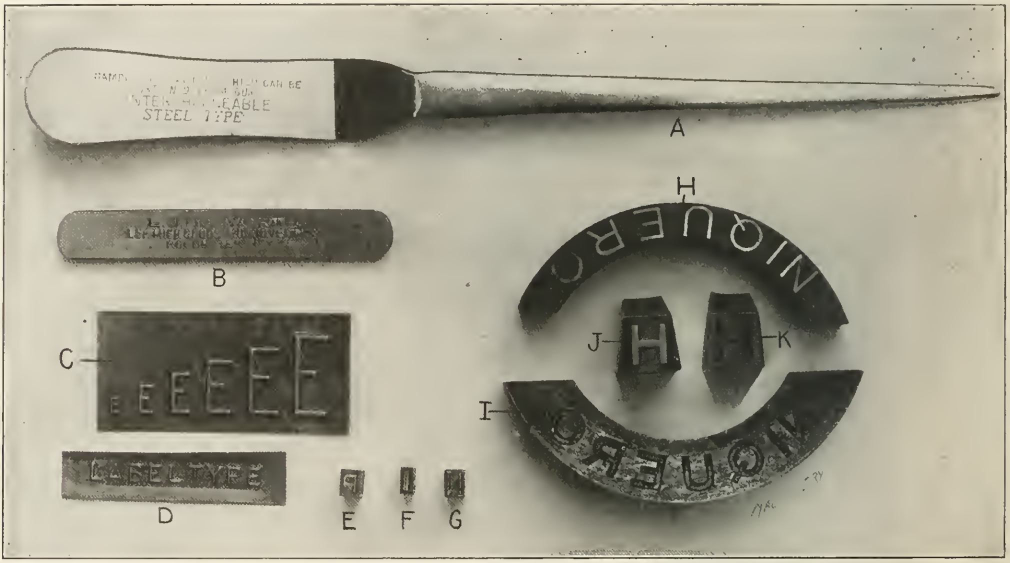

Fig. 1. Samples of Steel Type and Work stamped from them

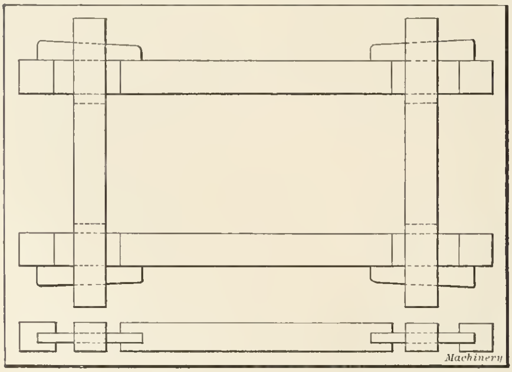

Fig. 2. The Chase in which the Type is held for Grinding

Preparing the Blanks

The stock from which steel type is made is cold-drawn high carbon steel, and the three-foot long strips come drawn very accurately to size. In making a given font, stock is selected of such proportion that all the letters may be made upon a standard size of blank excepting the letter I which requires a narrow blank. By making a special style of M and W, the use of wide blanks is obviated. As the type is finished to a length of 0.625 inch (standard printing type is 0.918 inch high), the blanks are sawed to this length plus 0.005 inch—just enough to allow for finishing. A 5A font has 150 characters; therefore this number of type blanks is cut off, using a cutting-off fixture on a milling machine, while clamped in the special chase shown in Fig. 2. This chase is a simple outline with adjustable sides which may be keyed about the font of the type. Different sizes of these chases are used to accommodate fonts of large or small type. Keyed in this frame the type blanks are taken to a surface grinder and while held on a magnetic chuck they are ground to a length of exactly 0.625 inch. In order to keep this size uniform, an ordinary limit gage is used for checking the lengths of the blanks. This gage is shown at *A*, Fig. 12.

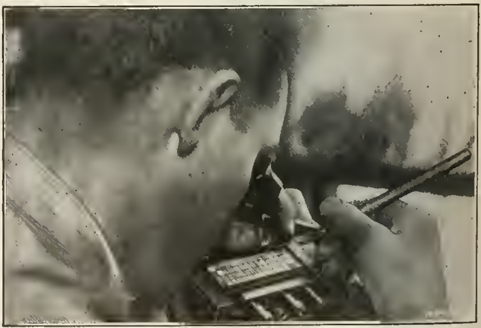

Fig. 3. Laying out the Letters on the Type

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*For further information on cutting letters in steel, see "Steel Letter Stamping Dies," published in MACHINERY, January, 1912, engineering edition.

† Associate Editor of MACHINERY.

Routing out the Type

The blanks, which are now all of standard length, are next locked in a special holder shown in use in Fig. 3 which is used for handling the type from this stage until ready for hardening. The blanks are set up in this box with thin spaces separating them and strips to separate the rows. The object of separating the blanks will be made apparent later. By tightening the set-screws on the sides and end of this holder the blanks are held rigidly so that they can be machined without difficulty. While locked in this box any necessary laying out is done as shown in Fig. 3. Some of the cutting may be done without previous laying out, such letters as O. U and other easily made letters are handled in this manner. The more difficult shaped characters like R, S, and & are usually carefully laid out before cutting.

One of the machines used for routing or milling out is illustrated in Fig. 4. This is a Becker vertical milling machine specially adapted for this class of work. The box with the blanks locked in it is clamped on the table of the machine, and by means of special high-speed cutters the letters are routed out. At *A* in Fig. 5 is shown the style of cutter used almost exclusively on this work. These cutters are made of high-speed steel shaped like a diamond, as indicated in the illustration. It is obvious that the two lips of the diamond do the cutting and as the point of the cutter is sharpened chisel-shape, it may be fed downward when reaching into the center of a letter O or similar character. These cutters are finished with an average included angle of 30 degrees.

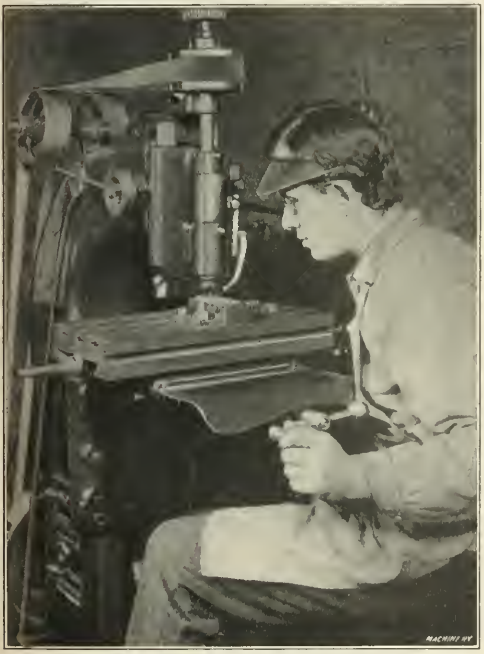


Fig. 4. The Milling Machine on which the Type is routed

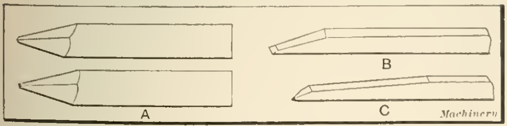


Fig. 5. Cutter and Gravers used in Type Making

If the letters must be cut deep and narrow, it is necessary to use a cutter of less degree. At best, this work is hard on the cutters and they must be favored as much as possible in order to keep them in good condition. It is much easier to start a small cutter like this from the side of the work than to force it to cut to its depth straight downward; and it is for this reason that the blanks are separated by a space in the holder. In routing out the different parts of the work the cutter is guided by both of the feed handles. The handles are worked separately over the horizontal and perpendicular lines and simultaneously over the inclined lines. Through continued practice an operator becomes adept in its manipulation. An air blast is provided to keep the chips clear from the cutting point, and the work is done without the use of lubricant of any kind. Large cutters are used wherever possible, for they, of course, give the best service. The average cutter speed is 1400 R. P. M. To keep the cutting to standard depth, the adjustable stop for the spindle is set, and the cutter is brought down to the right depth by pressure upon a foot treadle, thus leaving both hands free for the operation of the feed handles.

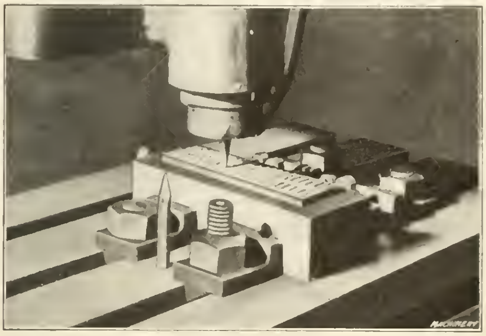


Fig. 6. Detail View showing how the Cutter works on the Type

Hand chipping or filing is not resorted to. By relying solely upon machine work for removing the metal several advantages are gained. In the first place the bevels are kept uniform, which would be practically impossible if a file or chisel were used. Even bevels mean that no matter how deep the type is forced into the material to be stamped the impression will be even. By the use of the machine the horizontal and perpendicular lines are kept at right angles to each other so that at the final finishing it is only necessary to smooth up the sides, which can easily be done without losing the alignment of the letter. The third reason for milling the entire letter rather than filing or chipping the outside is that the work may be finished completely in the holder, thus requiring a minimum of handling in producing the work. Referring to Fig. 6 it will be seen just how the cutter is used in routing out the type.

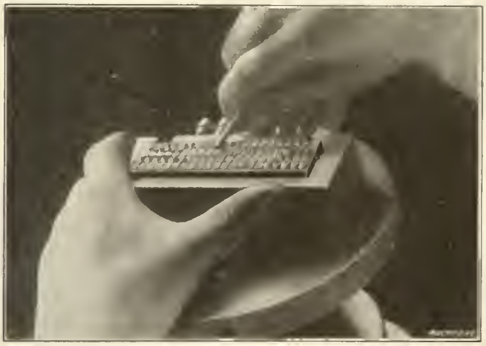


Fig. 7. Trimming the Type with a Flat Graver

Engraving the Type

There is, of course, a limit to the amount of work which can be done on the blanks by routing. After this point has been reached the remainder of the work must be accomplished by hand, using engraving tools like those shown at *B* and *C*, Fig. 5, for the purpose. Fig. 7 illustrates a type-cutter starting to trim up a font of type. Here he is shown with a flat graver squaring up the sides of the routed letters, an operation which requires a skilled workman. For this hand work the type is still retained in the holder, being mounted in the engraver's vise shown in this illustration. The tops and bottoms of the letters are first squared up, then the outsides of the letters are similarly treated with the flat graver which is shown in detail at *B* in Fig. 5. Next the pointed graver, illustrated at *C*, Fig. 5, and known to the trade as a "Spitz tool," is employed for cleaning up the insides of the letters, squaring out the round corners left by the cutter and otherwise completing the work. While trimming up the type it is essential that uniform bevels be maintained, that the sides of the letters be free from irregular spots, and that the faces of the type be even; of course, the sizes and proportions of the letters must agree. Obviously, the work requires much skill, and as the metal being worked upon is tool steel the operation is especially trying.

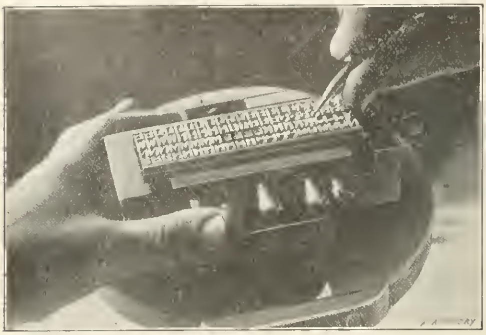


Fig. 8. Using a "Spitz Tool" in Trimming

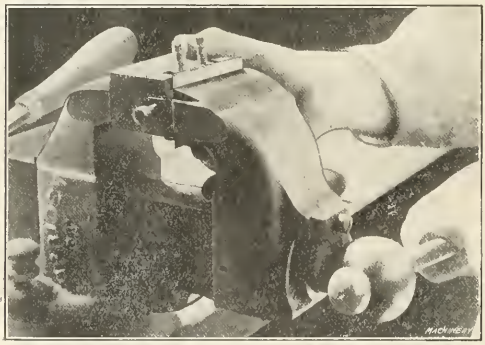


Fig. 9. Taking an Impression of a Font of Type

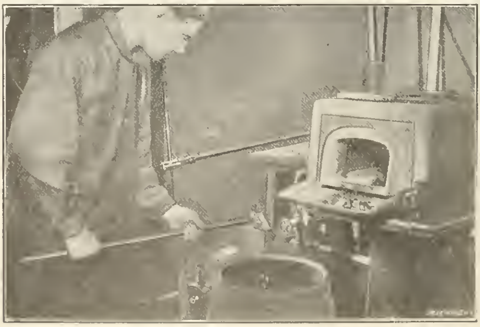


Fig. 10. Hardening the Type

After all the cutting on the work has been completed an impression of the letters in the holder is taken in the manner indicated in Fig. 9. The box of type is held between the vise jaws and a piece of cardboard of the proper quality is placed against the faces of the letters next to the vise jaw and pressure applied to the handle of the vise. This of course causes the letters to be imprinted on the cardboard and by inspecting the resulting impression the workman can tell if the letters are perfectly straight, of the same size, height, etc., more readily than he could by inspecting the type itself. While it is very important that the printing surface of the type blank be maintained, occasionally it becomes necessary to face the end of a piece of type slightly. For this purpose a special facer is used which may be seen at *B* in the illustration Fig. 12. Another case where this facer is utilized is when making up single pieces of type. This facer is a simple affair having a corner into which the blank is pressed, at the same time being held against a stop at the bottom while a file is used on the part of the blank which projects above the hardened top of the facer-jig.

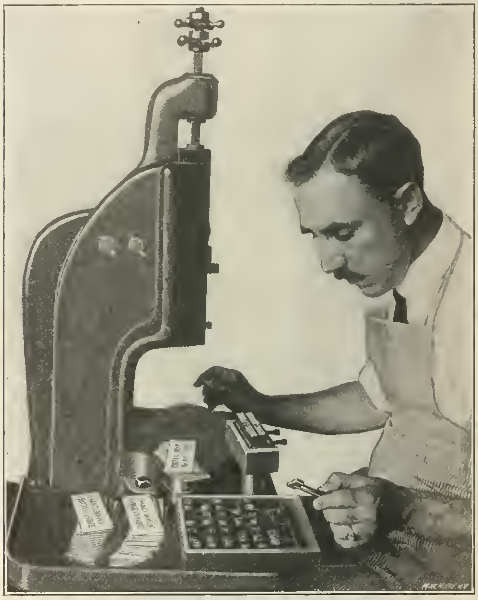


Fig. 11. Method of using Steel Interchangeable Type

After the engraver has finished the hand work upon the type it is ready to be hardened. This operation is illustrated in Fig. 10 from which it will be seen that the type is heated on a thick iron plate, using a muffle furnace. When at a proper heat the hardener slides the pieces from the plate into a brine solution. After the temper is slightly drawn the type is ready for use for stamping or printing.

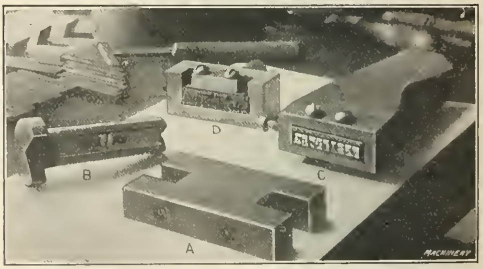


Fig. 12. Type-holders, Facer and Gage

Using the Type

For stamping metal articles like those shown at *A* and *B*, Fig. 1, the type is used in a foot, screw or power press, according to the character of the work. For printing on cloth or similar material it is used in a printing press in the ordinary way. Fig. 11 illustrates a pressman setting up steel type for printing soft aluminum plates, a foot press being used for the purpose. The type-holder or chase is similar to the box in which the type is held for cutting, except that it has a hardened steel plate at the bottom and is fitted with a shank so that it may be held in the press. A smaller, but similar holder, is shown at *D*, Fig. 12, and on a larger scale in Fig. 13. Holders are also made for stamping by hand and one of these is shown at *C* in Fig. 12. The only difference between this holder and the one shown at *D* is that it is made from a forging which is provided with an end which may be struck with a hammer. As in the case of the holder shown at *D* this hand stamping holder is fitted with a hardened plate at the bottom of the type-holder to prevent the type bodys sinking into the soft steel holder. One of the great advantages of using steel type rather than solid steel stamps is that different words may be set up without going to the expense of having new stamping dies cut. In addition when a piece of type becomes broken it is only necessary to insert a new piece.

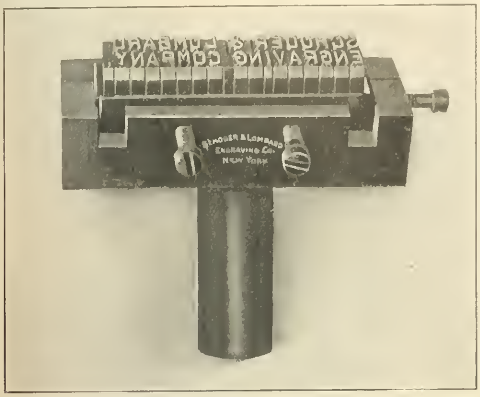


Fig. 13. A Small Type-holder set up ready for Use

Embossing Type

Type for embossing letters in sheet metal is also made along the same lines. Referring to Fig. 1 again, at *C* and *D* may be seen specimens of embossing by means of movable steel type. This type is made the same as stamping type except that the letters are sunk in the blanks. The letters are laid out and routed and then finished by hand in the same manner as raised letters. For forcing the sheet metal into these letters copper "forces" may be made by striking a piece of copper into the previously set up type, or, if the metal to be embossed is too thick to permit of this being done, raised letter type, made to correspond to the sunken letter type, is used. Embossing type of this character is difficult to make. First the sunken letters must be cut, then the corresponding blanks for the raised letters must be held in perfect alignment with the sunken letters and an impression taken. The sunken letter type has of course been previously hardened. The steel surrounding the impression on the raised letter blanks is then routed away. By thus fitting each raised letter to its corresponding sunken letter and numbering the pairs, it is insured that good alignment will be secured. With a font of this embossing type metal articles may be embossed with any desired words or lettering.

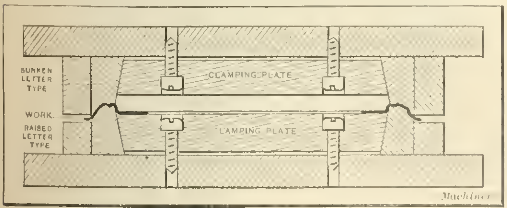


Fig. 14. An Interesting Use of Embossing Type

One Application of Embossing Type

An interesting set of embossing type was recently made by the Schoder & Lombard Engraving Co., for embossing automobile lamp trimmings. The maker of automobile lamps wished to stamp the dealer's name on each lot of lamps ordered, but as the name had to be embossed on the rim of the lamp which surface was also crowned, the dies necessary for each individual shipment were quite expensive, and of course a separate die was required for each name to be embossed. To overcome this die expense the manufacturers made a stamping fixture to fit into a power press. The general design of this fixture is shown in Fig. 14, and as will be seen it consists of two halves; the lower part is fitted to receive the raised letter type and the upper holds the sunken letter type. Suitable clamping plates may be drawn down against the beveled sides of the type. The raised letter type is set up in proper position and the location of the corresponding sunken letter type is adjusted before being finally clamped in position. The work is then treated in the ordinary manner, being laid upon the lower die and the letters embossed between the type. In making the type blanks rings were first turned to the proper dimensions. The blanks were then sawed from these rings being in the form of segments. Two of these pieces are shown in Fig. 1 at *J* and *K*. It will be seen that after once being equipped with these tools this method of embossing was more economical than was the case when the solid dies were used, for it will be readily appreciated that the cost of these special dies was high. Two of the solid embossing dies that were formerly used are shown at *H* and *I*, Fig. 1.

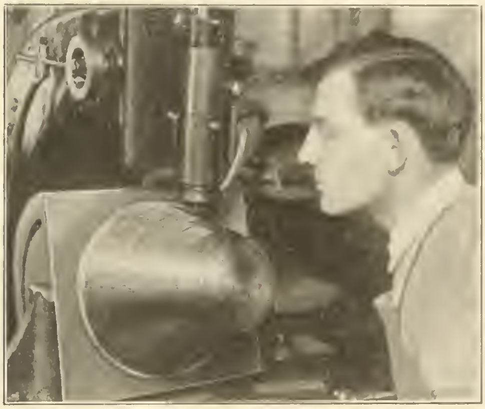


Fig. 15. Milling the Perforations in a Hat Mold

A Special Machine Engraving Job

Although somewhat foreign to steel type making, the operation shown in Fig. 15 is interesting, being done on one of the Becker milling machines used for type making. The work is done on a brass shell, 1/16 inch thick, and is used in the hat-making industry. It is necessary to perforate this shell as indicated by the black marks on the work. To do this the shell is mounted upon an adjustable angle-iron, first being supported upon a wooden arbor. While in this position the cutting is done with one of the tools used for type-making. The work is turned from time to time to present different surfaces of the shell to the cutter, and while the job is tedious it is effectively accomplished on this machine

* * *

BRITISH INDUSTRIAL CONDITIONS

The British Board of Trade returns for 1912 indicate that the machine tool industry in Great Britain was in a flourishing condition during the past year. The exports of machine tools were valued at about $4,675,000, which was about 20 per cent more than in 1911. The total value of exports of all classes of machinery amounted to over $160,000,000, being an increase of more than $10,000,000 as compared with the preceding year. British shipbuilding also broke all previous records during the past year. There were at the end of the year, in course of building, merchant vessels with an aggregate gross tonnage of about 2,000,000, and battleships with a total tonnage of 500,000.

SKILTON DIGS SOME CLAMS—A VACATION STORY

BY A. P. PRESS

Skilton had a bug—not the good old-fashioned kind that we always have with us, and which the poem says, "has no wings, but arrives at its destination just the same." Skilton's bug was an entirely different kind, and its name was "Scientific Management" or, as he expressed it: "The Conservation of Energy."

It is true Skilton had good reasons for having this insect, for the nature of his work forced it upon his mind continually, but Skilton's theory was that the same practice could be applied to the everyday walks of life—in the kitchen, down cellar after coal, and in fact, there was no limit to its application.

He went through the square in this way and every clam * * * was deposited in the bucket with one motion of the arm

So when the middle of August came around, and he and Mrs. Skilton and the three little Skiltons went on their annual vacation, he proposed to put his theory into practice. They went, as all good city people do, to the seashore, only it was to the real seashore where you get your clams with a digger and bucket, and do not cross the palm of the native with silver unless you are forced to when the fish do not bite.

The first morning after breakfast Skilton proceeded to demonstrate his theory down on the clam flats. His idea was that if he could get next to a native, he could work out his idea without saying anything and prove it to be just what he had said it was.

Equipped with a round bucket, because mathematics had proved to him that a round receptacle held more in proportion to its weight than any other shape, and a new clam digger, he started for the flats. Half way down to the beach he fell in with a barefooted boy, who seemed to consist chiefly of a long pair of legs, encased in overalls much too large, and a shock head of hair that would have made John D. (and some of the rest of us) green with envy.

"Going clamming, sonny?"

"Well I guess so."

"Guess I'll drop in with you."

And "drop in" Skilton did, and the two meandered down to the clam flats. Getting down to the beach Skilton proceeded to put theory into practice. He marked out a square of about ten by twenty feet, and started down in the lowest corner (it is easiest to dig up hill, you know). He took just the same amount of earth with the digger each time, and reduced his motion so as to use the least possible amount of muscular exertion to each one, and when he came to a stone, removed it with the same care and put it one side.

He went through the square in this way and every clam, when he found it, was deposited in the bucket with one motion of the arm. He got through his track and counted his clams and he had thirty-seven, and then started over where "Legs" was working. The boy had his basket nearly full, but a look at the beach disgusted Skilton. He had dug here, there, and everywhere, and when he got to a rock he just let it be. (He knew there were no clams under it.) And when they did not come out thick enough he had gone on to a new spot. A shiftless way, thought Skilton, but it certainly brought results.

"Kind of dirty, aren't they, sonny? Think we had better wash them?"

So out in the clear water they both waded. The boy did not seem to mind it, but it did not feel good to Skilton to get his feet wet. Skilton poured out his clams, dipped in his pail, rinsed it out two or three times, picked up his clams again, and pronounced them clean. The boy dropped his basket into the water, gave it a shake and a swirl, and picked it up with just clams, and no dirt left, and they started for home. Going back of the last bunch of sea-weed, Skilton says:

"Say, what will you take for the clams?"

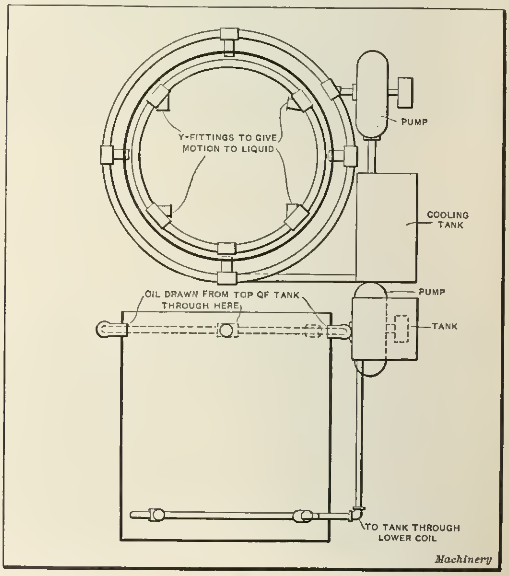
"A quarter."

There was an exchange of commodities and Skilton put his thirty-seven clams on top of the others and went home. Mrs. S. was pleased, and they had the clams for dinner. But scientific management, as applied to digging clams, was not served at the table the rest of the vacation.

* * *

AN OIL QUENCHING TANK AND COOLING SYSTEM

The accompanying illustration, taken from *American Vanadium Facts*, shows a cylindrical quenching tank and cooling system used by the American Locomotive Co. for quenching engine parts. The chief feature of interest of this tank is the means provided for keeping the oil at a uniform temperature. The hot oil is drawn off from several points about two feet below the surface and is pumped through a series of coils, submerged in running water, then back through the tank at points close to the bottom. The tank is set within another sheet-iron tank sunk in the earth, and is so placed that its top is a few inches above the floor level. The circulating water is pumped by a No. 2 Gould rotary pump through 250 feet of two-inch pipe. The cooling tank as shown in the illustration is not drawn to scale. With this equipment, anywhere from thirty-five to forty tons of forgings can be quenched in twenty-four hours.


PUMP
Y-FITTINGS TO GIVE MOTION TO LIQUID
COOLING TANK
OIL DRAWN FROM TOP OF TANK THROUGH HERE
PUMP
TANK
TO TANK THROUGH LOWER COIL
Machinery

Oil Quenching Tank and Cooling System used by the American Locomotive Co.

* * *

The approximate output of automobiles in the United States durnig 1912, was 275,000; the estimates given vary from 250,000 to 285,000. Judging by the reports from several automobile companies this output should be considerably increased in 1913.

THE HUMAN FACTORS IN ENGINEERING PRACTICE*

ORGANIZATION METHODS, PRINCIPLES OF MANAGEMENT, ETC.

Organization is recognized as an economic necessity to the effective control of cooperative human effort. Organization deals with men rather than with things, and industrial organization includes the elements of production, transportation and commerce. The business problem in any undertaking is to limit expenditures in such a way that a satisfactory margin of profit may be preserved. This requires the most effective team work, both on the part of the individuals who constitute the officers of the enterprise and those who form the rank and file of the industrial team. Organization is the art of uniting and directing the working forces in order that they may produce the most satisfactory result. It is the duty of the officials not only to operate a plant economically, but also to anticipate business fluctuations, to measure the productive value and desirability of extension, to check mere increase of size, and to make reasonable provision for a contracting expense of organization during periods of depression.

In a certain sense, the individual must organize his efforts if he is to be in any way certain of success. To succeed, he must first have a clear understanding of what he desires to do; second, he must determine the method he will use, and third, he must act constantly and persistently in the prosecution of the method which is to secure the desired result. Frequent changes in the method of procedure—even where such changes are for a better plan—will not lead to success. What is true of individual effort applies even more to the action and reaction of individuals in their authority over one another, and with the substitution of an organization for an individual, new difficulties arise. The individual suffers only from his own lack of ability, but where more than one person are concerned, there are added dangers of misunderstanding, of clashing opinions, of a diversity of interest, and of insubordination and intrigue. Organization cannot entirely eliminate these difficulties, but it can reduce them in direct proportion to its degree of efficiency.

The question of centralizing authority is one which requires careful consideration, and there are two extremes between which the most desirable results lie. If the officials are entirely unrestricted in their actions the interest of the industrial organization is often lost sight of and harmony of action becomes impossible. If, on the other hand, all power of initiative is placed in the hands of a central executive, he will have such an amount of detail to look after that great delay is unavoidable, and it will be impossible for him to study varying conditions which arise, with a result that general rules are applied in cases requiring special attention. Under such management the emergencies which arise in every industrial undertaking are handled in a feeble and inefficient fashion, and a disastrous breakdown of the organization is almost certain to occur.

Organization Methods

There are two important methods of handling the organization problem or a large undertaking having a number of plants—the divisional and the departmental methods. Under the divisional method, single plants and enterprises are given a more or less complete organization under one chief executive officer. The departmental method, on the contrary, provides an officer in charge of all similar departments regardless of where they are situated, with subordinate officers who report to him from each place. In actual practice the divisional plan of organization is not completely carried out, as motives of economy and varying local conditions do not permit of the sharp separation of work at different places. With the departmental plan of organization, this difficulty disappears, but others take its place. As a rule, no one department is sufficient unto itself, as its work requires the cooperation of other departments. Under this method of organization it is more difficult to eliminate any lack of harmony, because reference has to be made to a common superior officer who is not so closely in touch with local conditions. The divisional method of organization tends to develop more broadly trained men for the higher positions than is possible in the departmental plan. Such men have "gone through the mill" and have been brought closely in touch with the workings of departments other than those in which they have been employed, the result being that they have a broader outlook upon industrial conditions.

The Necessity for a Leader

The prime object of organization is to bring brainy men together for work and action, and a wise organization seeks and engages men of ambition. It is realized that success demands an aggregation of men of strong individuality, who are free to contribute their quota of wisdom, but who make their individual preferences secondary to the general policy of the organization. In order that work may be well done, and to have its action strong and forcible, the organization must move as a harmonious unit, and mere scheming can never lead to ultimate success. Herein lies the task of the leader—the organization of men, and the systematizing of things. Both of these factors are important and it is a fortunate coincidence when one individual combines capability in both directions. The principles followed in a good organization may be outlined as follows: 1. An executive with power to decide on all points where action must be taken is provided. 2. The responsibility of each position is fully and carefully outlined, in order that misunderstanding may be avoided. 3. The duties of the different organization positions are made to conform satisfactorily to the ability of those chosen to fill them. 4. No person is made subordinate to two or more superior officers, if it is possible to avoid such a course. 5. The power to discipline men in any department rests in the hands of the official who is held responsible for results. 6. The duties of the members of the organization are distributed so that a fair comparison of results is possible. 7. Wherever possible no positions on the staff are created which offer no further opportunity of promotion for an ambitious man.

The Place for the Engineer

The last twenty years of industrial development have been characterized by a steady advance in the part which the engineer has played in this field. In all branches of industry men of purely clerical and commercial experience have been replaced to a considerable extent by engineers. The result has been that such men, aided by their sound scientific and practical mechanical knowledge, have directed their energies toward a careful analysis and accurate solution of industrial problems, and where these men have also developed executive ability, the combination of self reliance, leadership and trained judgment has placed many engineers high in industrial organizations. At present many of our technical schools are training men to fill just such positions, and they are designated "engineers" for lack of a more adequate term.

Many an engineer has failed in organization work because of his limited knowledge of human nature and his inability to deal intelligently with his fellow men. Such men are content to be individual designers of distinction, or consulting engineers on purely mechanical matters, and in such work a lack of broad knowledge of human nature doesn't hurt them professionally. But this shortcoming certainly limits their opportunity of advancement to the highest positions in industrial work. Of all requirements of the engineer who is seeking a place in an industrial organization, there is none of such vital importance as executive ability—the art of getting things done. This should not in any way be confused with personal ability to do things. Executive ability is closely allied to character and may be developed to a certain extent, although it is originally a natural gift. There are many men who can invent, men who can clothe a scheme in engineering dress, who can carry financial and commercial preliminaries to a successful close, but who are unable to get the scheme itself carried out to a satisfactory conclusion. Many young engineers find themselves in the unfortunate position of knowing how to do a thing without being able to get it done. When the project is finished on paper some men have lost all interest in it, so that the idea for them is merely a creation of the mind without any real significance. Such men may be good calculators or excellent estimators, but they are not engineers. The engineer is the man whose task interests him right up to the final step which brings it to completion.

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*Abstract of lectures delivered to senior students of the Stevens Institute of Technology, Hoboken, N. J., by John Calder, of the Cadillac Motor Car Co., Detroit, Mich.

Cooperation

The ability of the young engineer must be supplemented by the faculty of getting along harmoniously with his fellow executives. It may sometimes appear advantageous for a man to hold aloof from his fellow workers, and in rare cases this may actually be true, but failure to cooperate heartily with his fellows is a fatal error to the ultimate advancement of an engineer. No man ever failed in life through doing too much for others. Team work is the essence of modern progress and the higher industrial executives are now more on the alert to perceive and to reward it than over before.

Management of the Modern Plant

The modern element in the art of management is the adoption of what has long been known as the scientific method. Its industrial applications cover a wide field and a writer defines it as follows: "The critical observation, accurate description, analysis and classification of all industrial and business phenomena of a recurring nature, including all forms of cooperative human effort, and the application of the resulting records to secure the most economical and efficient production and regulation of future phenomena." In other words, all repeated experience with men and methods is criticised, carefully verified and recorded, and by the three methods of logical inference, *i. e.*, analogy, induction and deduction, is made to yield new results ready for application wherever they appear to be justified. Utility is the only justification for expenditures on scientific methods of management and there are quite a few of its results which cannot be economically applied to industrial conditions. The ability to avoid the application of new methods in cases where they are not suitable is lacked by men who have not had wide shop experience. Previous to the application of scientific management, observed differences in the efficiency of plant operation were largely due to the varying ability of managers.

In 1897—sixteen years ago—there were signs of an increasing number of technically trained men in the practical control of industrial plants, as distinct from laboratory work. This marked the unformulated and unnoticed beginning of the new element in management, and quite a few of the shop executives had been mentally prepared for advancement before the new era had been recognized. An analysis of the published matter on this subject, made by the writer at the time when the new movement began, shows that the directors of the metal working trades in particular had followed the path of least resistance and applied new methods largely from the accounting side of the business. This resulted in more reliable inventories and cost systems, and brought out the causes of inefficiency to a limited degree, so that it was possible to inaugurate reforms. But comparative cost systems could not establish standards of shop performance and methods of obtaining them; and although the accountant was first in the field, he lacked ability to deal with the work and was later supplemented by the experienced engineer, with an all-round training and a new point of view regarding the problem of management.

The Regulative Principles of Management

This new element in the art of management has been defined as the use of the scientific method in industry. The general problem of industrial establishments is economy, and may be defined as follows: "To furnish daily the prescribed quality and quantity of product in all its varieties by most efficient shop and labor arrangements, and with a minimum of cash capital locked up in the process." A productive organization and system of plant management which will accomplish this and continue to do so with harmony and to the satisfaction of both the employer and the employe attains the desired end. In problems of management the most satisfactory results are derived from observing the three following classes of industrial conditions. 1. The economic results of different arrangements and forms of materials and all operations upon them. It is the object of the scientific method to make the most of past experience to see that efficient methods are used. 2. The economic results for varying executive methods for effectively directing human effort as a whole in the use of the data obtained from observation of the operating conditions. 3. The economic results of steps taken to raise the industrial efficiency of the individual worker in every grade of service. This covers the entire problem of labor, reward and intensified activity. By carefully considering these conditions and the data derived in this way, it is possible in many cases to formulate a scientific basis for economically handling business and industrial conditions which recur periodically.

Review of the Past Ten Years

Ten years ago the recognized divisions in management were being modified more or less consciously under the influence of the scientific method. In varying combinations these divisions have appeared in specific "systems" during the past ten years combined with some special method of labor reward or incentive; but essentially they are all industrial practices of long standing. It was at this stage of the movement that a number of accountants, followed by engineers, specialized in the promotion of industrial efficiency and from time to time published their "systems" of management. Foremost and most important of these "systems" was that now termed "scientific management," which F. W. Taylor advanced in 1903 as an outcome of his researches into the art of cutting metals. In many ways his experiments differed in no important essential from the previous investigations for determining other mechanical and physical constants, but the large number of variables which were involved rendered his labors exceptionally difficult and tedious and had hitherto deterred engineers from attempting a solution. They led in particular to a scientific re-arrangement of men, materials and operating methods, upon which was based the generalization that the laborious and expensive task of framing a true science for every element in industrial problems was not only possible, but an absolute necessity as a preliminary to securing higher efficiency. Mr. Taylor went even further and claimed that the main elements of his experimental efforts were identical with those required for the solution of a vast number of other and quite different shop and business problems.

Many factory executives, who are convinced that the application of the scientific method is the inevitable and natural course in the solution of industry and of business, are by no means agreed that Mr. Taylor's solution, or indeed any of the formulated systems which have followed it, are equal to the requirements of industry as a whole. They believe that before the scientific method can be made capable of general application, it will be necessary for it to find application in a large variety of industrial problems from which experience may be secured.

Some Reflections on Ways and Means

It can scarcely be said that the Taylor system has made any impression outside of the machine shops and it has gone only a short way in that branch of industry. But this does not reflect discredit upon the scientific method, which must always face different conditions in industry from those met with in science, and constantly yield to and be measured by consideration of ultimate utility, of available capital, and of current prices and profit. It is futile to expect any future in industry for a scheme of management which uses science to the smaller benefit of the investor, although such a course may be followed by the zealous systematizer. It is seldom desirable to commit a concern to an elaborate program of re-organization which involves years of transition experience and expense. It is necessary for men believing in scientific management, but more conservative and experienced than the ardent systematizer, to hold the reins of business and "guide the team." An undesirable condition has arisen through the efforts of practitioners in methods of management to promote their business as rapidly as possible. With this end in view, figures have been published showing remarkable increases of efficiency that have been secured in certain cases, but without explaining what the conditions were before the new system was made effective. The latter is necessarily a most important point in enabling an estimate to be formed of the improvement that was effected through the substitution of a new system of management. There is perhaps no more useful service which the engineer can render in industrial work than to secure and circulate information which will convince factory owners and executives that the scientific method opens up no royal road to success, but that it simply affords a most practical and reasonable course toward the efficient control of industry.

* * *

MILLING KEYWAYS ON A PLANER

BY H. A. STENGER*

The illustrations show a Cincinnati planer which has been equipped with an attachment for milling keyways in shafting. In Fig. 1, a shaft is shown clamped to the table in three V-blocks ready for cutting two keyways 1¼-inch wide by ½-inch deep and about 20 inches in length; these keyways are located 18 inches from each end of the shaft, and they can be cut at one setting of the work and one cut. In using this attachment, the cross-rail of the planer is lowered so that it just clears the clamps used to hold the work. The milling cutter is held on a shaft running in a bracket bolted to the planer head, the toolpost being removed from the head and the bracket bolted in its place. The bracket used for this purpose was made from a broken crankshaft.

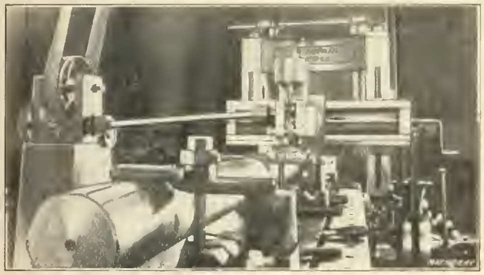

Fig. 1. Planer equipped with Fixture for milling Keyways

Fig. 3 shows a near view of the driving mechanism which is set up at the left-hand side of the planer for driving the milling cutter and feeding the work. This mechanism is belted to a countershaft and is made from an old locomotive driving-box. It is set up on a stand about twelve inches higher than the table of the planer and at a distance of 3 feet from the bed of the machine. It will be seen that this drive has two shafts, the upper one being belted to the countershaft and connected to the lower shaft by gearing. The lower of these two shafts is connected to the upper shaft of the milling attachment by means of a universal joint, and drives the milling cutter mounted on the lower shaft of the attachment through gearing.

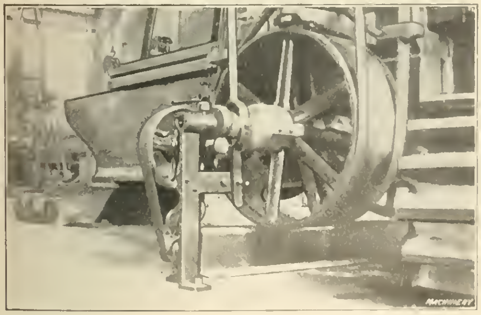

Fig. 2. Belt-driven Reduction Gear for feeding Table

A small shaft will be seen extending out at the back of the driving mechanism in Fig. 3. The 1½-inch belt running over the pulley on this shaft passes under the bed of the planer and drives the loose pulley through the worm-wheel connected with its hub by a clutch. The belt on this pulley runs up to the planer countershaft and drives the tight pulley by means of the second belt. For milling keyways with this attachment a very slow table travel is necessary and the drive is arranged to give the required speed reduction. When it is desired to reverse the direction of table travel, the clutch is knocked out and the belt shifted; the table can then be backed away by pulling the belt by hand.

The interesting feature of this attachment is that it is made almost entirely from material taken from the scrap pile. It has already been mentioned that the bracket for the milling attachment was made from a broken crankshaft and the drive from an old locomotive driving-box. Most of the gears that were required on the milling attachment and drive were available among our supply of lathe gears, so that it was only necessary to cut a few small pinions for use in this connection.

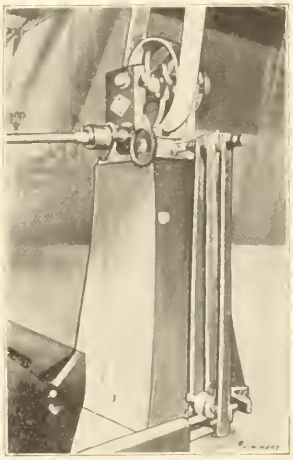

Fig. 3. Device that was used for driving Cutter and Power Feed

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CHROME-VANADIUM STEEL WHEELS

The results of comparative tests made on chrome-vanadium and carbon steel tender wheels on the Vandalia R. R. were recently made public. The tests show that chrome-vanadium wheels average 2½ times as much mileage per unit diameter of wear and turning as do carbon steel wheels in the same service. The average load per wheel was 17,875 pounds. The average mileage per 1/16 inch diameter wear was 12,857 miles for chrome-vanadium wheels and 9249 miles for carbon steel wheels; the average mileage per 1/16 inch turning was 6894 miles for chrome-vanadium steels and 3544 for carbon steel wheels.

The valuable characteristics of chrome-vanadium steel wheels are uniformity of material, absence of shelled or burned spots on tread, less flange wear, less material wasted in turning wheels in the lathe and consequent greater mileage per inch diameter of wear plus turning. The physical properties of the chrome-vanadium wheels are: Elastic limit, 98,000 pounds per square inch; ultimate strength, 140,000 pounds per square inch; elongation in 2 inches, 7 per cent. It is the general opinion of wheel experts that the capacity of a wheel or tire to resist wear and shelling depends on the elastic limit of the material. When shelling or kindred troubles occur they can be greatly reduced or practically eliminated by using steel having a sufficiently high elastic limit and other physical properties in proper ratio. The high elastic limit of chrome-vanadium steel used for tires is indicated in the foregoing summary of ten tests.

The wheels are subjected to special heat-treatment, developed as the result of research. The heat-treatment consists of heating the wheel to a temperature of 800 to 875 C. and then spinning it for a predetermined time in a trough of water with the tread immersed to a point slightly below the wear line limit of the wheel. The wheel is then taken out and cooled in air, after which it is reheated to 600 to 700 C. for annealing. By this method of heat-treatment the plate and hub of the wheel are not affected by the immersion of the rim in water, except that they undergo an annealing operation as a result of the hardening of the rim.

* * *

The steam engine has been threatened with extinction a number of times, but apparently it is not frightened. It seems to hold its own very well.

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*Address: Cowell, Via Bay Point, Cal.

STEAM POWER PLANT PIPING DETAILS—3

MAIN STEAM HEADER DETAILS

BY WILLIAM F. FISCHER*

The general arrangement of the piping at the main steam header is governed, to a large extent, by the arrangement of the boilers and engine units, and by other local conditions such as the general design of the building, structural details, etc. In this article, the writer will not attempt to show the complete design of a main steam header with its boiler and engine connections, methods of supporting mains, etc., but will describe the details at the header for one or more units and several methods of arranging the piping to accomplish certain results, leaving the reader to adopt what he feels is the best method for any specific case.

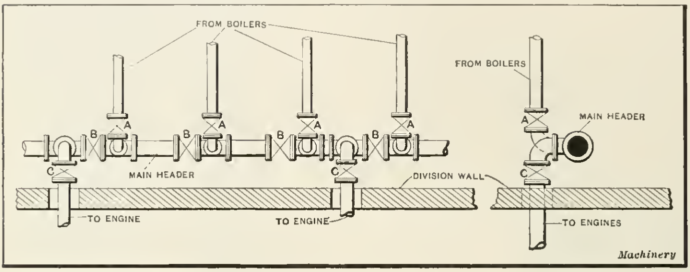

Fig. 13. Arrangement of Piping for a Plant with Boilers and Engines Back to Back in Separate Buildings

In Fig. 13 is shown a method of arranging the main steam piping in a power plant in which the boilers and engines are placed back to back in separate buildings with a division wall between them. As stated in the first installment, the main steam header, and as much of the steam piping as possible, should be placed in the boiler room so that a blow-out will not damage the electrical apparatus. In this case, the main header is run along the division wall at the rear of the boilers. The boiler branches make connection to the top of the header through the gate valves *A* and elbows, as shown.

The main header is protected by the gate valves *B* placed between each pipe connection to and from the header. The steam for the engines or turbines is taken from the top of the header through elbows and gate valves *C*. If so desired, the gate valve and elbow at each connection to or from the header may be replaced by an angle valve. The object of the valves *B* is to make it possible to isolate any section of the main header in case of accident, so that the plant will not have to be shut down while repairs are being made. This subject was discussed at more length in the first installment. The end elevation of the piping shows the connections to and from the header. One objection to this system is the large number of valves *B* that are required, and as these valves are quite costly, they are frequently placed between every third or fourth connection to the header instead of between each connection. In some cases these valves are omitted entirely, their use in any specific case depending upon the designer's judgment as to whether they are required or not. In central power stations where a blow-out in the steam main may seriously cripple the lighting and power system of an entire town or city, it is advisable not to take any chances of a "shut down." In any case, the designer should study the conditions carefully before deciding what arrangement of piping and valves to adopt for any particular case. Another objection to this system is the large number of flanged joints in the main header that must be made up with gaskets and repacked when leakage occurs.

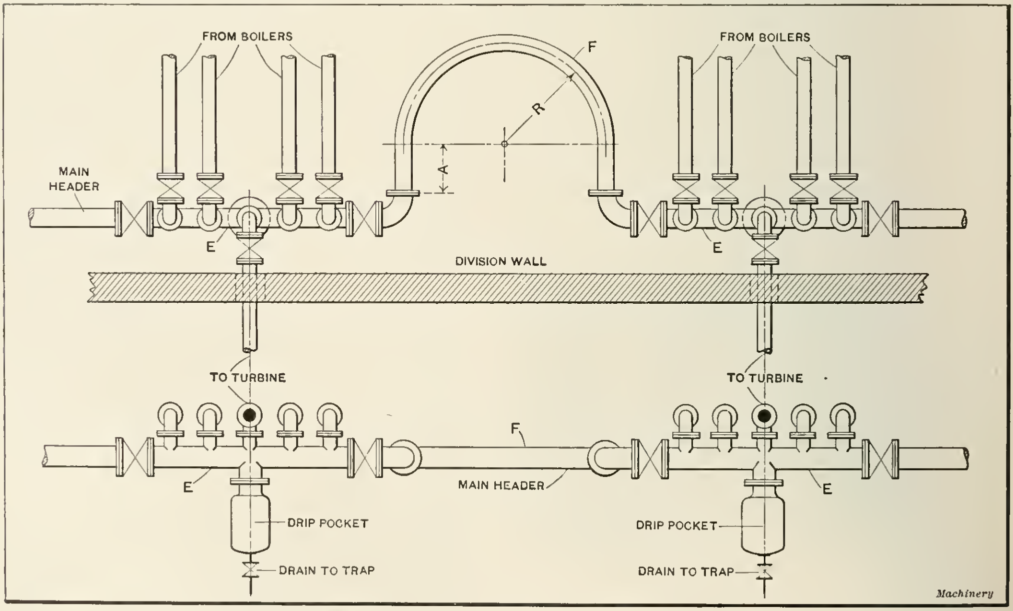

Fig. 14. The "Unit System" of Piping; in this Case Four Boilers and One Turbine constitute the Unit

In Fig. 14 is shown another method of arranging the piping at the main header. In this case, the branch pipes to and from the header make connection to the top of manifold fitting *E*, as shown, and each branch pipe is equipped with a straightway gate valve and elbow where it makes connection to the header. As previously mentioned, this gate valve and elbow may be replaced by an angle globe valve, if so desired, but the writer favors the construction shown in Fig. 14. A gate valve is placed at each end of the manifold fitting *E*, thus dividing the main steam header into independent units or sections, making it possible to cut any section of the header out of service as desired. This piping is arranged on what is known as the "unit system." In this particular case, four boilers and one steam turbine is considered a complete unit, since four boiler units are required for the operation of each turbine unit. Therefore, if the valves at each end of the manifold fittings are kept closed, the piping system will be operated on what is known as the "unit system of operation." The steel manifold fitting is cast in one piece, thus doing away with a considerable number of flanged pipe joints in the main header, and a drip pocket should be placed beneath each manifold fitting, as shown. This drip pocket will keep the piping system free from water, thus preventing water-hammer and similar troubles in the piping system and in the engine cylinders. The expansion bend *F* provides for expansion and contraction in the main header and prevents the strain from falling on the pipe joints. This bend should be made from a piece of "full weight" steel pipe, heated in a furnace and curved or bent to the required dimensions. In order that this bend be made as flexible as possible, the radius *R* should be as large as existing conditions permit, and never less than six times the diameter of the pipe from which the bend is made. For the same reason, the straight ends of the bend *A* should be as long as possible, and not less than 1½ times the diameter of the pipe.

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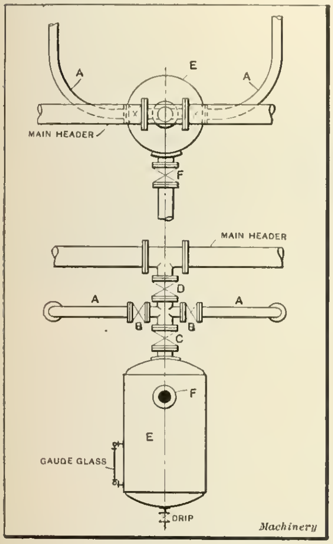

Fig. 15. Another System of Piping for Unit Operation; the Main Header acts as Tie-line between Units

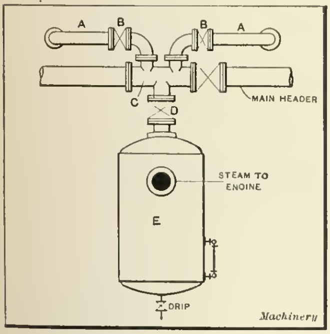

Fig. 16. Arrangement of Piping where Separator drains Condensation from Main Header

Another method of arranging the piping at the main header for independent unit operation is shown in Fig. 15, the main header acting merely as a tie-line between the several different units. In this case each engine or turbine has its own complement of boilers which discharge into the boiler headers *A*. These boiler headers or branch pipes are brought together at the main header through the valves *B*, the steam from the boilers entering the separator *E* through the valve *C* and passing on to the engine or turbine through valve *F*. Ordinarily, the valve *D* is kept closed, thus isolating the main header. In this way, each unit may be operated independently of the others and at its most efficient and economical steam pressure. Thus, the boilers for one unit may be operated at 125 pounds gage pressure, another unit at 150 pounds gage pressure, and another at 180 pounds gage pressure, as desired. (By gage pressure is meant the steam pressure in pounds per square inch as registered on the boiler steam gages.) If it is desired to shut down any one engine unit, and use the steam from the boilers temporarily to supply an engine or turbine of any other unit, valve *F* may be closed, valves *B*, *C* and *D* opened, and the steam passed through the main header to the desired engine unit. By leaving valve *C* open, any water carried over from the boilers will flow to the separator and not be carried over into the main header with the steam. In this particular case the steam separator *E* is quite large, being of the receiver type, and for this reason it was placed in the boiler room as shown, rather than in the engine room.

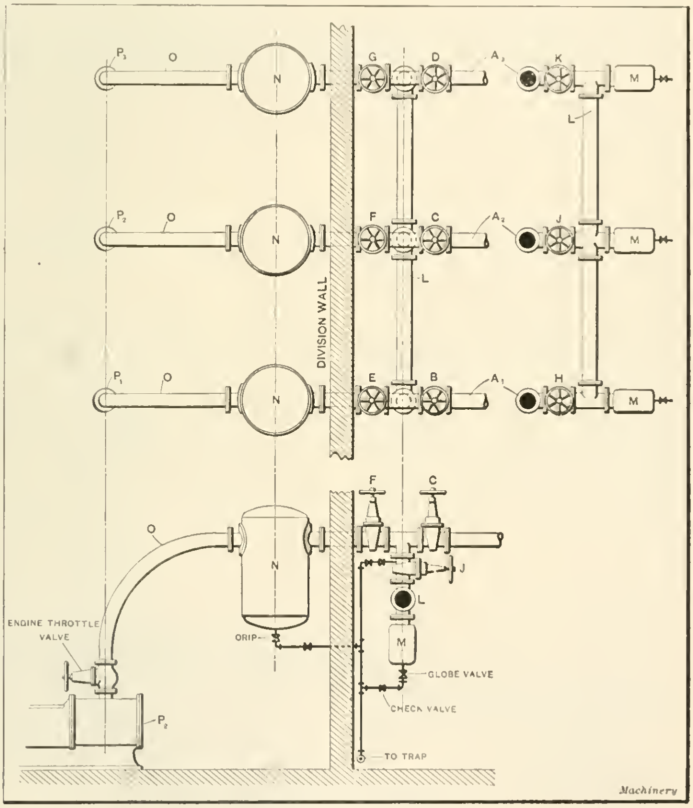

Fig. 17. Arrangement of Piping for Unit Operation, showing Method of diverting Steam from One Boiler to Different Engine Units

In Fig. 16 is shown another method of arranging the piping at the main header. In this case the steam from the boilers enters at the top of the main header through bends *A* and valves *B* as shown. A special manifold tee *C* is used, which takes the place of three standard tees and reduces the number of joints in the header. The separator *E* keeps the header drained free from water during operation through the valve *D*.

Still another method of arranging the steam piping system for independently operated boiler and engine units is shown in Fig. 17, where the boiler headers A_1, A_2 and A_3 supply steam to the engine units P_1, P_2 and P_3. In this case each engine unit has its own complement of boilers, and the main header *L* acts merely as a tie-line between the different units; this header is protected by drip legs *M* to keep the header and piping drained free from water during operation. These drip legs and also the steam separators *N* (shown on the engine room side) should be drained to a steam trap, pump and receiver, or other suitable device for returning the water of condensation to the boilers. When each engine unit is to be operated independently of the others, valves *H*, *J* and *K* should be closed, thus isolating the main header *L* entirely. If it is desired to pass the steam from any one set of boilers to any one engine unit, this may be accomplished by opening and closing the proper valves at the main header. As an example of the flexibility of this system, assume that engine units Nos. 1 and 2 are in operation, each engine being supplied by its own complement of boilers, and that boiler and engine units No. 3 are out of service at the time. In this case valves *E*, *B*, *F* and *C*. are open and valves *H* and *J* closed, permitting the steam from boiler headers A_1 and A_2 to flow direct to engine units Nos. 1 and 2, respectively. Now, assume that it becomes necessary to shut down engine No. 1 and put engine No. 3 in service in its place, using steam from boiler header A_1 without interfering in any way with the operation of engine and boiler units No. 2. In this case, valve *J* being already closed, it will be necessary to close valves *E* and *D*, and open valves *B*. *H*, *K* and *G*; engine unit No. 3 is then ready for service, using steam from boiler header A_1 in place of A_2. Valves *H*, *J* and *K* should be drained above the seat, as shown in the end elevation, as they form a water pocket in the line when closed. The steam separators are shown in the engine room, in this case, but they may be placed on the other side of the division wall (in the boiler room), if so desired. A vertical type of separator may also be used, having a top inlet and bottom outlet, in which case it could be placed directly above the engine throttle valve. Bends *O* should be curved to a long radius in order to provide for expansion and contraction strains in the piping system.

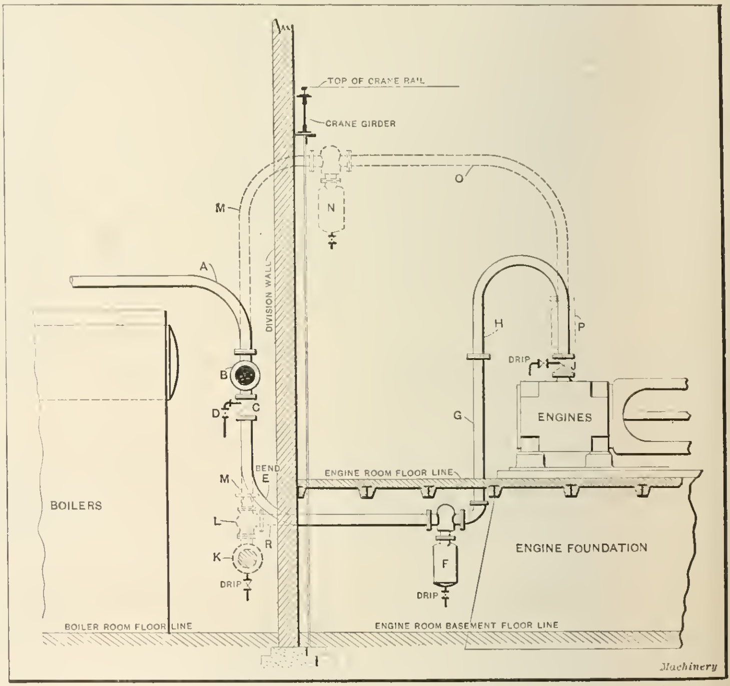

Fig. 18. Two Methods of connecting Engines with Main Steam Header, where Engine and Boiler Room Floors are on Different Levels

Steam Connections between Main Steam Header and Prime Movers

In the second installment of this article, in Figs. 6 and 7, examples of incorrect and correct piping connection between header and engines were illustrated and discussed. In Fig. 17 another method of connecting the engines with the main steam header is shown. In this case the steam separators are placed in the engine room close to the division wall, and long radius bends *O*, leading from the separators to the engine throttle valves, provide for expansion and contraction of the piping on the boiler room side.

Fig. 18 shows two different methods of connecting the engines with the main steam header in a power plant in which the engine room floor line and the boiler room floor line are on different levels. In this case the engine room basement floor line is on a level with the boiler room and the engine room floor line is at a higher level. Referring to the piping shown in full lines, the steam from the boilers enters the main steam header through bends *A*. The main header is placed at the rear of the boilers, as shown at *B*, and may be supported by brackets bolted to the division wall, or hung from the roof beams overhead (not shown). From the main steam header, the steam is taken off to the engines through valve *C*, bend *E*, steam separator *F*, riser *G*, bend *H* and engine throttle valve *J*. In a steam line connecting the engine with the main header, a valve should always be placed close to the header, as shown, so that the line may be shut down when necessary to pack joints, etc. The throttle valve at the engine is usually supplied by the engine manufacturer. The steam separator *F* is of the receiver type, and as it is placed in the engine room basement, at the lowest point of the piping system, any water of condensation forming in the main header and branch pipes will drain into the separator, thus keeping the main steam header free from water, and, at the same time, preventing water from being carried over to the engines. In this case the steam connection is taken from the bottom of the header, and as valve *C* forms a water pocket in the line (when closed) it should be tapped above the seat and a drip connection provided as shown at *D*. In a case of this kind the designer may find it more convenient to place the main steam header a few feet above the boiler room floor line, as shown by the dotted lines at *K*, in which case the valves and piping are more accessible than when placed overhead as shown at *B*. With the steam header located as shown at *K*, the steam line to the engine may be taken from the top of the header through angle valve *L* and the straight pipe *R*, which makes connection with separator *F*, the piping beyond this point remaining the same as in the previous case. The main steam header should have drip connections provided at the bottom, as shown, and the drips should be piped to a steam trap or other device for returning the condensation to the boilers.

The dotted lines in the engine room show the steam piping to the engines carried overhead. The steam from the main header is taken off through bend *M*, separator *N* or *P*, bend *O*, and throttle valve *J*. If the horizontal type of separator is used, as shown at *N*, the vertical leg of bend *O* above the throttle valve will gradually fill up with water when the valve *J* is closed. To prevent this occurring, the throttle valve *J* should be tapped above the seat and a drip connection provided. The vertical leg of bend *H* (above the throttle valve) is also likely to fill up with water, due to condensation in that section of the piping when valve *J* is closed.

With the overhead system of piping (shown dotted) a vertical type of separator *P*, placed directly above the engine throttle valve, is preferable to the horizontal type indicated at *N*.

THE REMINGTON "NEGATIVE ANGLE" SIGHTING SYSTEM

A NEW METHOD OF SIGHTING MILITARY AND SPORTING RIFLES

The high velocities and low trajectories attained by the bullets fired from modern rifles have not been accompanied by corresponding improvement in hitting efficiency, either in warfare or hunting. The ratio of misses to hits in battle is enormous. In war, hunting, manufacturing, transportation and all the activities of life, the demand is for higher efficiency, and from a purely scientific standpoint the new system of rifle sighting described in the following should be of interest. It should be of particular interest to sportsmen, as it probably means that average shooting efficiency can be doubled or tripled. And whatever may be our prejudices regarding war, the fact is that if war is necessary it behooves us to be on the winning side. "The man behind the gun" is the unit of efficiency. If he can be made twice as efficient in battle as the average soldier is to-day, it is equivalent to doubling the size of the army. In the following analysis of the system the advantages are made evident.

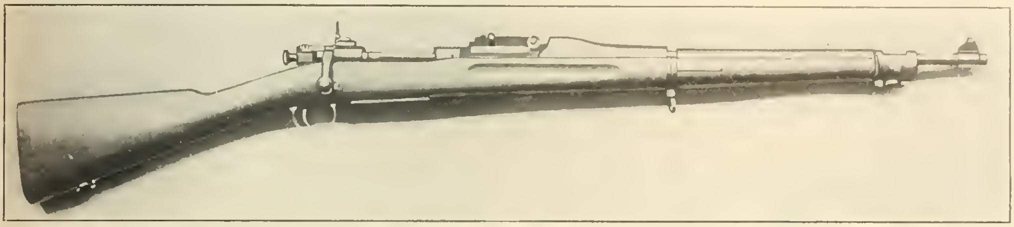

Fig. 1. U. S. Springfield Army Rifle fitted with Remington "Negative Angle" Battle Sight on Bolt

Mr. Harcourt Ommundsen, one of the inventors, by winning the King's prize, the Service Rifle Championship, and Grand Aggregate (the two latter on several occasions), has established his reputation as perhaps the most accomplished rifleman in the British Empire. Mr. Edward J. D. Newitt, who collaborated with Mr. Ommundsen in the practical application of the invention to war and hunting conditions, is equally well known in Great Britain as a marksman, ballistic engineer, and a pioneer of progress in aiming devices for projectile weapons.

The invention should be described as an evolution of the art or method of shooting rather than an improved sight, though sights of special construction are employed in the application of the system. In many respects the invention is analogous to that of the pointed bullet. Though elongated bullets of almost every conceivable shape from cylinders to pyramids have been made, tried and abandoned in the past seventy years, ten years have not yet elapsed since Gleinich demonstrated that an attenuated bullet having a point constituted by shoulders of a specified curvature met with less resistance from the air than any other shape. This enabled the use of lighter bullets without sacrifice of ballistic efficiency; higher velocities thereupon became possible, trajectory was flattened and the efficiency of the rifle, theoretically, was advanced considerably. Whatever may be the theoretical efficiency of rifles as regards ranging power and striking energy, the condition precedent to its realization, either in war or in hunting, is to hit, and for many years past Messrs. Ommundsen and Newitt have devoted their energies to enhancing the hitting efficiency of rifles, this, at present being by far their weakest feature.

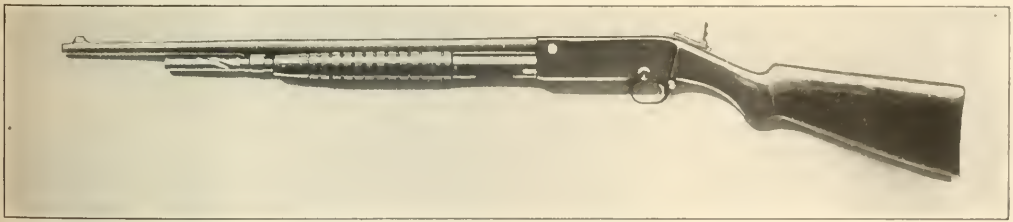

Fig. 2. Remington "Negative Angle" Sporting Rifle

When we read of the devastating hurricanes of lead that sweep the modern battlefield and then, by cold mathematics, demonstrate that but one in ten thousand of the bullets constituting this hurricane accomplishes more than to scatter a few grains of mother earth, we may rightly question whether modern war weapons are really more effective than the clubs and bows of our ancestors. It is difficult to realize, but if the statistics of warfare are to be relied upon, it requires twenty-five men to fire two hundred cartridges apiece, or fifty men to fire one hundred cartridges each, to effect one hit in a battle with modern firearms. Indeed, our boasted modern improvements have effected little more than to prolong war, increase the area of the battlefield, the size of armies and expense.

In hunting, the up-to-date sportsman with the best of modern equipments may perhaps kill his game a little further off, but, shot for shot, he can accomplish no more than the aboriginal savage with his bow and spear. It is incontestable that the hitting efficiency of modern weapons has not kept pace with their advancement in other features. Supposing that, by any means, the average of hits to cartridges fired could be extended from one in, say, five thousand to only two in five thousand it would be equivalent to doubling the army; or we might decrease the army by half without sacrificing its fighting strength, and thus economize enormously on time and expense. It is these considerations which have inspired the inventors in their investigation of the causes of the failure of rifles in the field, and their efforts to diminish the difficulty of hitting.

The trouble began with the introduction of the conical bullet and rifled barrel into armies about three-quarters of a century ago. Up to that time a fixed notch for a backsight and a bead or point frontsight served all the requirements of aiming the old smooth-bore muskets—at least as straight as they would shoot. But with the advent of the accurate long-range rifle came the necessity of counteracting the effect of gravity. To get range, the bullet must be kept in the air as long as it takes to perform the journey. If this journey takes one second and gravity has ordained that any unsupported body like a bullet shall fall sixteen feet in one second, then if we desire the bullet to travel to a mark it will require one second to reach, the rifle must be pointed sixteen feet above that mark. But with the old fixed notch and point sighting combination this meant aiming above the object, and incidentally completely hiding it in the process. To overcome this difficulty some genius devised the tangent elevating backsight, a long name by which is implied mounting the old notch on a slide so that it could be raised and lowered. By this means the axis of the barrel could be fixed at any angle to the line of sight, and aim could be taken at the mark though the barrel was in fact pointing far above it, and by this means this genius and thousands of his descendants have considered that the problem was solved. As a matter of fact, this accomplished very little toward it. It is true that the shooter had no longer to judge how much his bullet would drop in traveling to the mark and then aim an equivalent height above it, but in exchange he had to judge how far the object was away, and adjust the height of his backsight accordingly, and a very little consideration will show that one is precisely the same and just as impossible as the other—in fact nothing had been gained except ability to see the object while aiming.

Very few appreciate how formidable is the problem of hitting an object at any distance with a modern rifle. First, the distance must be ascertained. It might be measured, but as this is seldom possible in hunting or war, it must, of course, be estimated. The rifle requires it to be estimated within a very few yards, and the longer the distance the nearer must be the estimation. No man has yet been or ever will be able to judge distance within the proximity required by the modern rifle sight, for the simple reason that the human body is not equipped with any distance-measuring faculty and a non-existent faculty cannot be developed by any process of education or training.

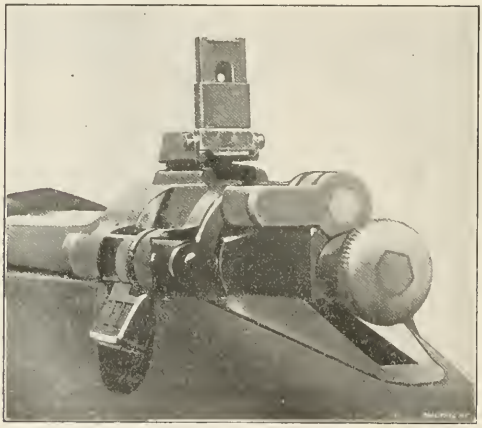
Fig. 3. Close View of Army Rifle Sight

But, assuming that this difficulty has been overcome there still remains the necessity of elevating the backsight with an exactitude which is measured by one or two hundredth parts of an inch, a feat very difficult to accomplish under the most favorable circumstances and wholly out of the question in the stress of battle. These difficulties have been to some extent appreciated and something has been accomplished toward ameliorating them—this, curiously enough, by reversion to the old fixed notch backsight.

The U. S. Springfield, and the military small arms of several other nations, is equipped with what is known as a battle sight. This may be a separate fixed notch, or the ordinary elevating notch when in its lowest or normal down position. This fixed notch battle sight has a certain amount of elevation which imparts a line of flight to the bullet in which at no point in the length of the resulting range does the bullet rise higher above the point of aim than the height of the object fired at. If aim is always taken with such a sight at its lowest extremity, the object will be hit in some part at any point in the range. But here another difficulty arises. In battle the usual objects are men who alternately adopt postures of different heights. When advancing they may be erect or about sixty-eight inches high, when halting they will lie down and offer a target anywhere from twelve to eighteen inches high, or they may kneel, crouch or assume positions giving any height between the two extremes. Consequently there is a good deal of difference of opinion as to the most appropriate elevation to adopt.

For example, if the battle sight is elevated to give a trajectory (the curved path of a bullet is called trajectory) of which the vertex is the height of the average erect man, then for the greater portion of its range it will pass harmlessly over the heads of men in the kneeling or prone positions. On the other hand, as the higher the trajectory the longer is the range, a sixty-eight-inch trajectory is useful for keeping the enemy at a distance, and it is not yet certain whether or not the most effective results will be obtainable at the relatively longer distances—when the enemy is in an erect position and offers a larger target, or when he is closer and lies down. Most nations have adopted a battle sight elevation which gives a trajectory somewhere between fifteen and twenty inches high at its vertex, thereby sacrificing the longer range possibilities of a trajectory suitable alone for erect men in favor of a trajectory suitable for men in the prone position. Some, on the other hand, have adopted an elevation giving a trajectory of intermediate height.

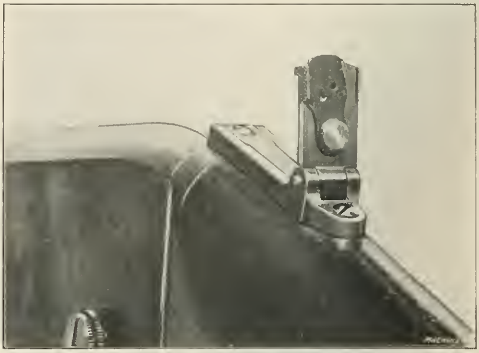
Fig. 4. Close View of the Sporting Sight

The U. S. Springfield battle sight, for example, has a trajectory thirty inches high and will hit any object thirty inches and upward in height at any distance up to five hundred and thirty yards, but as a prone man seldom presents a target higher than eighteen inches it is not suitable for shooting at prone men. The selection of a thirty-inch trajectory for a battle sight elevation cannot be described as ideal inasmuch as it has a limited danger zone for men who are in the prone position and unnecessarily shortens the range for men in the erect position. Doubtless the idea is that indifferent shooting on the part of the soldiers will discount this difficulty. It might similarly be argued that an inaccurate rifle might cor-

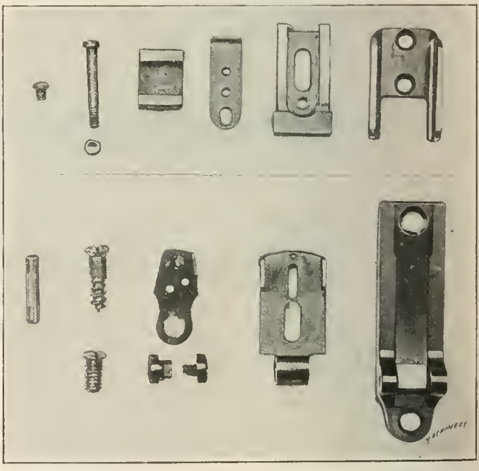
Fig. 5. Component Parts of Army and Sporting Sights

rect bad aiming, and to continue such an argument to its logical conclusion it might be contended—indeed it already is contended by some distinguished military authorities—that in the hands of the average soldier the best results are obtainable from an improperly elevated, inaccurate rifle, incorrectly aimed. This is tantamount to admitting that hitting on the battlefield is largely a matter of chance and it is better to rely upon chance and probabilities than on skilled men and perfect rifles. Notwithstanding this, most nations are spending vast sums on perfecting their rifles and training their soldiers to shoot, while the possibilities of chance, as a means of attaining fine effect in battle, have been abundantly exploited in recent wars, and have proved a most uneconomical and hopeless failure.

However, such are the difficulties of estimating distance and adjusting sight elevation, that the practicable battle range of military rifles has come to be regarded as the range given by their battle sights, within which both estimation and adjustment are unnecessary, and the trend of development in war rifles in the last ten years has been entirely in the direction of increasing the velocity of the bullet with the one purpose of extending the battle sight range. The present practical limit of velocity of rifle bullets is something less than 3000 feet per second. The German Mauser has about 2900 feet per second velocity; the Swiss rifle, about 2800 feet; the U. S. Springfield about 2700 feet, and the latter is by far the most accurate military small arm extant. To increase the range given by a thirty-inch trajectory by 100 yards, would imply an increase in the velocity of the bullet of about 500 feet per second, which at present is out of the question; consequently, further increase of range from enhanced velocity is unlikely for some time to come. A considerably lengthened range may, however, be obtained by development of the battle sight and the improved method of sighting known as the Remington "negative angle" system. This battle sight by which the system is adapted to military small arms, consists of a plate containing two apertures, mounted in a compact framework and attached to the rifle just over the bolt, conveniently close to the eye, in which position alone the aperture or peephole as an aiming medium is reliable. One aperture gives a trajectory sixty-eight inches high, the other thirty-six inches high. Only one aperture is exposed at a time, the act of exposing one automatically obscuring the other. The change is made by moving the slide up or down between its arresting stops about one-tenth inch. This can be done instantaneously by sense of touch alone without the assistance of the eye and with the rifle at the shoulder.

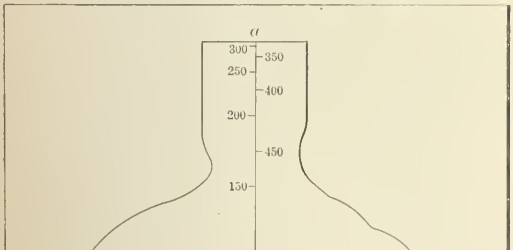

Fig. 6. Illustrating the Relation of Springfield Army Rifle Trajectory to a Prone Figure

It is a generally accepted theory that the trajectory given by any angle of elevation will be constant relative to the line of sight, though the latter may be raised or depressed relative to the ground, within all necessary limits. Messrs. Ommundsen's and Newitt's invention prescribes a practical application of this theory, whereby a trajectory higher than the object can be employed and the range correspondingly extended.

In Fig. 6, *a b* is a vertical projection of the thirty-six-inch trajectory of the Springfield rifle, superimposed on the figure of a prone man drawn to the same scale. The horizontal dotted line *c–d* is the ground line and × the negative point of aim. The figures on each side of *a–b* indicate the height of the bullet at the distance expressed by these figures. It will be observed that the distance between the ground line and the point of aim is equal to the height of the figure, and it is obvious that such a figure shot at with such a trajectory would be hit at any distance between 90 and 505 yards if aim were taken at ×. Similarly, if the aim were raised to the ground line, any object exceeding thirty-six inches in height would be hit at any distance up to 575 yards. Mainly for the purposes of repelling an attack and keeping the enemy at a greater distance than this, the second aperture in the battle sight is provided. With the slide up, a sixty-eight-inch trajectory, giving a range of about 750 yards, is obtained. With this, by ground line aim, a standing man will be hit at any distance less than 750 yards and by negative aim, kneeling and crouching men are vulnerable up to about 600 yards.

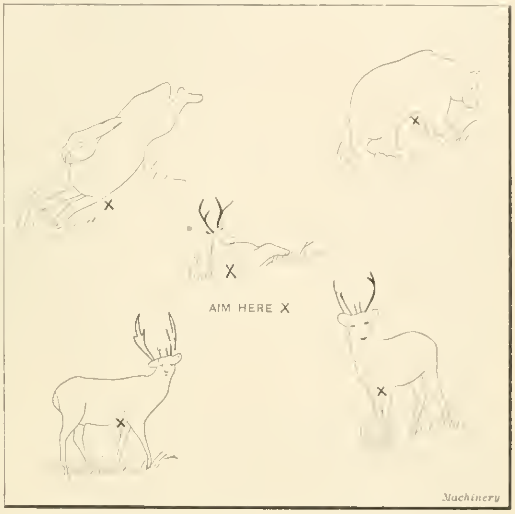

Fig. 7. Showing Constant Points of Aim on Animals to hit Vital Spot

Under the present system if the Springfield rifle were equipped with a battle sight suitable for men in the prone position, *i.e.*, a battle sight giving a trajectory eighteen inches high, the battle range for figures of all heights would be limited to about 450 yards. With the Remington negative angle battle sight, prone men may be hit to 500 yards, kneeling men to 600 yards and erect men to 750 yards, a gain which is not likely to be reached by any enhancement of velocity for many years to come. Moreover, whatever velocity may be reached in the future, a similar relative gain may still be made by means of this sighting system. It will probably be contended that to aim negatively requires as much estimation as to judge a distance. It will not, however, escape observation that as the object is necessarily visible while aim is taken, it furnishes a visible gage with which a depth below equal to its own height is quite easily compared. Nothing, in fact, in the nature of judgment or estimation is required, while the curve of the trajectory affords considerable latitude at all distances for the inevitable errors of aim which occur with all sights and all marksmen under all conditions.

In using the negative angle battle sight, distance and sight adjustment are put entirely out of consideration. When an object is near enough to be aimed at it can be hit. Three rules alone are employed: 1. At prone men use lower aperture and aim negatively. 2. At erect men use the higher aperture and aim at ground line. 3. At men in any other position use the lower aperture and aim at the ground line.

In applying the system to the conditions of hunting, a somewhat similar sight, giving twelve-inch and five-inch trajectories, is employed. Change from one aperture to the other is made by pushing a disk from left to right. The higher aperture will always be employed for deer, bear, moose and other large game, the lower for woodchuck and small game. The illustration Fig. 7 shows the constant point of aim which must be taken under all circumstances, irrespective of distance. With a modern American rifle, such as is commonly employed for such game, the range given by the hgher aperture is about 300 yards and by the lower aperture about 150 yards.

It will not be forgotten that though a deer is a relatively large animal, the vulnerable portion—the heart region—which must be hit to insure a clean sportsman-like kill is only about six inches diameter, and to hit this even at short distances with the present sights and system of shooting, demands the same correct estimation of distance and exactitude of sight adjustment as was presented in the military problems just discussed. In the majority of instances, misses while hunting are attributed to bad shooting or inaccuracy in the rifle. As a matter of fact ninety per cent at least are due to improper elevation of the backsight. To correctly elevate a backsight, is just as difficult in hunting as in war, and a sight which is independent of adjustment is just as essential in one case as in the other.

The average deer is about eighteen inches thick above the prescribed point of aim, and from 40 to 250 yards is the range given by a twelve-inch trajectory. The path of the bullet then will lie between three inches high or low of the center of the heart region. Thus, an effective sporting range, sufficient for all practical purposes, is obtained.

This system is applicable to rifles of all calibers, and the effective sporting range will be governed by the velocity of the bullet, that of black powder velocities (about 1250 feet per second), being somewhat less than that of smokeless powder velocities (about 2000 feet per second).

The Remington negative angle sighting system described in the foregoing, comprises not only the sights, which in themselves are simple, but the system of aiming, which within limits automatically compensates for the fall of the bullet in its flight. It will be placed on the market by the Remington Arms-Union Metallic Cartridge Co. of Ilion, N. Y. and Bridgeport, Conn.

* * *

PROPOSED CHANGES IN FRENCH PATENT LAW

The French Government is proposing to amend the patent law of France. The main features of the bill, which is likely to pass, are as follows: Duration of patents shall be fifteen years. Samples or models must be deposited in sealed boxes at the same time that the sealed letter containing the application is handed in. Persons resident abroad must appoint a representative living in France who will receive all communications. Applications must be written in French and must not contain any designation of weights or measures other than in the metric system. An inventor of a device already patented abroad can obtain a patent in France. Such a patent will be independent of the patents obtained for the same invention in other countries.

Loss of patent rights will follow (1) if patentee does not pay his annual dues; (2) if the patentee imports into France objects similar to those of his patent, but manufactured abroad; (The loss of patent right will not be incurred by a patentee who can prove that the quantity of goods manufactured in France in the three years preceding action taken for loss of rights has been at least double the quantity imported.) (3) if the patentee has not worked his patent in France or French colonies within three years, or shall cease to work it in any three consecutive years, unless he shows reasonable cause for lack of working.

TESTING LUBRICATING OILS

The *Journal* of the American Society of Mechanical Engineers gives, from a German contemporary, the following practical directions for determining roughly the qualities of lubricating oils without the use of special testing apparatus. To determine the presence of solid impurities in the oil, kerosene is added to half a tumbler of oil until the whole becomes quite thin. The mixture is then passed through filter paper or ordinary white blotting paper, and after all the oil has passed through, the paper is washed with kerosene; the residue on the paper, if any, will show if the oil had any solid impurities. Impurities may also be roughly detected by smearing a piece of writing paper with oil and holding it against the light; if the oil is free from solid impurities the blot will be equally transparent throughout—otherwise, the solid particles will show. The oil must not resinify: to test it in this respect pour it into a shallow dish and leave in a warm place about a week. There must not be the slightest crust at the end of that time. Another way to test it is by mixing it with fumes of nitric acid: if the oil is pure, a thick mass will form in a few hours, while resinifying oil will remain thin. Acids are very injurious impurities in lubricating oil, since in time they attack the machine parts lubricated. To test for them, copper oxide or copper ash is added to the oil in a glass vessel; acid-free oil retains its original color, while, if it contains acid, it becomes greenish or bluish. Another test is to drop the oil on a sheet of copper or brass and leave it there for a week; if the oil contains acid there will be a green spot on the metal. Blue litmus paper dipped in acid-free oil stays blue, but becomes red if the oil contains acid. A good oil must be greasy in order to have good lubricating qualities; to find which of several oils is best in this respect, place a few drops of the different oils on a smooth, slightly inclined metal or glass sheet; the drop of the best oil will travel furthest in a given time.

* * *

GRAND CENTRAL TERMINAL

The Grand Central Terminal which has been in process of construction in New York City for several years, was opened to the public February 2. The terminal is for the use of the New York Central & Hudson River R. R. and the New York, New Haven & Hartford R. R. The main structure is 301 feet wide and 722 feet long at the street level and about 455 feet wide below the street. The tracks are on two levels and are over 33 miles long. There are 42 tracks for through trains and 25 for local trains. The combined capacity of all tracks is over 1000 passenger cars. The total area of the terminal property is about 70 acres. The main waiting room on the out-going track level is 301 feet long, 125 feet wide and 125 feet high. The depression of the tracks and the substitution of electric locomotives for steam locomotives made possible the reclamation of a large area of very valuable land in the heart of the city. The terminal property comprises, besides the main terminal structure, warehouses, the Grand Central Palace, the Biltmore Hotel and other structures. The streets formerly cut off by the railway have been restored to the public and a commercial center established convenient to shipping facilities. The capacity of the new terminal is estimated to be 100,000,000 people a year.

* * *

EFFECT OF POOR ILLUMINATION ON THE EYES

Experiments undertaken with the object of ascertaining the effect on the eye of various kinds of illumination, indicate that after three hours' work in ordinary daylight, there is hardly any change in the working efficiency of the eye. After three hours' work in artificial light consisting of incandescent lamps with flat porcelain reflectors over them at the height of about eight feet from the floor, the keenness of the eyesight had fallen off very greatly, and a distinct loss in the muscular adjustment for accurate vision was perceptible. The study of the proper artificial lighting is a subject of much importance, and it is likely that the next few years will see a still greater improvement with regard to artificial illumination than has the last decade.

CROWN FACE PULLEYS*

A REVIEW OF THE PRACTICE IN PULLEY CROWNING AND SUGGESTIONS FOR OBTAINING THE BEST RESULTS

BY GEORGE N. VAN DERHOEF†

The crowning of pulleys is defined by one of the well-known dictionaries, as near as I can remember, somewhat as follows: "Pulleys are commonly made with a rounded face because the convexity keeps the belt on when various other things make it run off." This definition may, perhaps, be considered by some of the readers quite as lucid and as much to the point as the following dissertation, but as the subject of pulley crowning has received scant attention in the mechanical journals, I will take the risk. I do not know to whom we are indebted for the valuable discovery that crowning a pulley will tend to keep the belt from running off. A number of writers have given, or attempted to give, an explanation as to why a belt runs to the center of a pulley when provided with a rounded face, but I have been unable to find any definite statement as to when or where the practice originated. My impression is that it was the invention or rather discovery of a mechanic employed in an English cotton mill.

The amount of crowning that should be provided varies according to different writers; hardly any two make the same recommendation. Some writers give the amount of crown as a percentage of the belt width, and give figures all the way from 1/12 to 1/96. Others give it as a taper of so much to the foot, quoting 1/16 inch, 3/32 inch, 1/8 inch, 3/16 inch, 1/4 inch, 5/16 inch, 3/8 inch and 1/2 inch. One writer seems to have a leaning towards as much as 1 inch taper per foot. In addition to these simple standards, some express a liking for fancy curves or for faces made truly rounded, using a radius of from three to five times the belt width or more.

Some authorities, however, seem to have realized that there are several factors entering into the question of pulley crowning and have tried to make allowance for them. For example, one recommends a crown of 1/20 the width in the case of leather belting and 1/150 the width for cotton belting; another allows 1/16 to 1/8 inch per foot of width for high speeds and 1/4 inch for low speeds, while another recommends not over 1/8 inch for 2 feet breadth for pulleys 48 inches in diameter or less, and in no case over 3/16 inch. Undoubtedly this wide divergence in recommended amounts of crowning is based on the judgment and observation of the individual writers or in some cases on shop practice handed down from a rather nebulous past. Very little in this mass of data appears to be based on any definite theory as to what should be used, or to have been checked up by actual experience.

The general theory as to why a belt runs to the center of a crown face pulley is simple, but it is not altogether easy to explain without a number of diagrams, which might after all, make the matter confused. In the first place, a crown face pulley should be considered as two tapered cone pulleys having the large ends placed together. We can then think of the belt being divided in the middle or as two belts running side by side, each on its own taper cone pulley. Now we know that if we have two parallel shafts, one which we will call the driving shaft carrying a straight face pulley and the other a taper cone pulley, and the two pulleys are connected with a belt, the belt will travel toward the large end of the taper cone pulley when started into motion. There are two reasons for this: First, if the belt leads on to the taper cone pulley exactly at right angles to the shaft, instead of going around the cone in its own plane, it tends to describe a conical spiral path on the face of the cone, the spiral running toward the large end of the cone like a screw thread. This can be proved by simple experiments which anyone can make. Take a piece of paper three or four inches wide and about eight inches long; roll this up into a cone so that one end is about three-fourths the diameter of the other, and fasten the edges together with paste. Then trim both ends square with the scissors. Now mark a straight line from end to end of the cone and square with the ends; draw an arrow near the small end of the cone and at right angles to the line and with the point of the arrow just touching the line. Next, cut the cone from end to end just behind the arrow and lay the paper out flat on the table. This will constitute what a draftsman would call "a development of a conical surface on a plane." With a rule, extend the arrow all the way across the paper and you will find that it goes across in a diagonal direction. Now roll the paper up again and paste the edges together and you will see that this straight line becomes a screw thread running toward the large end of the cone and representing the path the belt tends to take.

The second reason referred to is this: On account of the cone being larger at one end than the other, the edge of the belt nearer the large end is longer than the edge nearer the small end; this makes the belt curve or bend sideways slightly. The curvature of the belt is towards the high side and it leads the belt onto the cone at a slight angle instead of square with the face. As everyone knows, when a belt is led onto a pulley at an angle, it runs to one side. We see from this that there are two factors acting at the same time, both tending to make the belt travel toward the large end of the cone. This dual action is very important and is commonly overlooked; it enables us to explain some of the queer things that happen to belting in the shop.

In the foregoing, the supposition was, of course, that the shafts are parallel. Now take a case where the shafts are level and at the same height from the floor but not parallel. Arrange the shafts so that they are closer at the small ends of the cones than at the large ends. If the lack of parallelism is just right, the belt will run to the small end of the cone instead of the large end when started in motion. The reason for this action is that the angle due to curvature sideways of the belt as previously explained, is not as great as the angle the other way, so that the belt is held onto the taper cone because of the lack of parallelism of the shafts. The result is that the tendency to run to the side from which the belt leads is greater than the tendency to run to the large end of the cone and the belt actually travels to the small end. If the angle between the shafts is just right, it is possible to run a belt on the middle of the face of a taper cone pulley.

To go back to the original proposition of two taper cones with their large ends placed together and the belt split down the middle so as to form two belts side by side, it could be explained that as each belt runs to the high side of its own taper cone, both belts will run together at the middle where the tendency of one of the belts to run to the right will be opposed by that of the other to run to the left. This is why it is so common to see a belt running first a little to one side and then to the other. Other things being equal, the force with which a belt runs to the large end of a cone depends on the width, so that in the case of a belt running on the crown face pulley the moment it gets out of center a greater force on one side than on the other tends immediately to force it back to its proper position. When the shafts are perfectly straight and in line, the pulleys accurately finished. and the belt uniform in width, thickness and character of surface, the side motion will be so small that it can hardly be seen. As all these conditions are seldom realized, it is common practice for pulleys to be made slightly wider than the belt.

There is sometimes a belt in the shop which persists in running to one side of a pulley until about one-half inch hangs over one side and it continues to run this way steadily. The reason for this is that one of the conditions is present under which a belt tends to run to the small end of the cone. The belt runs over the edge of the pulley an amount sufficient to relieve the tension on the over-hanging edge. The balance of forces then being adjusted. the natural tendency of the belt to run to the large end of the cone holds the belt from going further toward the small end. The common practice in the shop, of knocking a countershaft out of line in order to make the belt run right, is perfectly justifiable when the pulleys or belts are imperfect, unless the more scientific procedure is adopted of throwing them away and buying first-class equipment.

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* See "Pulley Crowning" by George A. Gauthier in the September, 1905, number.

† Consulting engineer with Dodge Mfg. Co., Mishawaka, Ind.

It is not generally known that straight face pulleys are often in effect cones of a very slight taper. This may be due to hard spots in the face which vary the coefficient of friction and make the pulley act as though it were turned with a slight taper. The actual amount of crown that should be given a pulley depends on the "other things" referred to in the dictionary definition. Among these may be cited: lack of parallelism between shafts; shafts that are not straight; pulleys that are not turned true or that are finished smoother on one side than on the other; springing of shafts under changes of load; belts that are not uniform in quality or in thickness, or which do not stretch uniformly when under strain. Lack of balance of pulleys is probably not a direct cause, but doubtless is an indirect cause as it produces some of the direct causes mentioned.

The wide variation in the method of crowning recommended by various authorities, can now be understood. In those industries where high-grade machinery is used and the best attention is given to keeping shafting in line as well as to the careful selection and care of belting, a tendency toward the use of small amounts of crowning will be observed.

Inasmuch as the circumference of a pulley is greater at the center of the crown than at the edges, it is obvious that a small slip and consequent loss of power is taking place all the time the crown pulley is in operation. This is one of the reasons, particularly in the case of large powers, why rope driving is so extensively used. If a pulley has a ¼-inch crown, it means a difference in the circumference of a little more than ¾ inch. In a revolution of the pulley, this difference must be taken out as slip. If the speed of the belt is a mean between the two circumferences, there must be forward slip to part of the belt and backward slip to the remainder. The amount the slip is modified by the change in length of the belt as it stretches in going from the slack side of the drive to the tight side and shortens in going from the tight to the slack side, is too slight to make material difference. The ¾ inch just mentioned, in the case of a 4-foot pulley, is distributed over slightly more than twelve feet of the circumference, while with a 12-inch pulley it is distributed over slightly more than three feet. If it were not for other reasons, the crown should be proportional to the diameter of the pulley. As it is, we can confidently expect better wear of a belt and higher efficiency of the drive, by using large pulleys than small ones. We can also see one of the reasons why belts to high-speed small pulleys should be made amply wide so as to be under small strain per inch of width.

The crowning of a pulley only tends to keep the belt on when the belt as a whole does not slip. A slipping belt will run off a crown faced pulley quicker than from a straight faced one. Where the danger of slip is great, particularly in the case of a small pulley driven by a large one, it is advisable to use a moderate crown and provide flanges. The moderate crowning will lessen the danger of slip and the flanges will keep the belt on where a high crown will not. Do not infer from this that flanges are better than a crown—as a rule they are not—but simply regard them as an expedient or safeguard.

The amount of crowning that can be safely used depends upon the resilience of the belt. When the stretching of the belt due to the crown exceeds the elastic limit a permanent set is given to the belt which detracts from or neutralizes the action of the crown. This explains the reason why pulleys on which cotton and certain other kinds of belting run, are given a much smaller amount of crown than that which can be safely provided for leather belts. In this connection, the difference between stretching and elasticity should be fully understood. Stretching may be described as permanent elongation of the belt due to stress, while elasticity is the amount the belt lengthens under stress but which is taken up again as soon as the pull is removed. We try to buy belts of a high degree of elasticity, but we stretch them thoroughly before we put them in use.

It is claimed that a leather belt may lead onto a pulley at an angle of 2½ degrees when the pulley has a crown of 1/20 the width of face. In other words, this would mean that an error in alignment of the shafts of 2½ degrees is permissible.

The recommendation has been made that one of the pulleys of a pair be made with a straight face so that only one of the pair of pulleys would have a crown. This writer considers it to be pernicious advice, inasmuch as the belt would be less injured by a crown of one-half the height on each pulley. When a belt is used to drive a pair of tight-and-loose pulleys, it is practically necessary to make the driving pulleys with a straight face so that the belt can be easily led back and forth across the face as it is shifted from the loose pulley to the tight pulley, or *vice versa*. The tight-and-loose pulleys, however, are made with crowning faces so as to hold the belt in place after it is shifted. The belt shifter is simply a device used to upset the balance of forces described and that hold the belt to the center of the pulley so that it will run over onto the other pulley. The shifter is for the purpose of setting up a condition under which the natural forces will lead the belt to the desired position.

Now while the foregoing mostly applies to the belt as it runs onto one of the pulleys, it is, of course, obvious that the same action takes place when the belt returns from the second to the first pulley. When the second pulley only is crowned, the belt is delivered to the first pulley at a slight angle but it has a tendency on this pulley to travel to the same side as it does on the crown face pulley. It was probably this fact that led to the recommendation of making one of a pair of pulleys with a straight face. The plan, however, of giving the smallest possible crown to both pulleys, certainly seems to be based on the better principle and is the one largely followed.

The question as to whether the crown should be formed by a curve or made flat on each side of the center line like two taper cones joined at their large ends, is open to discussion, but with the slight amount of crown that should be used, it is practically impossible to determine which is the better, so it may properly be considered as a manufacturing detail.

* * *

LOHMANNIZING

The protection of iron and steel is at present effected by means of three zinc-coating processes: the old hot-galvanizing process, the cold-galvanizing process (electrolytic zinc plating) and the sherardizing process. The process of "Lohmannizing," invented by Mr. H. J. Lohmann, and described in the journal of *Engineering Chemistry*, differs from these in that it is not restricted to the application of zinc coatings, but may, it is claimed, be used for coating of zinc, lead, and tin in varying preparations to suit the requirements of each case.

The process of Lohmannizing begins, as is usual, with pickling the iron and steel articles in a bath of sulphuric acid. Then the article is dipped into the Lohmann bath, which, being "composed of an acid and an amalgamated salt, further cleanses the pores and cavities, and deposits metallic salt upon the entire surface, penetrating into the most minute pores and cavities." The Lohmann bath is a solution of hydrochloric acid, mercuric chloride, and ammonium chloride. Next follows drying, and then immersion in the molten protective alloy, the temperature of which is 950 to 1000 degrees F. An amalgam or chemical union is then formed, it is claimed, between the amalgamating salt and the protective alloy. The temperature of the immersed article rises as it comes in contact with the molten alloy, and, when it reaches a temperature of 500 degrees, volatilization of the mercury occurs.

Since the mercury passes from the surface of the alloy, the complete surface is said to be left free and open for the protective alloy to fill its pores and cavities, there being freedom from oxidizing influences. Inasmuch as the claim is made that a perfectly satisfactory lead-plating can be obtained by the Lohmann process, it would seem that this process would be of value in the production of lead-lined apparatus.

* * *

Aluminum is now extensively used in galvanizing to produce a smooth, bright coating on the galvanized articles. A very small quantity, says the *Brass World*, is required, and is added to the zinc when melted.

FIXTURES AND GAGES USED IN MANUFACTURING THE "MULTIGRAPH"

DEVICES USED IN THE LATHE, SHAPER AND MILLING MACHINE METHODS OF INSPECTION

BY DOUGLAS T. HAMILTON*

The "Multigraph," manufactured by the American Multigraph Co., Cleveland, Ohio, is an office appliance used principally for producing typewritten form-letters and circulars in quantities. The device is a printing press on a small scale, and can be used for a large range of work usually produced on a much larger and costlier machine. It consists of two drums; one of these, called the "supply drum," carries the type, from which it is supplied to the other drum, called the "printing drum"; these drums are mounted end to end on a base that may be set on a table. A wide ribbon or printer's ink attachment is used in printing, the ribbon being used largely for form-letter typewriting, and the ink attachment chiefly for circulars. There are a large number of interesting fixtures and gages employed in the manufacture of this office appliance, and a few of these will be described in the following.

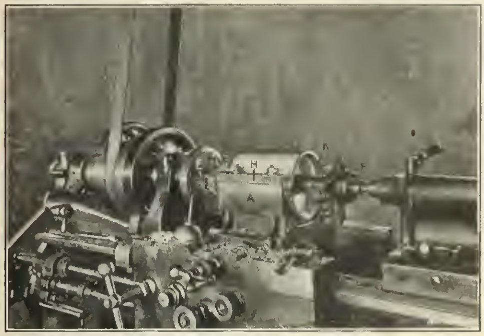

Fig. 1. Counterboring Fixture for Segmental Type Bar Drums with Work in Place

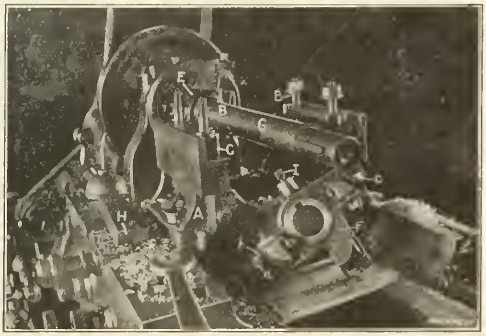

Fig. 2. Fixture shown in Fig. 1, with Work and One Tool-head removed

Fig. 3. Truck carrying Segmental Drums representing Eight Hours' Work in the Fixture shown in Figs 1 and 2

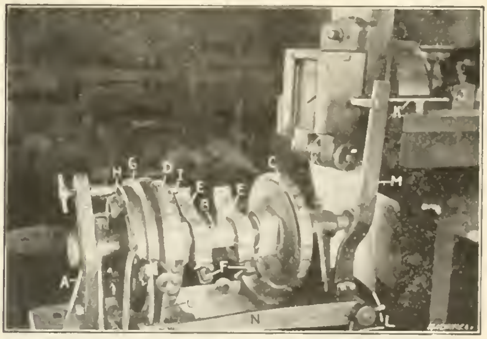

Fig. 4. Fixture shown in Fig. 5, with Work removed, showing Method of clamping and locating the Segments

A Counterboring Fixture for the Lathe

The drum which carries the type is made in two pieces from aluminum castings, see Fig. 3. The first machining operation on these aluminum segments is to surface the faces which are to come in contact. This is a simple operation which is performed on a disk grinder. The next operation is to counterbore both ends and face the drum to length. A special fixture applied to an 18-inch Bradford lathe, as shown in Figs. 1 and 2, is used for this purpose. As these illustrations show, the regular tool-slide has been removed and a cast-iron fixture *A* substituted. This casting is machined to fit the dovetail on the top of the carriage, and is clamped rigidly to it. The top portion of the casting is machined to form a seat for the aluminum drum segments, and is drilled and tapped for studs *B*. Dowels *C* locate the segments endwise, by engaging in slots in lugs cast on the segments.

The machining is done with tools held in the two tool-heads *E* and *F*, fitted to arbor *G*, which is provided with a tapered shank and held in the lathe spindle. The tool-heads are driven by the arbor by means of keys which are a sliding fit in the heads. Three high-speed steel cutters are held by clamps in each tool-head; cutter *a* is used for facing the castings to length; cutter *b* machines surface *K*, Fig. 1, and the bottom of the counterbore, while cutter *c* rounds the inner corner.

The operator first places the two aluminum segments in the fixture, face to face, locating them endwise by the slots in the lugs; then he places the two clamping strips *H*, Fig. 2, on top of the castings and clamps them in place. Tool-head *F* is now slipped onto arbor *G* where it is clamped by set-screw *I*, bearing on the key. The tailstock is brought up and clamped, and the center located in the center in the end of the arbor. The lathe is then started and the fixture moved towards the faceplate, bringing the castings in contact with the tools in tool-head *E*. The tools are fed by hand, and the carriage comes in contact with a stop on the bed of the machine when the cutters have reached the proper depth. The carriage is now moved toward the tailstock, bringing the castings in contact with the tools in tool-head *F*, which perform the same operations on the other end of the castings.

The largest diameter of the counterbored portion in these segments is 7 inches and the depth to the shoulder $\frac{3}{4}$ inch. Kerosene is used as a cutting compound and is applied with a brush to the cutters. A very smooth surface is produced. The value of the fixture, from a production standpoint, is well brought out by the fact that about fifty pairs, or one hundred of these castings, are machined in 8 hours. This number is shown on the truck in Fig. 3, which is designed for holding a day's work.

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* Associate Editor of MACHINERY.

Shaper Fixture for "Rolling-in" the Type-retaining Rails

After the aluminum segments composing the printing drum have been faced to length and counterbored, and after a few minor operations have been performed, they are taken to a Brown & Sharpe automatic gear-cutter, where the slots for the type-retaining rails are cut and the outside is machined to the proper diameter. Three milling cutters are used; the one in the center cuts the slot, and the two outer ones finish the outside circumference. The next operation, after the rails for holding the type have been put in place, is to roll the metal between the rails or bars, so as to bind them securely in the segmental drum.

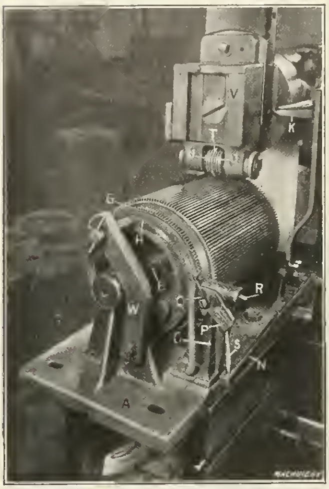

Fig. 5. Shaper Fixture for "rolling-in" Type Bar Rails on Segmental Drums

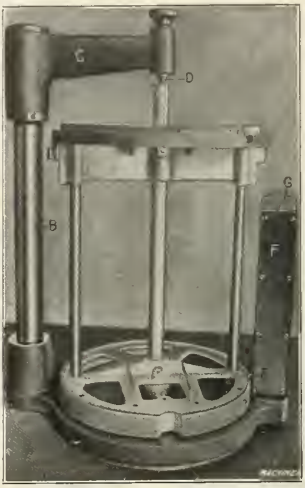

Fig. 6. Gage for testing Segmental Drum Frames

The "rolling-in" operation is done in a crank shaper as shown in Figs. 4 and 5. The fixture *A* is clamped to the table of the shaper. It is provided with two arms which act as bearings for shaft *B*. This shaft carries two disks *C* and *D* on which one segment of the drum is held by the hook clamps *E*, which grip a rod held in a drilled hole in the webs on the inside of the drum casting. The hole in the hook clamps is considerably larger in diameter than shaft *B*, so that when the thumb-screws *F* are screwed down on the shaft, they draw down the hooked ends of the clamps which grip the rod passing through the webs in the casting, thus holding the latter securely on the two disks.

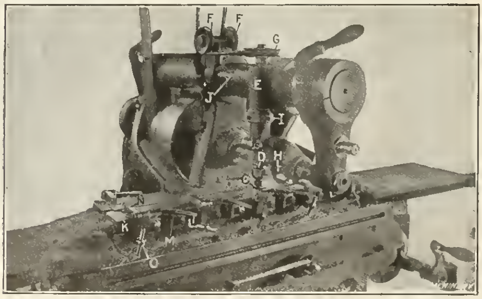

Fig. 7. Special Dovetail Milling Attachment for Front Cross-bar of Character Board

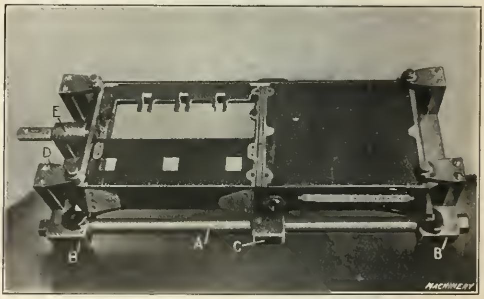

Fig. 8. Gage for testing Milled Surfaces and Drilled Hole in the "Multigraph" Base

An indexing ring *G* having 144 teeth is attached to disk *D* by two studs and thumb-nuts. This ring is turned down on one end and the ratchet ring *H* is screwed and doweled to it. A hole is provided in the segment which, when it is placed in the fixture, locates it in the proper position by means of pin *I*.

The indexing mechanism of this fixture is rather novel. Two studs *J*, only one of which is shown, are screwed into the flange of the ram. These carry bent rods *K*, which are adjustable and held in place by set-screws. On a machined seat of the fixture is held a small bracket *L*, provided with two arms that act as bearings for a fulcrum pin. This pin carries a short two-armed lever, which is connected with levers *M* and *N*. On the front end of the fixture is held another bracket *O* which carries the locking pin and the indexing mechanism.

The indexing mechanism, see Fig. 5, consists of a plate *P* which is fulcrumed on a shouldered screw in bracket *O* and carries ratchet pawl *Q*, kept in contact with the ratchet disk by means of a close-wound coil spring. Plate *P* is also provided with an eccentric slot in which a pin driven into locking pin *R*, and working in an elongated slot in the boss of the bracket, operates. This pin controls the outward movement of a locking pin which is pushed inward by a coil spring. Plate *P* is connected to lever *N* by link *S*.

On the back-stroke of the ram of the shaper, hooked rod *K* comes in contact with lever *M*, pulling it back, and raising the forward end of lever *N*. This lever, through the medium of link *S*, pushes up plate *P*, and as this is fulcrumed by a screw to the bracket, the pawl which is held to it also moves upward, rotating ratchet disk *H*. Previous to rotating the ratchet disk, the eccentric slot in plate *P* acts on the pin fitting in it, which, as the plate is raised, withdraws the locking pin *R* from the teeth in the indexing ring *G*, allowing the disks carrying the work to be rotated through a circumferential space equal to one tooth.

The tool used in "rolling-in" the rails consists of a knurling ring *T* with two spacing rolls *U* on each side of it. These rolls are held on eccentric sleeves on an arbor which passes through the lugs on the holder *V*, substituted for the regular clapper-box holder. The reason for holding the rolls on each side of the knurl on eccentric sleeves, is to provide for adjustment, so that the rails will always be held down tightly against the bottom of the slots in the drum segments. The knurled nuts on each side of the lugs are used to change the throw of these rolls; the nuts are held by screws when located in the proper position. The arm *W* attached to the forward end of the fixture is provided with a screw which takes the thrust of the "rolling in" tool.

A Dovetail Slot Milling Attachment for a Plain Milling Machine

An interesting fixture applied to a plain milling machine for milling a dovetail slot in the front cross-bar for the character board used on the "Multigraph," is shown in Fig. 7. The additional milling arm, which is applied in a rather unique manner, is used to carry and operate a dovetailing cutter, thus making it possible to completely mill the groove in one operation. The milling cutter used in roughing out the slot to the exact depth and width at the top is held on the regular arbor, and produces a slot in the brass bar as shown at *A* in Fig. 9. The dovetailing cutter *C*, shown in detail in Fig. 9, is held in a vertical spindle *D*, Fig. 7, which is rotated in bracket *E* by a round belt driven from the countershaft and running over idler pulleys *F* to pulley *G* on spindle *D*.

Bracket *E*, as shown in Fig. 7, fits over the overhanging arm of the milling machine and is also supported by the work arbor. The lower arm of the bracket is split, and is provided with a clamping bolt, so that the lower bearing can be adjusted to compensate for wear. The vertical adjustment is effected by graduated nut *I*. The upper portion of the bracket is L-shaped and carries a rod *J* to which the arm holding the idler pulleys is held. The milling cutter *H* precedes the dovetailing cutter, and thus relieves the latter from the heavy cutting.

The cutter used for finishing this dovetail slot is shown in detail in Fig. 9. It consists of a cutter head and shank made in one piece, and is drilled and tapped at the front end for the adjusting screw *a*, the head of which is tapered to an included angle of 15 degrees. The cutter has six teeth and three slots extending part way up the body, so that it can be expanded by the screw *a* when adjustment is necessary on account of wear or when the cutter has been ground. A collar *b*, held on the body of the cutter by a headless screw, supports the three "cutting members" when in operation on the work.

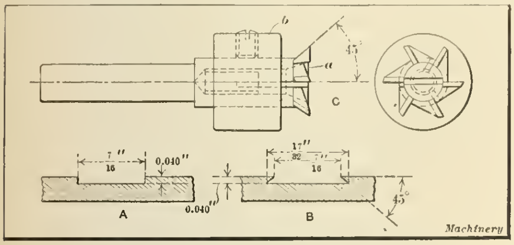

Fig. 9. Views showing how the Dovetail Slot is produced and the Dovetail Cutter used

The fixture used in holding the brass bar when milling the slot in it consists of an iron casting *K* bolted to the platen of the milling machine. This base casting is provided with a machined ledge on its top face against which the brass bar is held by four eccentric clamps *L*. These clamps are held on brackets *M*, bolted to the side of the fixture. The bar is held down on the fixture with five bell-crank clamps *N* also held on small brackets bolted to the fixture, and provided with "heel" thumb-screws *O* which operate the clamps. The other side of the fixture is similarly arranged to hold the strip for a second operation, which consists in cutting a saw slot for about half its length. These brass bars, which are 20 5/16 inches long, 1⅜ inch wide, and 5/32 inch thick, have the dovetailed slots milled in them at the rate of 20 per hour.

Gage for Assembled Segmental Frame

The frame on which the segmental printing drum is held is tested for truth after assembling, in the gage shown in Fig. 6. The lower part of this gage is an iron plate provided with a boss for holding the upright *B*; this latter is provided with a head and washer and carries the swinging arm *C* which retains the spring center *D*. A solid bushing is located in the base of the fixture, and when the truth of the frame is being tested, the shaft of the frame is located between the center and the bushing. The needle *E*, held in the box frame *F*, is bent, as shown, and bears on the machined surface of the frame as the latter is rotated. The arms of the needle are in the ratio of about 1 to 10; the indications are read on the graduated arc at *G*. Arm *C* is swung to one side to insert and remove the work.

Milling and Drilling Gage for "Multigraph" Frame

A simple but accurate gage for testing the milled surfaces and the location of the hole for the platen shaft in the base for the "Multigraph," is shown in Fig. 8. The frame of the gage consists of two binding rods *A* and three cross bars *B* and *C*, the outer bars being held against shoulders on the rods by nuts. Fastened to the two outer bars by screws and dowels, are four brackets *D*, in which flush pins are held for testing the height of the milled surfaces. These pins are kept down by coil springs, and when the casting is milled to the correct thickness, they come flush with the top faces of the bushings inserted in the brackets. If the casting is milled thinner or thicker than the required dimensions the variation is noted by the height of the flush pins in relation to the top faces of the bushings. The hole for the platen shaft is tested by an ordinary plug gage which fits in a bushing in bracket *E*. The simplicity of construction of this fixture is its especially commendable feature.

* * *

THE ELECTRIC STEEL FURNACE IN FOUNDRY PRACTICE

According to *Metallurgical and Chemical Engineering*, the use of the electric steel furnace in foundry practice is steadily increasing. This type of furnace is now being substituted in some plants for the crucible furnace or small converter, this substitution being due to the possibility of turning out a high quality steel at a much lower cost than is possible with the other methods referred to. The electric steel furnace is especially suited for the production of castings, since its use enables the finished steel to be held in the furnace without changing in composition; in this respect the use of the electric furnace is similar to that of a metal mixer. The temperature of the metal can also be raised or lowered to meet the requirements of different sized castings.

In the Girod electric furnace the hearth consists of a rectangular or circular iron shell which is lined with refractory material. The furnace is fitted with a sliding door through which the metal is charged and the slag removed; the tap-hole is at the opposite end of the furnace from the charging door. The furnace is supported by a steel frame mounted on trunnions so that it can be tipped forward to draw metal from the tap-hole or backward to skim the slag off the bath through the charging door. The furnace can be operated by any system of current—either continuous, single-phase or three-phase—and the usual tension is 65 volts for small furnaces and 70 volts for larger sizes. The current is supplied through carbon electrodes which hang vertically into the melting chamber, their lower ends being near the slag level. At the bottom of the hearth, as far as possible from the upper carbon electrodes, there are six steel electrodes which pass through the refractory bottom, and are in direct connection with the furnace shell and the low tension side of the power plant. By this arrangement current is forced to pass through the charge so that the entire mass is uniformly heated instead of having the bath merely "licked" on the surface by the arc. A further advantage of having current pass through the bath is that an electromagnetic field is produced which gives the bath a rotary movement that accelerates chemical reaction in the steel.

Among recent applications of the electric steel furnace, the following may be mentioned: The well-known German firm of Krupp & Co. has a fifteen-ton Girod furnace which is being used in the manufacture of special steels for war material, fine steels, etc.; this company is also installing a five-ton furnace to be used for melting ferro-manganese, for which purpose it possesses the advantage of reducing the quantity of manganese lost in the process. In France, several electric furnaces are being used for the manufacture of high-grade steel for projectiles, special steels, tool steel and high-grade steel castings. To bring this matter closer home, it may be mentioned that the following American firms are using Girod electric furnaces: the Bethlehem Steel Co., South Bethlehem, Pa., the Simmons Mfg. Co., Lockport, N. Y., and the Washington Iron Works, Seattle, Wash. The Bethlehem Steel Co. is installing a ten-ton furnace and the Washington Iron Works is installing a three-ton furnace which is to be used exclusively in the production of high-grade steel castings.

* * *

It is estimated that about 2400 men will be required for the operation and maintenance of the Panama canal and the departments in connection with it in the Canal Zone. It has been estimated that the annual payroll will amount to about $2,825,000 and that the total operating expense will amount to about $3,500,000 a year. Adding to this the interest on the investment, it is easy to understand that a considerable paying tonnage will have to pass through the canal in order to make it a financially sound proposition.

DESIGNING STEEL TOWERS FOR WOOD TANKS—4

THE FLOOR SYSTEM FOR FOUR-POST TOWERS

BY EDMUND B. LA SALLE*

In the January, February and March issues of MACHINERY, the methods used in designing steel towers for supporting wood tanks were considered in detail. To make a complete structure it is necessary to provide a steel floor system for supporting the tank on top of the tower, and in this article we will carry out the method of designing it. The design of towers sometimes suffers as a result of competition in prices. In structures of any kind where lack of safety—if such should exist—endangers human life, the first consideration should be that of safety. In this article, only the engineering requirements have received consideration, the ability to meet competition being left to the individual designer. The floor system has to support everything but the tower, and in determining the loads on the beams composing the floor system we must know the weight of all the items that it has to carry. In the February issue, formulas were given for arriving at the weights of all parts of the structure, and we will take a 20 foot by 20 foot tank as an example. The rated or commercial capacity of that size tank is 40,000 gallons and the gross capacity, as given in the table of capacities published in the February issue, is 41,540 gallons. In speaking of the size of a tank in gallons—as 40,000, 50,000, etc.—the rated capacity is meant. The total capacity is the one that we use in designing, except in the formulas for finding the weight of towers, but there we use the rated capacity as the formulas were derived upon that basis. The rated capacities increase and decrease by 5000 gallons, and the weights for the various items that are required in designing the floor system were previously found to be as follows:

Water = 346,167 pounds
Roof = 4800 pounds
Tank = 19,200 pounds
Railing = 440 pounds
Balcony = 2000 pounds
Floor = 8308 pounds.

Total 380,915 pounds

The load carried by the entire floor system is seen to be 380,915 pounds. In order to obtain the load on each beam we first compute the load per square foot of area of the tank bottom, and from that we can get the load per lineal foot of floor beam. The floor beams are also called "joists" and we will hereafter call them by that name. The area of a 20-foot circle is 314.16 square feet.

$$\frac{380{,}915}{314.16} = 1212.5 \text{ pounds} = \text{load per square foot of tank bottom.}$$

As the loads on the beams should always include the weights of the beams themselves, we have included the weight of the floor system, but in figuring the loads on the joists we should omit the weight of the cap-beams as they are not carried by the joists. In the February number, the writer gave the following formula for finding the approximate bending moment in the cap-beams:

$$M = \text{diameter} \times \text{capacity} \times 2,$$

where M is the bending moment in inch-pounds. For the example under consideration, we would have:

$$M = 20 \times 41{,}540 \times 2 = 1{,}661{,}600 \text{ inch-pounds}$$

$$\frac{1{,}661{,}600}{12{,}500} = 132.9 = \text{section modulus of required beam.}$$

The nearest size beam to that is a 20-inch, 75-pound I-beam which has a section modulus of 126.9. This would raise the fiber stress to

$$\frac{132.9}{126.9} \times 12{,}500 = 13{,}100 \text{ pounds per square inch.}$$

A fiber stress of 16,000 pounds per square inch is customary, and for such conditions, a 20-inch, 65-pound I-beam would be quite satisfactory. However, that stress is too high as recent tests on I-beams show that they fail at from 30,000 to 35,000 pounds per square inch—or practically at the elastic limit of the material. The writer has made it a point to never exceed a stress of 14,000 pounds per square inch for the cap-beams and 13,000 pounds per square inch for the joists. The customary cap-beam for a 20 foot by 20 foot tank is a 20-inch, 65-pound I-beam, and for the present we will assume that section as being the one we will use. We will call the approximate length of the cap-beams 18 feet. This would give a total weight for the cap-beams of 36 × 65 or 2340 pounds. Dividing this by 314.16 to distribute it over the tank area as before, we have 7.45 pounds per square foot. This amount is very small—about 6/10 of one per cent of 1212.5—so in practical work we could ignore it, as we would only be overloading the joists by that amount. As an example let us suppose that the fiber stress was 14,000 pounds per square inch when we omitted the weight of the cap-beams. When we include them the fiber stress will increase to about 14,000 × 1.006 = 14,084 pounds per square inch. A fiber stress of 14,000 pounds per square inch is used as an example because the increase would be larger in proportion than for a fiber stress of 12,500 pounds per square inch. To be theoretically correct we will omit the weight of the cap-beams in computing the joist loads, which will then become 1212.5 — 7.45 = 1205.05, which we will call 1205 pounds per square foot of tank bottom.

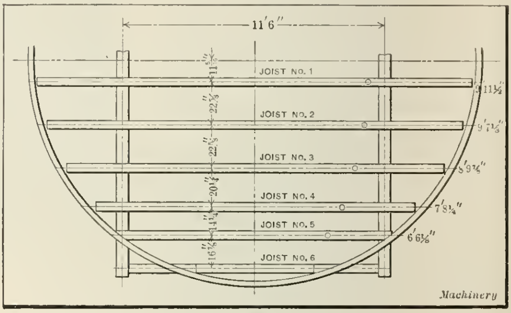

Fig. 15. Diagram used in determining Spacing of Joists in Floor Syetem

The maximum distance allowed between joists under wood tanks is 18 inches. This makes the maximum distance between centers of the joists 18 inches plus the width of the flange. We have to assume some size of beam in order to arrive at the approximate centers, and in case 10-inch, 25-pound beams are used, the maximum distance between centers would be 22.66 inches—say 22⅝ inches. We next lay out a diagram, similar to that shown in Fig. 15, representing the outside of the tank by a circle 20 feet in diameter to some convenient scale. Then draw two parallel lines 11 feet 6 inches apart to represent the cap-beams, the 11½ feet being obtained from the formula for finding the most economical centers for cap-beams. A line is then drawn representing the joist next to the center line of the tank, which will be 11 5/16 inches from it. Unless it is unavoidable, a beam should not be placed directly on the center line of the tank as that space is usually reserved for the riser pipe and its flanges. We will now determine the load on this joist which we will call joist No. 1. The "width of load" carried by this beam will be 22⅝ inches. The "length of load" can be obtained quite accurately by scaling, if the diagram is drawn to a large scale, and is the distance across the tank (or chord) at the center line of the load width. However, we need only use the half chord, as we can obtain the bending moment of the joists just as well that way, and then obtain the concentrated loads on the cap-beam, due to the joists, directly. The load on one half the joist is equal to the product of the width of load multiplied by the length of load (one half chord) multiplied by the intensity of the load per square foot of tank bottom. That is:

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$$W = B\ L\ w$$

where W = load on half the joist = reaction on cap-beam due to joist;
B = width of load;
L = length of load or half chord;
w = load per square foot of tank bottom.

For joist No. 1 we have all the necessary data except the value of L. This can be found by solving a triangle having the tank radius as a hypothenuse, the distance of the center line of the load from the tank center as a perpendicular and the half chord as a base. This base is the unknown quantity L. For joist No. 1 we have 10 feet as a hypothenuse and 11 5/16 inches as the vertical. This gives us a length L of 9 feet 11 15/32 inches, which we will call 9 feet 11½ inches, working to thirty-seconds being a needless refinement as other results are not that accurate. We have now all the required factors and compute half the total load on joist No. 1 as follows:

$W = B\ L\ w = 1.885 \times 9.958 \times 1205 = 22{,}625$ pounds.

From this we can obtain the bending moment at the middle of the beam. We must then compute the overhang for the part of the joist extending beyond the cap-beam separately. Fig. 16 illustrates how the middle bending moment is obtained. The center of gravity of the load in a longitudinal direction is located midway of the distance L. For joist No. 1, $\frac{L}{2}$ is equal to 4 feet 11¾ inches or 59¾ inches. Then the distance X shown in Fig. 16 is:

$$X = 69 - 59\tfrac{3}{4} \text{ or } 9\tfrac{1}{4} \text{ inches;}$$

$$M = 22{,}625 \times 9\tfrac{1}{4} = 209{,}281 \text{ inch-pounds.}$$

where M is the bending moment at the middle of the joist.

We will now check this bending moment by another method. The maximum bending moment for a simple beam uniformly loaded is $\frac{WL}{8}$, where W is total load between supports located a distance L apart. When we make w equal the load per square foot and B the load width as before, the maximum bending moment becomes,

$$M = \frac{wBL^2}{8} \text{ foot-pounds} = 1.5\ wBL^2 \text{ inch-pounds.}$$

For an overhanging beam where the overhang in feet equals l we have the bending moment

$$M = \frac{wBl^2}{2} \text{ foot-pounds} = 6\ wBl^2 \text{ inch-pounds.}$$

From the foregoing, we obtain the following expression for the maximum bending moment for a beam on two supports with overhanging ends, similar to joist No. 1:

$$M = \frac{B\ w\ (L^2 - 4\ l^2)}{8} \text{ foot-pounds.}$$

$$M = 1.5\ B\ w\ (L^2 - 4\ l^2) \text{ inch-pounds.}$$

These two formulas apply only where the overhang is not more than 0.207 of the total length of the beam or, in this case, the chord of the tank at the point under consideration. In the case of a tank resting on beams, the length of the load is independent of the length of joist, so that the load could continue on beyond the end of the beam any distance—if it were possible—and the bending moment would be controlled by the length of the load.

Working out joist No. 1 by the last formula given, we have: $M = 1.5 \times 1.885 \times 1205 \times (132.25 - 4 \times 17.7101) = 209{,}277$ inch-pounds, which is the same as we obtained by the first method for all practical purposes. The first method is more accurate and simpler than the second as there are not as many figures to handle.

We have now found the bending moment at the middle of the beam but that is not necessarily the maximum moment. To determine whether this is the case we compute the bending moment due to the overhang. For joist No. 1 the overhang is 4 feet 2½ inches. The bending moment in inch-pounds, as previously stated, is:

$M = 6\ wBl^2 = 6 \times 1205 \times 1.885 \times 4.208^2 = 241{,}417$ inch-pounds. This is the maximum bending moment due to the fact that the overhang of the load is greater than 0.207 times the length of the joist between the cap-beams. This could have been ascertained in the first place, had we so desired, by dividing the overhang of 4 feet 2½ inches by the chord 19 feet 11 inches which would have given us 0.211, thus showing that the overhang created the maximum bending moment.

We have assumed a 10-inch, 25-pound I-beam for the joists. The section modulus for that size is 24.4 which gives a fiber stress of $\frac{241{,}417}{24.4} = 9894$ pounds per square inch. This value may seem low, but we will find that as the overhang grows shorter the maximum fiber stress in the joist increases, and that it becomes a maximum when no overhang exists. Joist No. 1 is the only one where the overhang is the controlling feature, although the maximum bending moment may not be found in the overhanging part of this joist, the location of the maximum moment depending upon the centers of cap-beams that were adopted.

We will next take up joist No. 2. By calculation, we find the length L to be 9 feet 7⅛ inches. The center of gravity of this load would be located at the middle of this distance or 4 feet 9 9/16 inches from center of tank. The distance X in Fig. 16 would then equal 69 − 57 9/16 = 11 7/16 inches. The amount of the load, assuming that it can still be 22⅝ inches wide, would then be:

$W = B\ L\ w = 1.885 \times 9.594 \times 1205 = 21{,}797$ pounds.

The middle bending moment is then found to be:

$M = 21{,}797 \times 11\ 7/16 = 249{,}303$ inch-pounds.

$249{,}303 \div 24.4 = 10{,}217$ pounds per square inch = fiber stress. The overhang equals 9 feet 7⅛ inches — 5 feet 9 inches = 3 feet 10⅛ inches. Dividing this overhang by the chord we have: $3.845 \div 19.188 = 0.20033$. As this is less than 0.207, the maximum bending moment occurs at the middle and will do so in the balance of the joists.

In figuring joist No. 3 we had better determine the width of load which it can support rather than figure the fiber stress from a given load width. However, we must assume the same width as before in order to arrive at the length L. Joist No. 2 can carry the maximum load width of 22⅝ inches, so we will place joist No. 3 at that distance from joist No. 2. Then for the length L we get 8 feet 9⅞ inches. We take the nearest ⅛ inch in this case. The bending moment equals $w\ B\ L\ X$, and solving for B we have:

$$B = \frac{M}{w\ L\ X};$$

$$M = 24.4 \times 12{,}500 = 305{,}000 \text{ inch-pounds;}$$

$$X = 69 - 52.9375 = 16.0625 \text{ inches.}$$

$$B = \frac{M}{w\ L\ X} = \frac{305{,}000}{1205 \times 8.8225 \times 16.0625} = 1 \text{ foot } 9\ 7/16 \text{ inches.}$$

This shows that joist No. 3 is not good for the maximum load width of 22⅝ inches. As the load over the space between two beams is distributed equally between them, we know that joists No. 2 and No. 3 each take 11 5/16 inches of the space of 22⅝ inches between them. Then if joist No. 3 is good for 21 7/16 inches, we can give it a load on the side between it and joist No. 4 of 21 7/16 — 11 5/16 = 10⅛ inches. This will make a center to center distance between joist No. 3 and No. 4 of 20¼ inches. Joist No. 4 is located 20¼ inches from joist No. 3 and we calculate its allowable load width in the same manner. The length L becomes 7 feet 8¼ inches. The distance X equals 69 — 46⅛ = 22⅞ inches.

$$B = \frac{M}{w\ L\ X} = \frac{305{,}000}{1205 \times 7.688 \times 22.875} = 1 \text{ foot } 5\tfrac{1}{4} \text{ inches.}$$

We have then an allowable load width of 17¼ inches for joist No. 4, and to get the distance to joist No. 5 we subtract 10⅛ from 17¼ which gives 7⅛ inches or 14¼ as the distance from joist No. 4 to joist No. 5. In calculating the half chord or length L for joist No. 5 we find it to be 6 feet 6⅛ inches. The distance X equals 69 — 39.06 = 29.94 inches.

$$B = \frac{M}{w\ L\ X} = \frac{305{,}000}{1205 \times 6.51 \times 29.94} = 1 \text{ foot } 3\ 9/16 \text{ inches.}$$

The distance to joist No. 6 will then be:

$$(15\ 9/16 - 7\tfrac{1}{8}) \times 2 = 16\tfrac{7}{8} \text{ inches.}$$

We have now located all the joints, as shown in Fig. 15, and find two faults with the spacing. The first is that joist No. 5 is so placed that it has a poor bearing on the cap-beam. The second fault lies in the fact that joist No. 6 is too far toward the outside of the tank, so that it cannot carry a proper share of the load, due to its cramped position. It is always necessary to place an auxiliary joist on top of it, as the staves of the tank should never rest on a joist. A good form of construction used for this purpose is shown in Fig. 17. It will be seen that the main joist is connected directly to the webs of the cap-beams, and the auxiliary or sub-joist is supported on it by means of two separators made of short pieces of beams or castings. The object of separating the main and auxiliary joists in this way is to provide for securing the four-inch beams that are used to support the balcony. This construction will be taken up more fully later on.

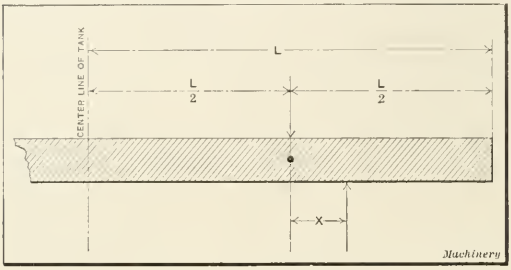

Fig. 16. Diagram illustrating Method of determining Bending Moments in Joists

We will now consider respacing the joists in order that they may all be placed in the most advantageous positions. It is necessary to move joist No. 5 a sufficient distance toward the center of the tank to give it a full bearing on the cap-beams and allow it to clear the tank staves by about an inch. One inch is the closest that the corner of any joist flange should come to the inside face of the tank staves; otherwise there may be trouble in erecting, as the tanks are not always of the exact dimensions called for. The variation is not large but it is not well to approach too close to the inside diameter. In order to locate joist No. 5 accurately, we will first figure the distance from the center line of the tank to the point where the inside circle of the staves crosses the line of the outside edge of the cap-beam flange as follows: The cap-beam centers are 11 feet 6 inches, and the flange width is 6¼ inches on a 20-inch, 65-pound I-beam. The thickness of the staves is about 3 inches. We now have a triangle to solve, having a hypothenuse of 9 feet 9 inches and a base of 6 feet ⅛ inch. The third side, which is the required distance of joist No. 5 from the tank center, is thus found to be 7 feet 8⅛ inches. The flange of a 10-inch, 25-pound I-beam is 4 11/16 inches wide. Half of that would be 2 11/32 inches, which we will call 2⅜ inches. Now if the outer edge of the flange of joist No. 5 just touched the point we have located, the center line of the beam would be 2⅜ inches nearer the center of the tank than the point referred to, or 7 feet 8⅛ inches — 2⅜ inches = 7 feet 5¾ inches. As previously mentioned, the flange should clear the inside face of the staves by about an inch and, therefore, we deduct one inch from 7 feet 5¾ inches which gives 7 feet 4¾ inches as the proper distance from the center line of joist No. 5 to center of tank. According to the spacing shown in Fig. 15, joist No. 5 is 91 1/16 inches from the tank center while we find it should not be more than 88¾ inches or 2 5/16 inches closer. We will also move joist No. 6 closer—say ⅞ inch—making it 16 inches from joist No. 5.

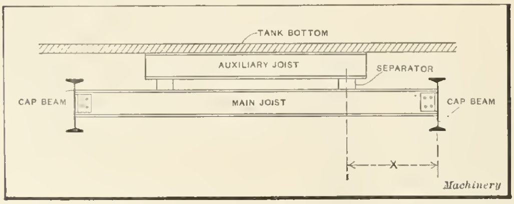

Fig. 17. Auxiliary Joist placed between Joist No. 6 and the Tank Bottom

According to previous calculations, joist No. 5 was good for a load width of 16 inches. As we have 8 inches of load on one side (toward joist No. 6) we can have only 8 inches on the other side and therefore we must have 16 inches between joists No. 5 and No. 4. Joist No. 4 is good for 17¼ inches, and as it has 8 inches of load on one side there can be 17¼ — 8 = 9¼ inches on the other side. This gives a space of 18½ inches between joists No. 4 and No. 3. Joist No. 3 is good for 21 7/16 inches and if there are 9¼ inches on one side, there can be 21 7/16 — 9¼ = 12 3/16 inches on the other side. This would make a space of 24⅜ inches between joists No. 3 and No. 2, but as we have a limit of 22⅝ inches, we cannot exceed that figure although less would be preferable, as we should reduce the load if possible. Now we can respace the joists to best meet the requirement of existing conditions, and we will begin by eliminating the fractional inches in the spacing, still keeping the load limit we have worked out in mind. We will place joist No. 5 at a distance of 89 inches from the tank center, instead of 88¾, and space the remainder of the joists according to Fig. 18. From this the reader can see that the loads on the beams are apparently reduced to some extent. We must remember, however, that when we move a joist toward the center of the tank the length of the load increases, and as it will be necessary to go over the joists again to get the loads on the cap-beams, we can compute the fiber stress to see that they are not overloaded.

We have not yet done anything with joist No. 6, as it is necessary to decide on the final spacing in order to arrive at the correct dimensions of the segment over which the load that it carries is distributed. If the diagram is made to a large scale, the dimensions can be scaled close enough for all practical purposes. We will, however, calculate all dimensions. Fig. 18 shows the division of the loads for each joist by means of dotted lines. Beginning with joist No. 1, we will proceed as before, using the same nomenclature, and determine the load and fiber stress for each joist with the arrangement shown in Fig. 18. As the reader is now familiar with the method used for this purpose, we will show the operations in their regular order and omit any explanation except where something new comes up.

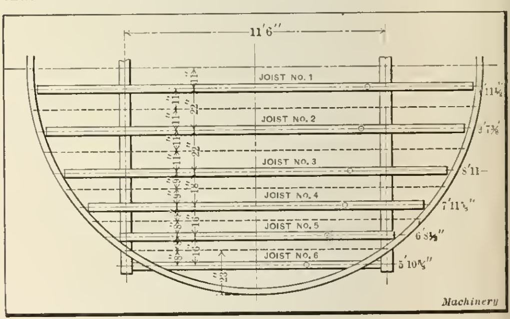

Fig 18. Diagram showing Joists respaced to receive a Better Distribution of the Load

Joist No. 1

$L = 9$ feet 11½ inches;

$W = w\,B\,L = 1205 \times 1.83 \times 9.96 = 22{,}000$ pounds;

$X = 69 - 59\frac{3}{4} = 9\frac{1}{4}$ inches;

$M = WX = 22{,}000 \times 9.25 = 203{,}500$ inch-pounds.

$$\text{Fiber stress} = \frac{M}{Z} = \frac{203{,}500}{24.4} = 8340 \text{ pounds per square inch.}$$

This is the fiber stress for the bending moment at the middle of the beam which we have worked out in order to compare it with the bending moment of the overhang. The overhang is 9 feet 11½ inches — 5 feet 9 inches = 4 feet 2½ inches.

$M = 6\,wBl^2 - 6 \times 1205 \times 1.83 \times 4.21^2 = 234{,}100.$

$$\text{Fiber stress} = \frac{M}{Z} = \frac{234{,}100}{24.4} = 9621 \text{ pounds per square inch.}$$

The fiber stress due to the overhang is quite a little more than the stress for the middle bending moment.

Joist No. 2

$L = 9$ feet $7\frac{3}{8}$ inches;

$B = 22$ inches;

$W = w\,B\,L = 1205 \times 1.83 \times 9.62 = 21{,}240$ pounds;

$X = 69 - 57\,11/16 = 11\,5/16$ inches;

$M = W\,X = 21{,}240 \times 11.33 = 240{,}500$ inch-pounds.

$$\text{Fiber stress} = \frac{M}{Z} = \frac{240{,}500}{24.4} = 9848 \text{ pounds per square inch.}$$

Joist No. 3

The load on joist No. 3 is not balanced about the center line of the beam, as will be seen by referring to Fig. 18. It has 11 inches on one side and 9 inches on the other; and to find the length of load we will have to determine the distance of its center line from the center of the tank and proceed as before. The center of the load is $\frac{11 + 9}{2}$ or 10 inches from the side line or one inch off the center line of the joist. Then the distance of the center line of the load from the center line of the tank is $11 + 22 + 11 + 10 = 54$ inches or 4 feet 6 inches. Solving the triangle as before we have as the distance: $L = 8$ feet 11 3/16 inches.

$W = w\,B\,L = 1205 \times 1.66 \times 8.93 = 17{,}880$ pounds.

$X = 69 - 53\frac{5}{8} = 15\frac{3}{8}$ inches.

$M = W\,X = 17{,}880 \times 15.375 = 27{,}500$ inch-pounds.

$$\text{Fiber stress} = \frac{M}{Z} = \frac{27{,}500}{24.4} = 11{,}260 \text{ pounds per square inch.}$$

Joist No. 4

The center line of the load on joist No. 4 is one-half inch from the center line of the joist and nearer the center line of the tank. We calculate the distance in the same way as for joist No. 3.

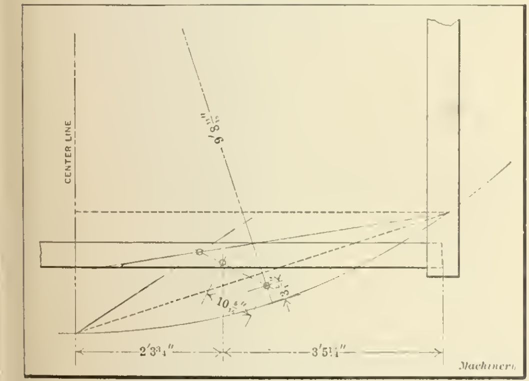

Fig. 19. Diagram used in determining Amount and Center of Gravity of Load on Joist No. 6

$L = 7$ feet $11\frac{5}{8}$ inches;

$W = w\,B\,L = 1205 \times 1.42 \times 7.97 = 13{,}603$ pounds;

$X = 69 - 47\,13/16 = 21\,3/16$ inches;

$M = W\,X = 13{,}603 \times 21.19 = 288{,}000$ inch-pounds;

$$\text{Fiber stress} = \frac{M}{Z} = \frac{288{,}000}{24.4} = 11{,}812 \text{ pounds per square inch.}$$

Joist No. 5

$L = 6$ feet $8\frac{1}{2}$ inches;

$B = 1$ foot 4 inches;

$W = w\,B\,L = 1205 \times 1.33 \times 6.71 = 10{,}778$ pounds;

$X = 69 - 40\frac{1}{4} = 28\frac{3}{4}$ inches;

$M = W\,X = 10{,}778 \times 28.75 = 309{,}900$ inch-pounds.

$$\text{Fiber stress} = \frac{M}{Z} = \frac{309{,}900}{24.4} = 12{,}700 \text{ pounds per square inch.}$$

This is slightly over the limit of 12,500 pounds per square inch but not enough to make it necessary to reduce the spacing. This we could do by moving joist No. 4 a little toward joist No. 5. The fiber stresses in joists No. 1 to No. 5 vary from 9621 to 12,700 pounds per square inch. We could reduce the size of the joists, if we placed a separator of some kind between them and the cap-beams to maintain the same level of their top surfaces. The question is, would it pay? The section modulus for a 9-inch, 21-pound I-beam is 18.9. If 9-inch beams were used, the fiber stress of joist No. 1 would be:

$$\frac{24.4}{18.9} \times 9621 = 12{,}420 \text{ pounds per square inch.}$$

The fiber stress for joist No. 2 would be:

$$\frac{24.4}{18.9} \times 9848 = 12{,}713 \text{ pounds per square inch.}$$

For joist No. 3 it becomes:

$$\frac{24.4}{18.9} \times 11{,}260 = 14{,}520 \text{ pounds per square inch.}$$

The stress in joist No. 3 with this sized beam is, of course, too large, but from the foregoing we can see that it would be possible to change the first two joists to 9-inch, 21-pound I-beams. We would thereby make a saving in weight of four pounds per lineal foot of joist thus altered. By the time we include the extra labor resulting from the change, it is doubtful if any saving would be made.

Joist No. 6

We will now take up the end joist No. 6. The first thing necessary is to compute the area of the segment over which the load it supports is distributed, as shown in Fig. 19. The area of a 20-foot circle is 314.16 square feet. The distance of the base of this segment from the tank center is 97 inches. This leaves 23 inches as the height of the segment, as shown in Fig. 18. Next we obtain half the chord in the same way as for the other joists, and it is found to be 5 feet $10\frac{5}{8}$ inches. The included angle between the extremes of the total chord of 11 feet $9\frac{1}{4}$ inches is found by first dividing half the chord by the tank radius. This gives the sine of half the included angle, from which the desired result can be obtained. Thus:

$$\sin\frac{a}{2} = \frac{5.885}{10.0} = 0.5885;$$

$$a = 72 \text{ degrees } 6 \text{ minutes.}$$

Then we get the area of the sector included in this angle from the following proportion:

$$\text{Area} = \frac{72 \text{ deg. } 6 \text{ min.}}{360 \text{ deg.}} \times 314.16 = 62.92 \text{ square feet.}$$

We next find the area of the triangle which has the chord for its base and the perpendicular distance 8 feet 1 inch from the center of the tank to the segment as its altitude. This area is:

$$8.083 \times 5.885 = 47.58 \text{ square feet.}$$

Then $62.92 - 47.58 = 15.34$ square feet, area of segment over which the load on joist No. 6 is distributed. All we need to consider is one-half the load, according to the method used on the other joists.

$15.34 \div 2 = 7.67$ square feet = area of half segment.

$7.67 \times 1205 = 9242$ pounds = load on half segment.

The next step is to find the center of gravity of the half segment in order that we may arrive at the bending moment of the joist. We divide the area into two parts, a triangle and a segment, as shown in Fig. 19. The center of gravity of the triangle can be found by bisecting the two adjacent sides and drawing diagonal lines as shown. The point where these diagonals intersect is the center of gravity of the triangle. Next we must find the center of gravity of the small segment. According to Kent and Trautwine, the distance of the center of gravity of a segment from the center of the circle of which it is a part (the tank in this case) is equal to:

$$\frac{\text{cube of chord}}{12 \times \text{area of segment}}.$$

We have the area for the total half segment, which equals 7.67 square feet. To get the area of the small segment, now under consideration, we must deduct the area of the triangular portion of which we just found the center of gravity from the total half segment. The area of the triangle is:

$$\frac{5.885 \times 1.916}{2} = 5.64 \text{ square feet}$$

Then 7.67 — 5.64 = 2.03 square feet = area of small segment. In order to use the formula given, we also need the length of the chord for the small segment. This we can obtain by working out the hypothenuse of the triangular portion which is found to be 6 feet 2¼ inches. Then the distance of the center of gravity of the segment from the center of the circle is:

$$\frac{\text{cube of chord}}{12 \times \text{area of segment}} = \frac{6.18^3}{12 \times 2.03} = 9 \text{ feet } 8\ 11/16 \text{ inches;}$$

10 feet — 9 feet 8 11/16 inches = 3 5/16 inches = distance from the outside of the tank to the center of gravity of the segment. Now we draw a line joining the centers of gravity of the triangle and the segment. This line is 14 inches in length and on it we must find the location of the center of gravity of the whole area. This we can do by the following proportion:

$$(5.64 + 2.03) : 5.64 = 14 : X.$$

where X is the distance from the center of gravity of the small segment to the center of gravity of the whole area under consideration. From this proportion we find $X = 10.295$ inches. We will call it 10 5/16 inches. This last point is located 2 feet 3¾ inches from the center of the tank and 3 feet 5¼ inches from the center line of the cap-beam, as shown in Fig. 19. This is the point of application of the load 9242 pounds on joist No. 6.

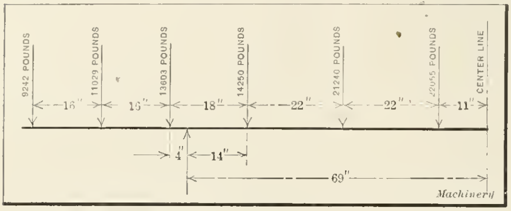

Fig. 20. Amount and Distribution of Loads applied on Cap-beams by Joists

Referring again to Fig. 17 we see that the separator is located a distance X from the center of the cap-beam. We must now decide where that separator can be located in order to use a 10-inch I-beam for the main joist, if possible. The load is 9242 pounds, the section modulus 24.4, and the allowed fiber stress 12,500 pounds per square inch. Then the distance

$$X \text{ equals } \frac{12{,}500 \times 24.4}{9242} = 33 \text{ inches from the center of the cap-}$$

beam or 36 inches from the middle of the joist. The longest length we can use for the auxiliary joist shown in Fig. 17 is 7 feet 7 inches. This places the separator 3 feet 9½ inches — 3 feet = 9½ inches from the end of the auxiliary joist. As the load is applied 27¾ inches from the center line of the tank, as shown in Fig. 19, the distance X in Fig. 16 becomes 36 — 27¾ = 8¼ inches on the sub-joist. The middle bending moment is then 76,246 inch-pounds. With 12,500 pounds as the fiber stress we need a section modulus of 6.1. The bending moment due to the overhang is 34,580 inch-pounds. For the sub-joist we can then use a 6-inch, 12¼-pound I-beam. As a rule the joists are all made the same size.

Cap-beams

The next thing in line is to determine the size required for the cap-beams. We have the loads on all the joists, but in figuring the bending moment we must include the weight of the beams themselves. This can be done in two ways. By increasing the loads due to the joists an amount that would take care of the weight of the cap-beams, or by leaving the joist loads as they are and calculating separately the bending moment in the cap-beams due to their weight and adding it to the bending moment due to the joists. The latter method is the easier one and will be used in the present discussion. Fig. 20 gives the arrangement of the loads applied on the cap-beams by the joists. There are two ways of obtaining the bending moment due to the joists. One is to add together the moments of all the loads about the center line and subtract their sum from the moment of the reaction about the center line. This gives the middle moment; then to get the end moment due to the overhang, we take the sum of the moments of the loads on the overhanging portion about the column center.

The second method, which is a shorter one, is to take all moments about the column center. For the middle moment take the inside loads, and for the end moment take the overhanging loads. The maximum moment is the difference between the first two moments, as follows:

14,250 × 14 = 199,500 inch-pounds.
21,240 × 36 = 764,640 inch-pounds.
22,055 × 58 = 1,279,190 inch-pounds.

Total 2,243,330 inch-pounds, middle moment.
13,603 × 4 = 54,412 inch-pounds.
11,029 × 20 = 220,580 inch-pounds.
9242 × 36 = 332,712 inch-pounds.

Total 607,704 inch-pounds, end moment.

From this we can see the overhang is not the controlling factor and we obtain the maximum moment due to the joists as follows: 2,243,330 inch-pounds — 607,704 inch-pounds = 1,635,626 inch-pounds, maximum moment.

We assumed to start with, that a 20-inch, 65-pound I-beam was large enough, but to get closer to the right size we will use the moment due to the joists to arrive at the proper size and change it later, if necessary.

$$\frac{1{,}635{,}626}{13{,}000} = 125.8 = \text{section modulus.}$$

This calls for a 20-inch, 75-pound I-beam. The approximate length of the cap-beams is 18 feet. We will only consider half of the beam. Then:

9 × 75 = 675 pounds, weight of half the cap-beam;
$X = 69 - 54 = 15$ inches (Fig. 16);
$M = 675 \times 16 = 10{,}125$ inch-pounds, middle moment in cap-beam due to its own weight.

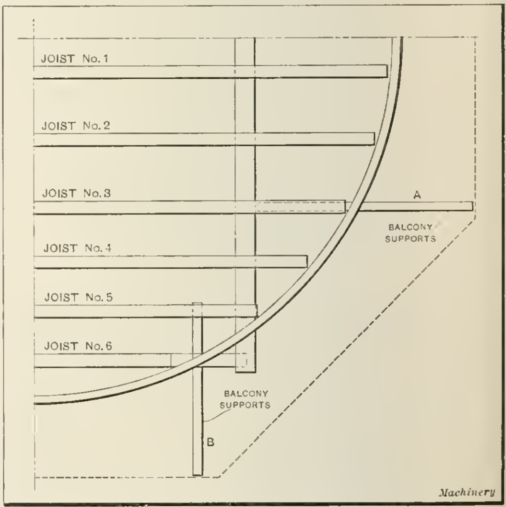

Fig. 21. Quarter Plan of Floor System, showing Beams for supporting Balcony

For the end moment we have:

3.25 × 75 × 19.5 = 4753 inch-pounds;

10,125 — 4753 = 5372 inch-pounds, maximum moment in cap-beam due to its own weight.

1,635,626 + 5372 = 1,640,998 inch-pounds, maximum bending moment in cap-beam.

$$\frac{1{,}640{,}998}{117} = 14{,}026 \text{ pounds per square inch, fiber stress in}$$

a 20-inch, 65-pound I-beam.

If we had used the weight of a 65-pound beam instead of a 75-pound beam, the fiber stress for the 65-pound beam would be reduced by about 5½ pounds per square inch and we would have a fiber stress of 14,020 pounds per square inch for the 20-inch, 65-pound I-beam. Now the designer can take his choice of the two sizes. It would not be out of the way to use the lighter beam, according to present practice, although we would only have a factor of safety of about 2¼. There is one more factor to consider in the selection of beams to carry given loads, and that is their shearing strength. While a beam may be strong enough to carry the load when applied as a bending moment, it may be weak in its ability to resist shearing stresses. Therefore, a shallow beam should be selected in preference to a high one. For instance, a 20-inch, 80-pound I-beam is sometimes preferable to a 24-inch, 80-pound I-beam for the reason just mentioned. In the case under consideration, a 20-inch, 65-pound I-beam is of ample size to carry the load in shear.

We have now proportioned the joists and cap-beams, and the only point that remains is to determine the size of the beams that support the balcony. The balcony should be made two feet wide inside the hand rail, and that determines the size of the beams. They are located as shown in the quarter plan of the floor system, Fig. 21. It is customary to use 4-inch, 7½ pound I-beams, and with 3½ feet overhang that size would support 900 pounds at the end with a fiber stress of 12,600 pounds per square inch, which load is probably more than the beam will ever have to carry. Beam *A* is hung under joist No. 3 by riveting, or any other secure method. Beam *B* is placed on top of main joist No. 6 with its end under joist No. 5, and is bolted in place. The balcony is made by placing wooden beams of the proper size across the balcony beams, the planking being nailed to these stringers.

If a steel tank is to be used in place of a wood tank, the calculations would be made in the same manner, except that the beams used as joists would have to be spaced to suit the thickness of the bottom, according to the table entitled "Maximum Centers of Beams for Steel Tank Bottoms" printed in the July, 1911 issue of MACHINERY. The formula for the most economical centers of cap-beams and columns would then be changed to read: Column and cap-beams centers = 0.586 *D*, where *D* is the outside diameter of the tank.

In a wood tank, the sides are slanting inward toward the top and this throws the load slightly toward the center. Another thing which might be mentioned is, that the maximum distance of 18 inches between the flanges of the joists previously given, is for 3-inch lumber in the tank bottom. For lumber 2 inches and less in thickness, the distance should be lessened in proportion to the strength, which would be gaged by the section moduli of equal widths compared.

* * *

The position of the fabricators of steel, especially the manufacturers of drop-forgings, has changed greatly during the past ten years with respect to the specifying of steel. Formerly it was the custom for the purchaser of drop-forgings to leave the selection of the steel to the drop-forge concern. The makers of drop-forgings, of course, selected the low carbon steels which are easily worked. Now the customer, especially the large ones, specifies minutely the chemical and physical characteristics of the steel to be used, and in some cases even the name of the steel company from which the steel shall be bought. The drop-forge manufacturer is relieved of responsibility for the steel used, but has greater difficulties imposed on him by the new conditions. Not only are the steels harder to work, but they must be put through special heat-treatments, the details of which also are minutely prescribed.

* * *

The British machine tool builders' association, known as the Machine Tool & Engineering Association, Ltd., has issued a very optimistic report for the past year. This report points out that the machine tool exhibition at Olympia was very successful, both from the point of view of the association as a whole and from that of the individual members who exhibited. The total number of exhibitors was 292 and the total attendance about 100,000. The association was recently invited to organize a collective exhibit of machine tools at the Ghent exhibition this year, but the response to the invitations from the individual members was so inadequate that the scheme has been abandoned. The financial condition of the society is very satisfactory, the balance on hand after meeting all current liabilities amounting to nearly £4000 ($20,000). During the past year twenty-three members have joined the association, bringing the membership up to slightly over one hundred.

MILLING MOTOR TRUCK SPRING CHAIRS

BY GEORGE E. POPE[*]

In determining the necessary tools for machining a spring chair of the design shown in Fig. 1, the problem of finishing the surface *A* came up. As this surface has a radius of 19⅝ inches it was, of course, out of the question to use a cutter of this radius, even if such a method were possible. It was appreciated at the outset that the logical method of finishing this surface was to make a large fixture for the vertical boring mill, set the spring chairs around on the proper radius, and thus finish a number of them at one operation. This idea was discarded because a fixture of this sort represented a considerable first cost and there was only a small number of the spring chairs to be made.

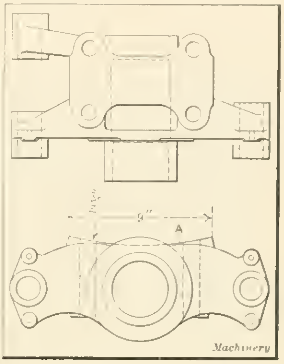

Fig. 1. Spring Chair for which Method of finishing Surface A was devised

Then a scheme was hit upon by which the surface *A* could be milled by the use of a fixture of comparatively small cost. This scheme, as illustrated in Fig. 2, was to design a suitable fixture for the horizontal milling machine; this fixture located the chair in a horizontal position from the large hole, which was previously finished to size. The largest cutter in stock was used in connection with a large Brown & Sharpe vertical milling attachment of the universal type. The cutter was set at an angle and the cutting was done by its edge as shown. It is evident that this method did not finish the surface with a true radius but left it elliptical. This was permissible, however, as these surfaces merely form seats for the truck springs and they are not expected to fit exactly, even if this surface is finished to a true radius.

In selecting a cutter, it can be seen, first, that the larger the cutter used the nearer the curve will approximate a circle; and second, that the diameter of the smallest cutter that can be used must be greater than the length of the surface to be milled. In fact, it will be readily seen that the smallest permissible diameter, greater than the length of the surface, will be determined by the limit of variation from a true circle that can be allowed. In determining the angle at which to set the cutter, the first consideration, after the diameter has been selected, is to find the minor axis of the ellipse. From the diagram shown in Fig. 3, a formula can be derived that will give the minor axis and also one that will give the amount of deviation from a true circle for any distance out from the center. For the derivation of a formula to determine the minor axis, the equations for a circle and an ellipse are employed, using rectangular coordinates with origins at O and O_1, respectively. These equations are $x^2 + y^2 = r^2$ for the circle and $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ for the ellipse. The notation in Fig. 3, which shows an ellipse superimposed upon a circle with the vertical center lines coincident and with the perimeter of the ellipse tangent to the circumference of the circle, is as follows: x = the distance from the common center line to the point where it is desired that the circle and the ellipse will coincide and is the common abscissa of both the ellipse and the circle. b = one half the minor axis of the ellipse. y_1 = the ordinate of the point on the ellipse. a = one-half the major axis of the ellipse. r = the radius of the circle it is desired to approximate. y = the ordinate of the point on the circle. Then with y_1 and b as the unknowns, simultaneous equations must be found that will eliminate y_1, as b is the dimension required. In other words, what is desired is the minor axis of the only ellipse that can be drawn through the point on the circle of which x is the abscissa, when r and a are given, and with center lines coincident and the outlines tangent. Then from the equation for the ellipse is derived

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$$y_1 = \frac{b}{a}\sqrt{a^2 - x^2}$$

From Fig. 3 is obtained $r - b = y - y_1$, which gives $y_1 = b + y - r$. Therefore

$$b + y - r = \frac{b}{a}\sqrt{a^2 - x^2}$$

from which

$$b = \frac{a\,(y - r)}{\sqrt{a^2 - x^2} - a}$$

From equation $x^2 + y^2 = r^2$ is derived $y = \sqrt{r^2 - x^2}$

and substituting $b = a\,\dfrac{\sqrt{r^2 - x^2} - r}{\sqrt{a^2 - x^2} - a}$

For the case of the spring chairs: $r = 19\frac{5}{8}$ inches, the chordal length of the surface to be milled = 9 inches, making $x = 4\frac{1}{2}$ inches; the cutter used is 14 inches in diameter, making $a = 7$ inches. Substituting these numerical valnes

$$b = 7\,\frac{\sqrt{19.625^2 - 4.5^2} - 19.625}{\sqrt{7^2 - 4.5^2} - 7} = 2.2341 \text{ inches.}$$

Now turning to Fig. 4 the angle at which the milling head must be set can be obtained. It can be seen by this diagram that if $2b$ represents the minor axis of the ellipse, and $2a$ the major axis of the ellipse and also the diameter of the cutter, $b \div a$ will equal the sine of the angle desired. This, for the example at hand, equals $2.2341 \div 7 = 0.3191$ for the sine. This gives an angle of 18 degrees 37 minutes.

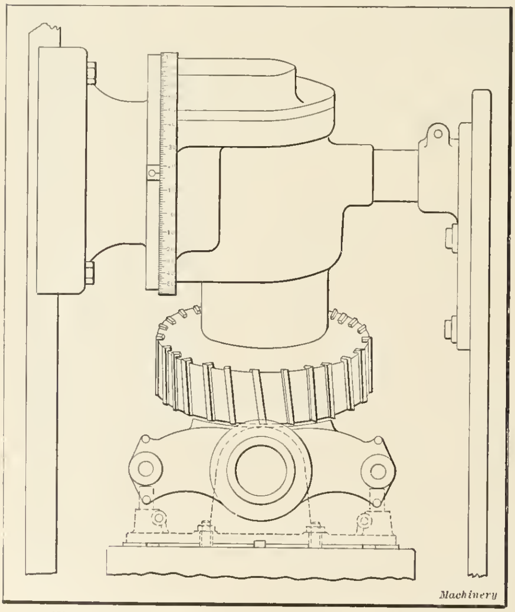

Fig. 2. Method of finishing Surface A on the Milling Machine

It can be readily seen that with the respective center lines coincident it is impossible for an ellipse and a circle to coincide except at one point in each quadrant of the ellipse. Returning to Fig. 3 it is evident then that there is a deviation of the outline of the ellipse from the circumference of the circle along the length of x. The respective outlines are, of course, tangent at the center line. This deviation can be investigated at different distances out from the center line in order to decide, by finding its maximum amount, whether this method of approximating a circle is accurate enough for the purpose under consideration. It must be remembered, as stated in a preceding paragraph, that this deviation can be diminished to any desired amount, provided the diameter of the cutter can be sufficiently increased. In other words, the deviation becomes zero when the radius of the cutter equals the radius of the surface to be milled. This investigation can be conducted by holding a and b constant, selecting different values for x, and then finding y_1 in the formula for an ellipse. From the formula for the ellipse the value of y_1 was obtained.

Then in the equation for the circle there will, be, of course, a new value of y for every different value of x that is selected. This value can be found by using the equation $y = \sqrt{r^2 - x^2}$. Selecting distances from the center line of 1, 2, 3 and 4 inches, y and y_1 equal the values tabulated below:

	1	2	3	4
y	19.5995	19.5228	19.3943	19.2130
y_1	2.2108	2.1406	2.0182	1.8329

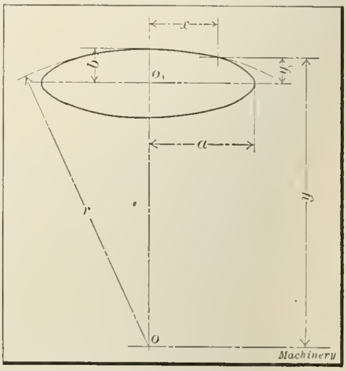

Fig. 3. Diagram showing Relation between the Desired Circle and the Ellipse actually obtained

Consulting the diagram in Fig. 3 again, it will be seen that $(r - b + y_1) - y$ will be an expression by which the deviation of the outline of the ellipse from the circumference of the circle can be found after knowing the various values of y and y_1. It is found to be 0.0022 inch, 0.0087 inch, 0.0148 inch and 0.0108 inch, respectively, at the points where x has values of 1, 2, 3 and 4 inches.

It will be noticed from these results that the outline of the ellipse rises quite rapidly away from the circumference of the circle, after crossing it at the point 4.5 inches from the center, and then gradually declines toward it again as it proceeds toward their common point of tangency. As 0.0148 inches is probably very nearly the maximum of deviation of the ellipse from the circle, this proved to be a very satisfactory way of milling these spring chairs.

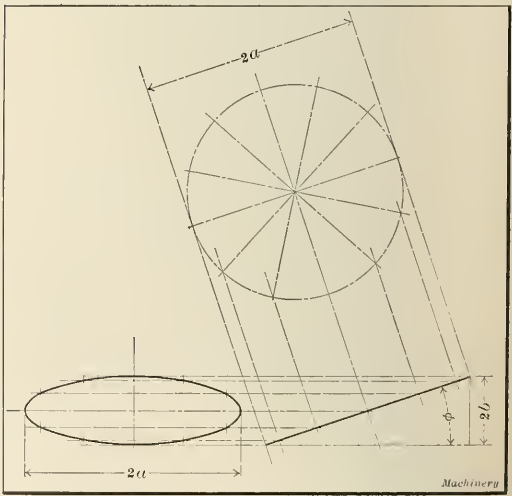

Fig. 4. Diagram used to determine Angle at which to set the Milling Cutter

* * *

Two French aviators, Lieuts. Varcin and Battinl, have in six months covered 12,000 miles and carried 600 passengers, without any accident.

CROSS-DRILLING AND MILLING ATTACHMENTS*

APPLICATION TO THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

Many parts which ordinarily require a second operation can be completed in one on the "Acme" multiple-spindle automatic screw machine by the use of special attachments. These are easily and quickly put into position, and owing to the "Acme" method of tooling, do not retard the output, except when extra heavy cuts are the longest single operation. In that case the time for the additional operation is the time required to make one piece, the regular operations being completed at or during the same time. The "Acme" automatic screw machine lends itself admirably to the application of special attachments, because of the stopping of the spindle in the third position for threading. This saves the cost of rehandling, and in the great majority of cases does not take any extra time.

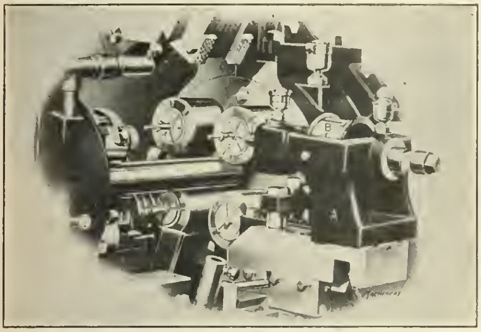

Fig. 1. Cross-drilling Attachment held on Cut-off Tool-slide

Cross-drilling Attachment held on Side-working Tool-slide

One of the standard cross-drilling attachments used on the "Acme" machine is shown in Fig. 1. This consists of a cast-iron frame *A* which is bolted to the top face of the cut-off tool-slide and works in the third position, where the work-spindle can be stopped. The cross-drilling and threading operations can usually be performed at the same time. The drive for this attachment is by a flat belt from a special overhead countershaft running on the pulley *B* which is fastened to the spindle *C* that carries the drill. This attachment, by a slight modification in its construction, can be driven by gears and a universal-joint shaft from the main tool-slide.

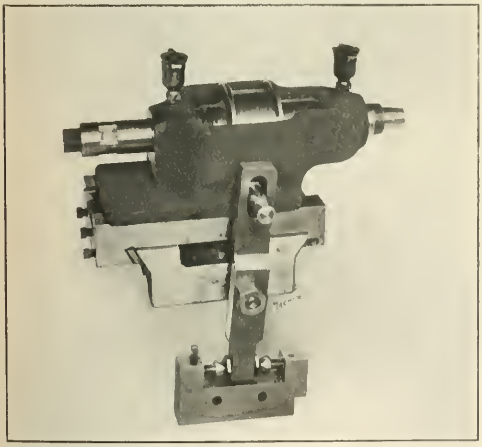

Fig. 3. Cross-drilling Attachment shown in Fig. 2 dismantled from the Machine

Cross-drilling Attachment with Accelerating Movement

Another cross-drilling attachment, held in a similar position to that just described but provided with an accelerating movement for increasing the travel of the drill, is shown in Figs. 2 and 3. Fig. 2 shows this attachment set up on the machine, and Fig. 3 shows it removed from the cut-off tool-slide. The attachment *A* is similar in construction to that shown in Fig. 1, except that it is mounted on two slides *B* and *C*. Slide *C* is fastened to the top face of the cut-off tool-slide, and slide *B* fits over the former and is furnished with a gib to provide for adjustment. This enables the drilling attachment to be moved longitudinally along the base, facilitating adjustments for the drilling of holes at different distances from the face of the chuck. Attachment *A* is operated by a lever *D* which is fulcrumed to the lower slide *C*.

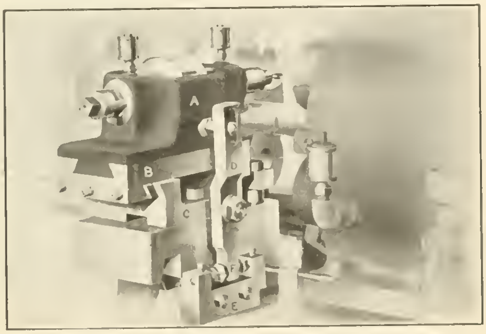

Fig. 2. Cross-drilling Attachment with Accelerating Movement

A block *E* provided with hardened adjustable stops *F* is fastened to the base in which the cut-off tool-slide works. This block, by means of its adjustable points, stops the lower portion of lever *D*, so that instead of following the movement of the cut-off tool-slide when it is fed in, it transmits a movement to the lower arm of the lever and thus accelerates the travel of the drill-holder. The ratio between the arms of lever *D* is $1\frac{3}{4}$ to 1, thus making it possible to drill a hole clear through a piece. The regular travel of the cross-slide is only equal to a little over one-half the diameter of the bar, so that when it is necessary to drill a hole entirely through the work, this attachment with accelerated movement can be used to very good advantage.

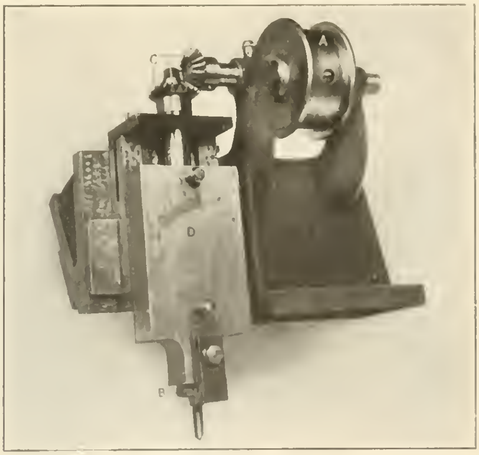

Fig. 4. Cross-drilling Attachment operated from the Top-working Tool-slide in the Third Position

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* For further information on National Acme automatic screw machine equipment, see "Automatic Screw Machine Equipment," March, 1913, and February, 1913, and articles there referred to.

† Associate Editor of MACHINERY.

Cross-drilling Attachment held on Top-working Tool-slide

A cross-drilling attachment, mounted on the regular top bracket, or a special bracket taking its place, and operated in the second position, is shown in Fig. 4. This attachment is driven from a special countershaft. The slide *D* in which the drill spindle *B* is located is adjustable sideways, thus enabling holes to be drilled in different locations in relation to the face of the chuck. This attachment is ordinarily used in conjunction with other attachments operating from the side or end, when the operations must be performed at angles to each other. The bracket shown in the illustration is used for drilling holes at right angles, but holes at practically any angle can be drilled by the substitution of a bracket suitable for the case in hand.

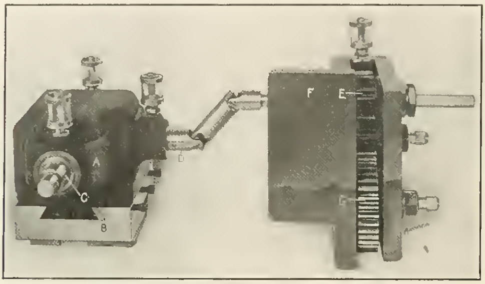

Fig. 5. Cross-drilling Attachment driven by Gears and a Knuckle-joint Shaft from the Threading Spindle Gears

Cross-Drilling Attachment held on Side-working Tool-slide and operated from the Main Tool-slide

A cross-drilling attachment which is held on the top face of the cut-off tool-slide and operated from the main tool-slide by the gears used in driving the threading spindle, is shown in Fig. 5. This attachment is particularly adapted for use on the motor-driven machines, but may be used equally well on the belt-driven machines, where it will eliminate the special countershaft. The top casting *A* is gibbed in the base *B*, which is fastened to the top face of the cut-off tool-slide and travels with it. The drill spindle *C* is driven by bevel gears receiving motion from the knuckle-joint shaft *D*, which is splined to fit a key in the gear *E*. The bracket *F* is bolted to the main tool-slide, and the gear *G* meshes with the gear driving the threading spindle.

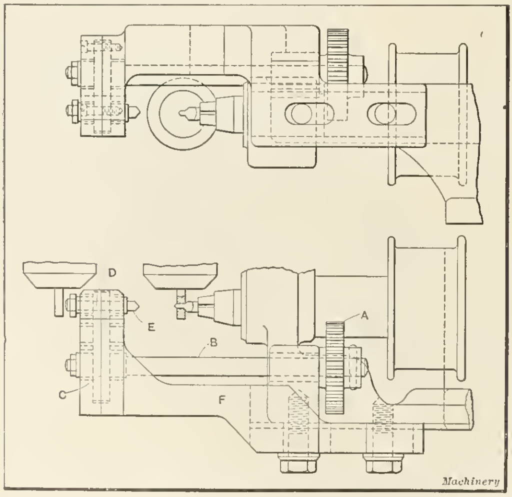

Fig. 6. Cross-drilling Attachment with Opposite Spindles

Cross-drilling Attachment with Opposite Spindles

The cross-drilling attachment shown in Fig. 6 is provided with opposite spindles and is adapted for drilling cross holes, and, in addition, counterboring or countersinking from both sides. It can also be used for drilling parallel holes of the same or different diameters at a given distance from each other and from the face of the chuck. The holes can either be drilled entirely through the work or to any distance desired. When necessary, the attachment can be provided with an accelerating device for increasing its travel. The second or auxiliary spindle of this attachment is driven by spur or bevel gears from the regular drill spindle. When driven by spur gears, the drive is through gear *A*, shaft *B* and gears *C* and *D*. Gear *D* is keyed to the spindle in which the countersink *E* (or drill) is held. The bracket *F* carrying the auxiliary mechanism is bolted to the front side of the regular attachment used for cross-drilling. The type of attachment which this auxiliary device is used in connection with is shown in Fig. 1.

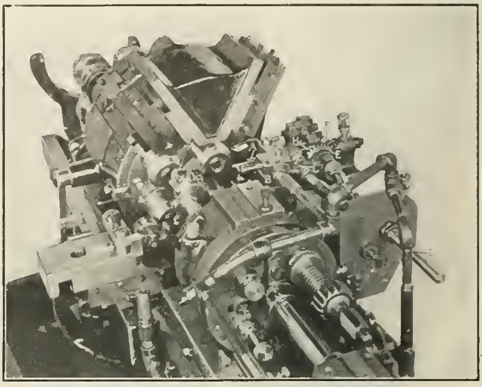

Fig. 7. Cross-drilling and Milling Attachment driven by Gears and a Knuckle-joint Shaft from the Threading Spindle Gears

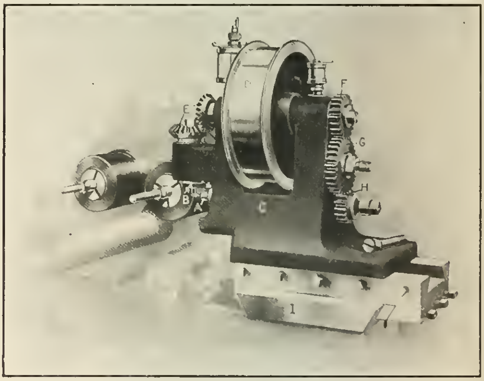

Fig. 8. Cross-drilling and Milling Attachment with Spindles located at Right Angles

In operation, as the cylinder indexes, the stock comes between the spindles of the attachment, and the machine is so cammed that the cut-off tool-slide feeds forward, drills the first hole, and then pulls back far enough to bring the drill held in the opposite spindle in contact with the work. The

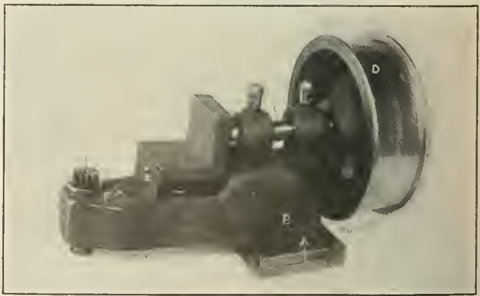

Fig. 9. Slab Milling Attachment held on Side-working Tool-slide and carrying One Milling Cutter

slide then feeds forward part way again before the next indexing operation.

Combination Cross-drilling and Milling Attachments

The attachment shown in Fig. 7 is provided with two horizontal spindles *A* and *B* holding a drill and an end milling cutter, respectively. The frame of this attachment is fastened to the top face of the cut-off tool-slide, and the tools are operated in the third position. The spindles *A* and *B* are driven from the knuckle-joint shaft *D* by gears meshing with the gears driving the threading spindle, as is shown more clearly in Fig. 5. Power is transmitted by this knuckle-joint shaft to the drilling and milling spindles by means of the bevel gears *E* and *F* and spur gears *G* and *H*. Spur gear *H* forms an integral part of the drill spindle, which also carries the bevel gear *F*. This attachment is brought into position and fed toward the work by the arm operating the cut-off tool-slide.

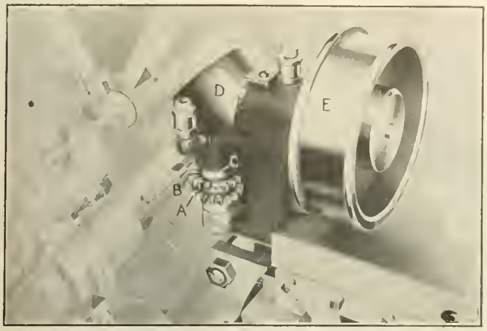

Fig. 10. Slab Milling Attachment carrying Two Milling Cutters

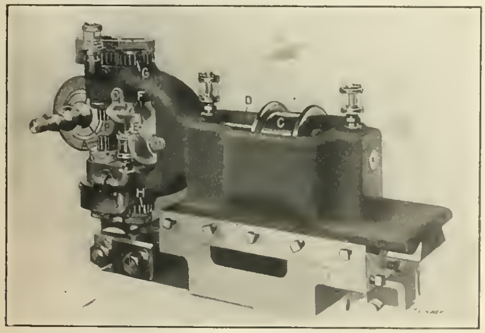

Fig. 11. Slab Milling Attachment carrying Two End-mills

A two-spindle drilling and milling attachment in which the spindles are located at right angles to each other is shown in Fig. 8. This attachment is used for drilling a cross hole and milling a flat on the work as indicated by the piece lying on the base of the attachment. The casting *C* which carries the spindles *A* and *B* is fastened to the top face of the cut-off tool-slide, and carries a driving pulley *D* which is driven through a flat belt from a special overhead countershaft. Pulley *D* is keyed to the top horizontal shaft and drives the vertical milling spindle through bevel gears *E*. On the rear end of the top horizontal shaft is a spur gear *F* which, through the intermediate gear *G*, drives the spur gear *H* fastened to the drilling spindle *A*. This attachment is adjustable longitudinally on the base *I*, the latter being fastened to the top face of the cut-off tool-slide. The attachment can be provided with an accelerating movement if desired.

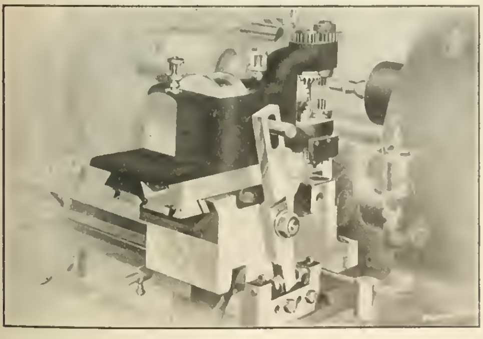

Fig. 12. Attachment shown in Fig. 11 provided with Accelerating Movement

A milling attachment, held on the side-working tool-slide and carrying one cutter or end-mill presented in a vertical position, is shown in Fig. 9. The base *A* of this attachment is fastened to the top face of the cut-off tool-slide, and carries a bracket *B* provided with bearings for holding the horizontal spindle *C*, which is driven from the overhead countershaft by a belt running on pulley *D*. Spindle *C* drives another horizontal spindle (enclosed in the fixture), through bevel gears which are covered by the guard *E*. The horizontal shaft inside the fixture drives the vertical stud *F* through bevel gears. Stud *F* carries a spur gear meshing with another spur gear on the cutter-spindle *G*. This attachment is used in the third position, the work-spindle being locked when milling is under way.

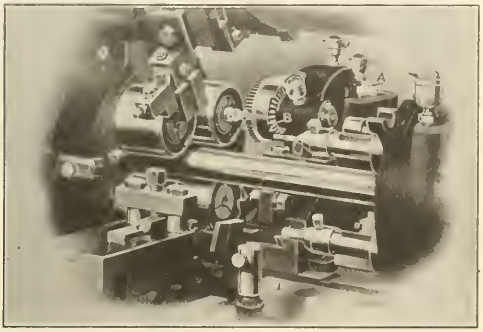

Fig. 13. Slab Milling Attachment driven by Bevel Gears

Vertical Spindle Milling Attachment carrying Two Cutters

Fig. 10 illustrates a vertical-spindle slab milling attachment, designed for carrying two face milling cutters *A* and *B*. These cutters are held on the vertical spindle *C* and are separated by a spacing washer of the required thickness. The attachment is held on the top face of the cut-off tool-slide, and is arranged for milling two flats on a cold-rolled steel piece, which is turned out at the rate of fifty-three pieces per hour. The vertical spindle *C* is driven by bevel gears (enclosed in the guard *D*) and the pulley *E*, the latter being belted to a special countershaft. It is possible to drive this attachment without employing a special countershaft by connecting it directly through a telescopic knuckle-joint shaft to the gears driving the threading spindle, as illustrated in Fig. 5.

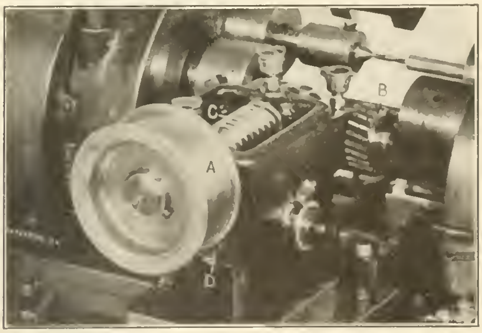

Fig. 14. Slab Milling Attachment driven by a Worm and Worm-wheel

Another vertical-spindle slabbing attachment somewhat similar in construction to that just described is shown in Fig. 11. In this case, however, two end milling cutters *A* and *B* are held as shown. The spindles carrying the end-mills are driven from a special countershaft belted to pulley *C*. This pulley is keyed to the shaft *D* which drives the vertical shaft *E* through bevel gears enclosed in guard *F*. On opposite ends of shaft *E* are held gears *G* and *H*, which mesh with gears on the vertical milling spindles. This attachment is fastened to the top face of the cut-off tool-slide and is operated as previously described. Fig. 12 shows a modification of this attachment which increases its usefulness by the addition of the accelerating movement. This feature has been previously described.

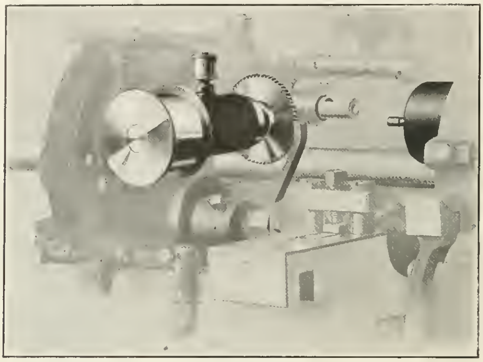

Fig. 15. Slotting or Milling Attachment held in Third Position Tool-spindle

A slab milling attachment carrying a face milling cutter having its axis parallel with the axis of the work is shown in Fig. 13. This attachment is also held on the cut-off tool-slide, and is driven by pulley *A*, which is keyed to a shaft located at right angles to the milling spindle and carrying a bevel pinion that meshes with the large bevel gear *B*. This gear is located close to the cutter to obviate chatter and give a more powerful drive.

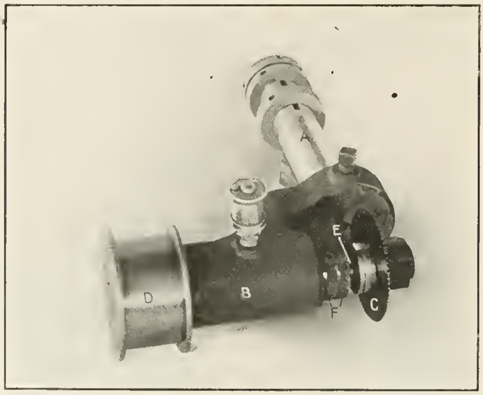

Fig. 16. Attachment shown in Fig. 15 dismantled from the Machine

Another slab milling attachment which is suitable for heavier milling than that shown in Fig. 13 is illustrated in Fig. 14. In this attachment, the pulley *A* drives the milling cutter *B* through a worm *C*, worm-wheel *D* and two spur gears, not shown. The milling cutter in this case is 3½ inches in diameter by ⅞ inch face, and is serrated to break up the chips and facilitate the milling operation. A worm and worm-wheel drive is more powerful than a bevel gear drive.

Milling Attachment held in Main Tool-slide

An attachment which can be used for both slotting and end milling is shown in Figs. 15 and 16. This attachment is held in the threading spindle and is provided with a shank *A*, Fig. 16, to which the bracket *B* is held by a set-screw. The drive for the saw *C* (or milling cutter) is from a special overhead countershaft by a belt which runs on pulley *D*, the latter being fastened to the cutter-spindle *E* carrying the saw. The knurled nuts *F* are used to take up end play of the spindle.

Fig. 17 illustrates another type of end milling or slotting attachment, which is held in the third position and driven by gears. The bevel gear *A* receives power from the regular gears that are provided for driving the tools held in the second position tool-spindle. The cutter is adjusted for depth by means of a special device on the rear end of the main tool-slide. This attachment is held rigidly, being tied to both second and third position tool-spindles, and cannot be swung around to any position, as is the case with the attachment shown in Figs. 15 and 16. The work-spindle in the second position is stopped when the end milling or slotting operation is being accomplished.

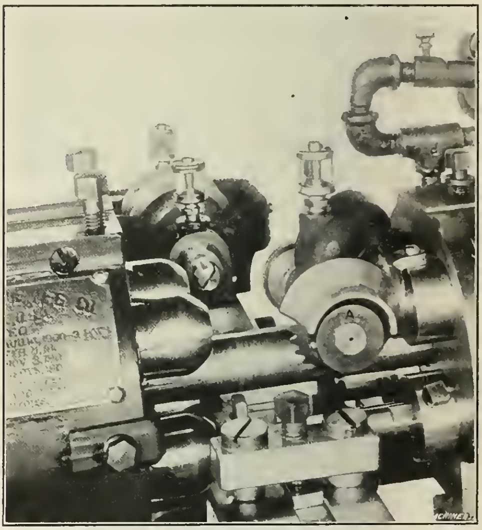

Fig. 17. Slotting or Milling Attachment held in Third Position and driven from Gears in Second Position Tool-spindle

The end milling attachment shown in Fig. 18 is also held in the third position tool-spindle, and driven by gears on the threading spindle through bevel gears in the attachment. In this attachment two cutters *A* and *B* are held on the vertical spindle, and are operated in a plane parallel to the top faces of the side-working tool-slides. This attachment can be swiveled to any position for presenting the cutters in their proper relation to the work.

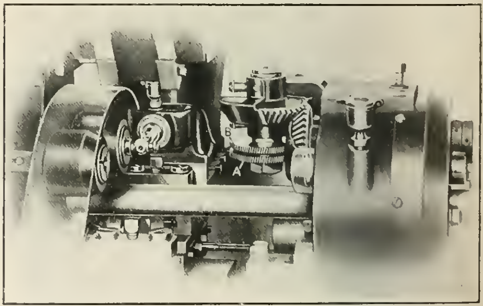

Fig. 18. Milling Attachment held and driven in Third Position Tool-spindle

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The British destroyer *Lurcher* achieved during its official trial of eight hours an average speed of 35.34 knots. The destroyer is driven by twin Parson turbines. The vessel is 265 feet long, 25 feet 7 inches beam. A speed of 35.34 knots corresponds to about forty-one statute miles per hour.

STANDARD TAPERS FOR SAFETY EMERY WHEELS

BY CHARLES G. SMITH[*]

The standardization of shapes for emery wheels and safety collars is a question which demands the immediate attention of manufacturers and users of grinding wheels. Unless a standard is adopted and complied with, the use of these collars and taper wheels will become more dangerous than safe and result in a number of accidents which might have been avoided. There are many companies using grinding wheels that have recently undertaken to make their own safety collars, and in several cases the collars have not been made to a shape which is in conformity with any of the established standards. This condition has been fostered by the fact that some manufacturers of grinding wheels are willing to make wheels to suit any shape of collar. This practice should be stopped immediately.

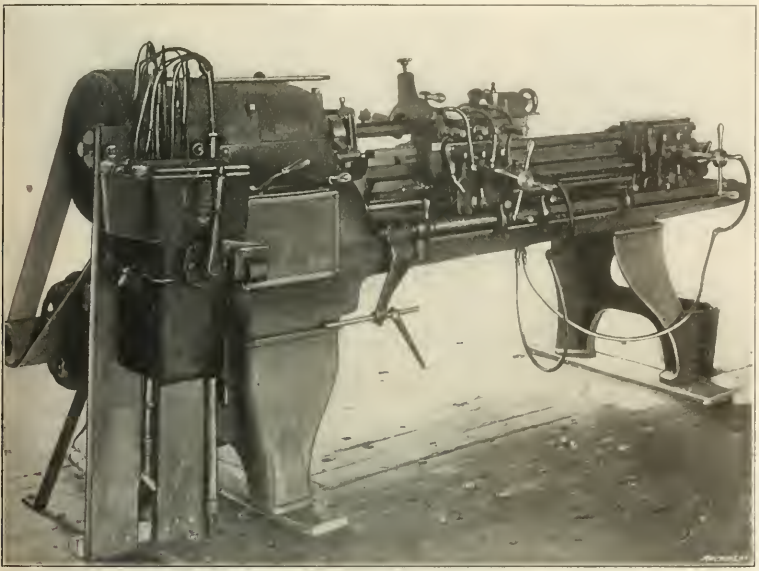

Fig. 1. A "Lo-swing" Lathe Motor-driven ready to turn Motor Armature Shafts

The Pittsburg Emery Wheel Co., Pittsburg, Pa., has adopted a standard taper of ¾ inch to the foot for grinding wheels and the safety collars which fit them, the wheels being tapered on both sides. Some of the older style of safety collars made by this company had the taper beginning at a distance of three inches from the center, but all of the collars are now made with the taper starting at two inches from the center, and all of the wheels have the untapered section at the center six inches in diameter.

The Safety Emery Wheel Co., Springfield, Ohio, formerly manufactured some of its safety collars with a taper of ½ inch to the foot, the taper beginning at a distance of two inches from the center, but several years ago a taper of ¾ inch to the foot with the taper beginning at a distance of two inches from the center was adopted as a standard.

The writer understands that the Carborundum Co., Niagara Falls, N. Y., has adopted a standard taper of ¾ inch to the foot, the taper beginning at two inches from the center of the collar in some cases and three inches in other cases. The wheels are made flat on one side and tapered on the other.

A number of instances have come to the writer's attention where pieces of a broken wheel have slipped from collars with a taper of ½ inch to the foot and caused serious damage. With the use of collars on wheels which are tapered on both sides to ¾ inch to the foot, where the collars and wheels fit each other perfectly and where the collar diameter is within four inches of wheel diameter, there have been practically no casualties or serious damage caused by broken wheels. By clamping a wheel with ¾ inch taper sides in a pair of collars having taper of ½ inch to the foot, the pieces are practically sure to fly in case of the wheel breaking, as the collars will not be in close contact with the wheel. A wheel with ½ inch taper sides will not necessarily break if mounted between collars with a ¾ inch taper, but the constant use of ¾ inch taper collars to hold a ½ inch taper wheel will ruin the collars for use on ¾ inch taper wheels, as the tightening of the nut in the spindle will spring the collars at the center. Where more than two inches of the wheel is exposed beyond the safety collars, a safety hood should be mounted on the machine, in addition to the use of the collars.

If all manufacturers of grinding wheels would adopt a taper of ¾ inch to the foot, with the untapered portion at the center of the wheel 6½ inches in diameter, and make all safety collars with a taper of ¾ inch to the foot, with the taper beginning at a distance of two inches from the center, it would appear that the maximum safety in grinding wheel operation would be assured. In this connection, it should, of course, be understood that users of grinding wheels can still make their own safety collars, but they should be made in conformity with the above standard. This standard applies to wheels of more than 12 inches diameter. Where wheels of less than 12 inches in diameter are used (this does not apply to 12-inch stubs of larger wheels) an untapered section three inches in diameter at the center of the wheel would be a satisfactory standard, and this would enable collars six inches in diameter to be used and still provide a sufficient hold on the tapered sides of the wheel when they were partially worn out.

* * *

A "LO-SWING" LATHE TEST ON MOTOR ARMATURE SHAFTS

The Fitchburg Machine Works, Fitchburg, Mass., recently ran a series of tests to determine the motor horsepower required to turn electric motor armature shafts and the average time per shaft. The shafts are $24\frac{11}{16}$ inches long, 2 inches diameter, and are of 0.30 point carbon steel, being what is commonly known as "machinery" steel. The rough diameter of the stock was 2⅛ inches. The record of these tests is valuable, as they indicate the great economies that can be effected in machine shop practice by the use of "single purpose" machine tools developed for repetition work required to be machined in large quantities.

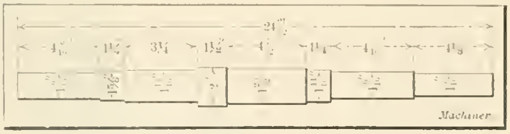

Fig. 2. Motor Armature Shaft of 0.30 Carbon Steel

The tests were run on a "Lo-swing" lathe equipped with the typical tool rests and turning tools used on this machine for shaft turning. The tool rests of this well-known machine tool are so constructed that there is only one slide between the tool and the lathe bed and, therefore, only one oil film between the bed and the cutting tool. This rigid support for the tool enables the machine to take heavy cuts without chatter. The tool arrangement comprises multiple tool rests, all supported directly on the ways; these tools are adjusted at certain distances apart depending on the length of the different diameter sections of the shaft being turned.

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[*] President, Pittsburg Emery Wheel Co., Pittsburg, Pa.

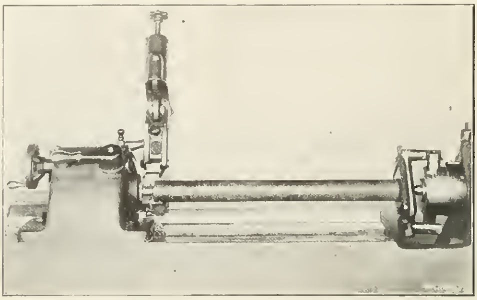


Fig. 3. Ready to start cutting with First Tool

Fig. 1 shows the lathe as set up for the test. It is driven by a 10 H. P. Westinghouse motor, running at 1700 R. P. M., mounted on the back of the headstock leg and belted to the constant speed pulley. The controller is in front, convenient to the operator. The readings of power consumption were taken on an Esterline recording wattmeter which makes an autographic record consisting of a series of dots instead of the common unbroken line.

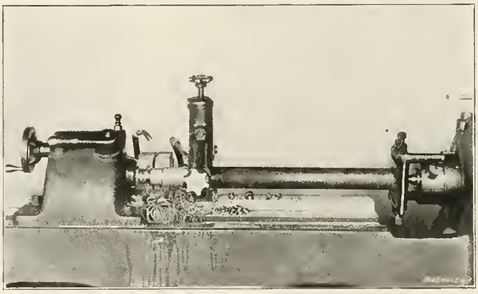


Fig. 5. Ready to start cutting with Third Tool

TABLE I. DATA ON SHAFT TURNING

Tools Cutting	Depth of Cut, Inches	Metal Removed per Minute, Cu. Ins.	Time Required per Cut, Seconds	Motor H. P.
No tools cutting......	0	0	0	1.2
Tool 1................	$\frac{9}{64}$	4.26	174	3 1
Tools 1 and 2.........	$\frac{8}{64}$	5.54	122	4.2
Tools 1, 2 and 3.......	$\frac{1}{16}$	7.14	106	5.2
Tools 1, 2, 3 and 4.....	$\frac{1}{16}$	8.62	52	6.3

Machinery

The turned shaft shown in Fig. 2 would require eight distinct turning operations if turned in an engine lathe with one tool. But on the "Lo-swing" lathe, the cuts on each end are taken progressively, four diameters being turned simultaneously when the tool cutting the smallest diameter goes into action. Fig. 9 shows diagrammatically the progression of the tools, the power consumption for each condition of turning being shown, that is, with one, two, three and four tools working, and the time required for each stage of cutting. The diagrams at the right in Fig. 9 show the horsepower for successive stages of turning and the time in minutes and seconds for each cut. The work speed was 250 R. P. M., or 131 lineal feet on the two-inch diameter. The feed was fifty turns to the inch.

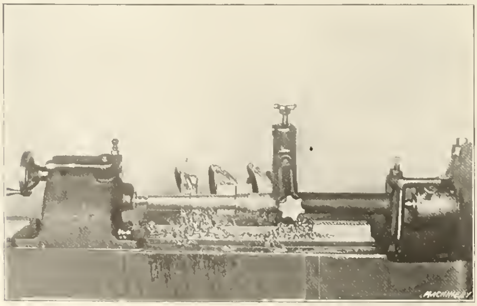


Fig. 7. Showing Four Cuts Finished

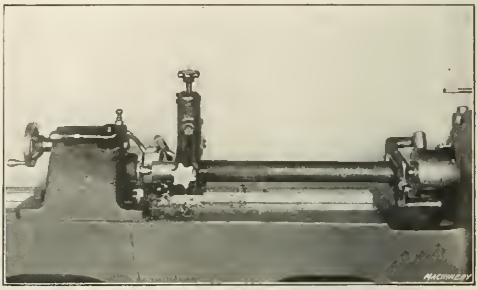


Fig. 4. Ready to start cutting with Second Tool

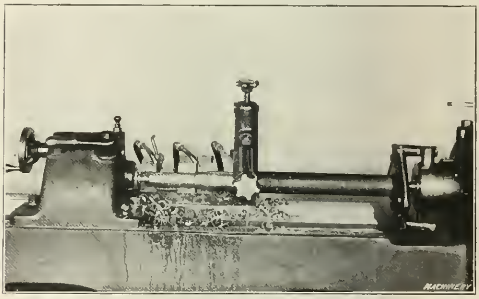


Fig. 6. Ready to start cutting with Fourth Tool

The power required to overcome the friction of the motor and machine was 1.2 H. P. When the first tool went into operation, the power consumption rose to 3.1 H. P., the depth of cut being 9/64 inch, and the amount of metal removed 4.26 cubic inches per minute. When the second tool began cutting, the power consumption rose to 4.2 H. P., the metal removed then being 5.54 cubic inches for both tools. The progression of cuts and the corresponding power consumption and total metal removed per minute is given for one, two, three and four tools in Table I. Table II gives the corresponding data

TABLE II. DATA ON SHAFT TURNING

Tools Cutting	Depth of Cut, Inches	Metal Removed per Minute, Cu. Ins.	Time Required per Cut, Seconds	Motor H. P.
No tools cutting......	0	0	0	1.2
Tool 1................	$\frac{1}{32}$	1.00	127	2.0
Tools 1 and 2.........	$\frac{6}{32}$	5.54	107	3.8
Tools 1. 2 and 3.......	$\frac{1}{32}$	6.36	60	4.8
Tools 1, 2, 3 and 4.....	$\frac{1}{32}$	7.14	43	5.6

Machinery

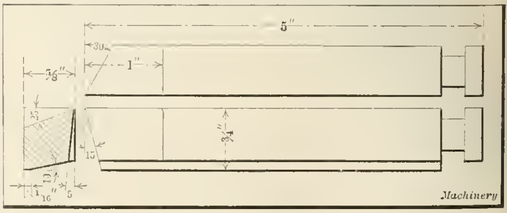


Fig. 8. Standard Turning Tool used in the "Lo-Swing" Lathe

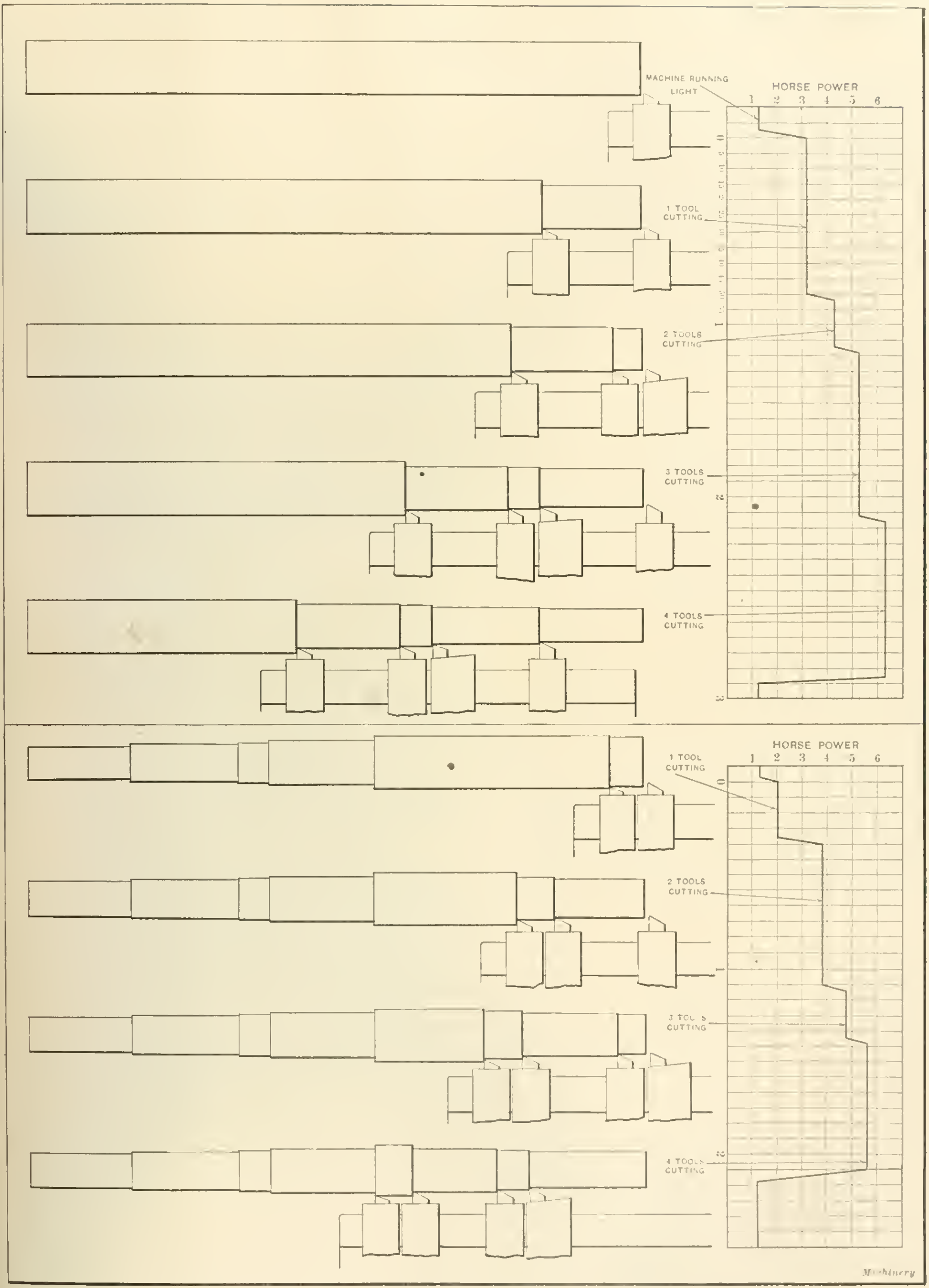


Fig. 9. Showing Cuts and Horsepower required with One, Two, Three and Four Tools cutting on Each End of Motor Shaft

for the turning operations on the other end of the shaft. The time required for the first multiple turning operation as shown in the diagram, Fig. 9, was 2 minutes and 54 seconds, and for the second multiple turning, 2 minutes and 6 seconds. The total time required for turning five shafts including the changes was 35 minutes and 20 seconds, or an average of 7 minutes and 4 seconds per shaft. The shafts, of course, were rough-turned, only the finishing being done on the grinding machine.

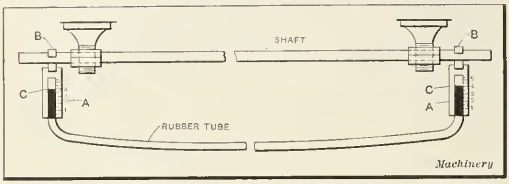
This shaft is a typical example of work for which this single purpose tool is adapted. The use of single purpose tools should become more general as their advantages over general purpose tools are more fully appreciated.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

METHOD OF LEVELING LINESHAFTING

In the February issue of MACHINERY Mr. E. L. White describes a method of leveling lineshafting. The writer has used a method somewhat similar to this but believes that it is better because it enables one man to handle the work without assistance. The accompanying illustration shows the apparatus required, from which it will be seen that it is along the same general lines as that described by Mr. White. The difference lies in the fact that the glass tubes at the ends of the rubber tubing are mounted on small wooden blocks *A*. These blocks have a scale of inches laid off on them and are provided with band-iron hooks *B* which are used to hang the blocks on the shafting. The apparatus is filled with water, as described in the previous article under this heading, and in using it the two blocks are hung on the shafting at some distance apart. The level of the water at *C* is then observed in the two tubes and if there is any difference, it shows that the level of the shafting must be adjusted accordingly.



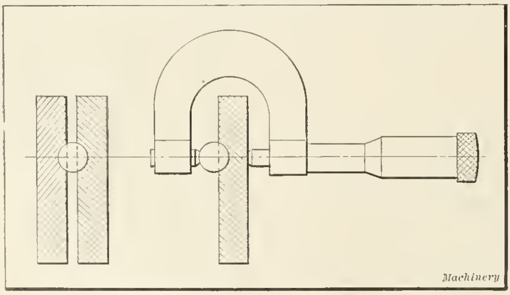
Method of leveling Lineshafting

Youngstown, Ohio. H. ERSKINE

TESTING HARDNESS OF METALS

The accompanying illustration shows a method of testing the comparative hardness of the softer metals and alloys, such as bearing metals, different grades of brass, etc. The method is only comparative and it is necessary to have a standard with which to compare the sample that is to be tested.

Both the sample and standard plates should be flat and it is better to have them of the same thickness, if possible. The test is made by putting the two plates between the jaws of a vise and inserting a hardened steel ball between them. The jaws of the vise are then screwed up in order to force the steel ball into the surface of the test sample and the standard, care being taken to have the pressure distributed uniformly on both of the plates. The next operation is to remove the plates from the vise, place the ball in the dent in one of them and caliper from the face of the ball to the back of the plate, as shown in the illustration. Then caliper the steel ball and subtract its diameter from the first reading. Subtract this result from the calipered thickness of the plate, and it will give the depth to which the ball has been forced into the plate.



Test for determining Comparative Hardness of Metals

If we let:

A = distance from the face of ball to back of plate,
D = diameter of the ball,
T = thickness of the plate,
B = depth to which ball was sunk into plate.

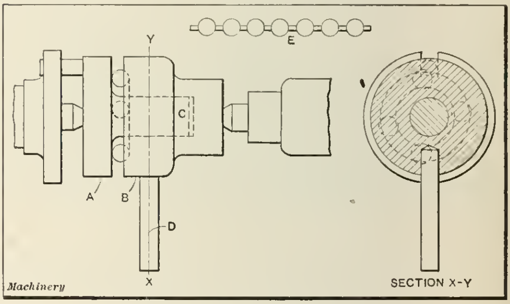
Then $B = T - (A - D)$

Perform the same operation with the second sample and then a comparison of the two values of *B* will give an approximate idea of the comparative hardness of the two metals under test. Of course, there are other factors that have some effect on the depths to which the ball will sink into the plates besides the comparative hardness of the two metals. But where only rough approximations are required, this method of determining the hardness of metals will give good results, and it has the advantage of being quick and simple.

Kenyon, R. I. H. M. NICHOLS

MAKING SOFT METAL BALLS

The device shown in the accompanying illustration was used by the writer for making soft metal balls. Referring to the illustration it will be seen that it consists of two members *A* and *B* which are mounted between centers in a lathe. The contact surface of plate *A* is flat and the balls to be formed are rolled between this surface and a groove in plate *B*. It will be seen that *A* is driven by a pin inserted in the faceplate, while *B* is prevented from rotating by the shank *D* which is held in the toolpost. The spindle *C* fits into a corresponding socket in *B*. The groove in which the balls run, is turned slightly eccentric to the center about which *A* rotates and, as a result of the crosswise motion imparted to the balls, combined with a steady and even pressure from the tailstock, an excellent finish is produced. The error in the finished work will not exceed 0.002 inch, which is quite close enough for the purpose for which these balls are required. The balls are cast in strings, as shown at *E*, and cut up to be finished in this attachment. Lard oil is used for lubricating the balls while they are being rolled.



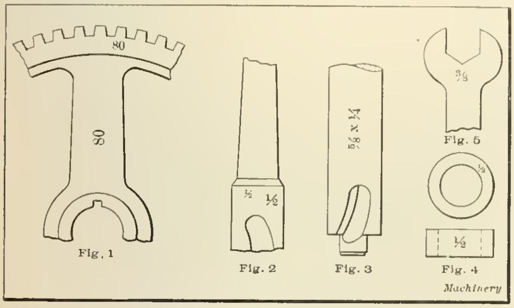
Lathe Attachment for making Soft Metal Balls

J. F. ESTLE

Linden, Mass.

NUMBERING MACHINERY AND TOOLS

The best method of placing numbers on tools and machine parts is not generally understood. The use of the proper sized numbers and their proper location is just as important a matter as any other machine shop operation. It is evident to one who has made any study of this matter that there are a great many machine parts on which the numbers have been misplaced. While it is important that all numbers placed on work should be as large as it is possible to have them, it is of equal importance for such numbers to be placed where they can be easily found. For instance, it is common practice to stamp the number of teeth on a gear on the side of the rim, as shown in Fig. 1. This is poor practice because the workman who is looking for a gear with a given number of teeth may have to look all around the rim before he locates the figures; this is especially true if the gear is "gummed up" so that the numbers are practically invisible. All gears should have the number of teeth cast on the arm or web, and where such a practice is followed the numbers can be found at a glance. Some tools are stamped with such small figures that although they may be easily found they are nevertheless difficult to read. Fig. 2 illustrates a case of this kind where the advantage of using larger figures will be readily apparent. Fig. 3 shows the correct method of marking a counterbore, the diameter of both the cutter and the pilot being given. Fig. 4 shows two views of a collar used on a milling machine arbor; the top view illustrates the common fault of placing the figures on the side, where lack of space makes it necessary for them to be of small size. This method has a further serious fault, in that the figures are hidden when the collar is placed between two cutters on the arbor, so that there is sometimes an uncertainty as to its thickness. Both of these faults can be removed by placing the figures on the edge of the collar, as shown in the lower view.



Figs. 1 to 5. Examples of Correct and Incorrect Methods of numbering Tools and Machine Parts

Although there is a great deal of work that is improperly marked, there is also a large amount which is not marked at all. When the sizes are not placed on tools, time is wasted in stopping to measure them. This results in the loss of time which is taken up in guessing and remeasuring to find the actual size of a tool. Wrenches form a simple example of this kind, but if all such tools had the size of the opening marked upon the face of them, as shown in Fig. 5, a lot of trouble would be avoided. Those who are interested in keeping down operating expenses in a shop will find that the time saved through the use of proper sized numbers and correct systems of numbering will constitute a considerable item.

Hartford, Conn. James E. Cooley

DISTRIBUTION OF CATALOGUES

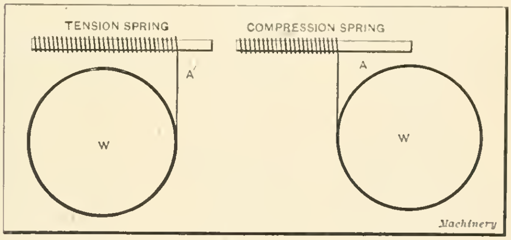
I was much interested in Mr. John F. Winchester's reply in the March issue of Machinery, to the editorial regarding the distribution of catalogues. During several years experience in drafting rooms and machine shops I have seen machinery catalogues put to a variety of uses, other than that of affording a reference for the purchasing department. The fact that nearly all machinery catalogues contain interesting data concerning the products which they show, and tabulated information on different technical subjects, would appear to indicate that manufacturers expect their catalogues to be used as a reference, knowing that this use will keep their products before the public. Mr. Winchester's plan of familiarizing himself with a given type of machine by studying the catalogues in which it is shown is certainly a good one. The average text books describe different classes of machinery, but do not often point out the features of different types as clearly as the manufacturer will do in his own catalogue. This fact will help to explain why so many students make requests for catalogues.

At the same time it cannot be denied that the liberality of different firms in regard to the distribution of catalogues is somewhat abused. I have seen a catalogue destroyed the same day that it was received. This was not through ignorance or neglect, but arose from the fact that, as there was no place provided in the factory for keeping catalogues, certain pages were torn out to be preserved in a data book and the remainder of the catalogue discarded. In this connection I would suggest that each firm supply its engineering department with a cabinet or bookcase in which to keep catalogues received from different manufacturers, instead of having such catalogues filed in the purchasing agent's office, where they are not available for the workmen to use. If this suggestion was followed, the men would have the use of larger and better bound copies from which they would be able to secure a considerable amount of valuable information. Many firms are now furnishing smoking and reading rooms for their men and no doubt a cabinet containing machinery builder's catalogues would constitute a valuable addition to the furniture of such rooms.

Flange

WINDING SPRINGS

The writer has seen a number of different methods of winding springs, but he has never seen any information given about the method of holding the wire. The accompanying illustration shows methods of holding the wire for winding tension and compression springs, respectively. In both cases, the wire is rolled on the spool W. In winding a tension spring, the spool is placed so that the wire runs off to the mandrel A from the right-hand side of the spool. The wire has a certain amount of set in it due to having been wound on the spool, and this set tends to bring the coils of the spring close together so that the spring is quite stiff. In winding a compression spring, the spool is held so that the wire runs off to the mandrel from the left-hand side. In this case the set in the wire will spring the coils apart, when the spring is taken off the mandrel, so that a compression spring is produced. The coils are always wound close together on the mandrel, and the tension or compression of the spring can be regulated by changing the size of the spool on which the wire is wound. This result can also be obtained by means of the lead-screw on a lathe, but the writer knows of no way of winding a tension spring in which the coils are held together in so satisfactory a manner as in the method here described.



Method of winding Tension and Compression Springs

Westfield, N. Y. Earl W. Johnson

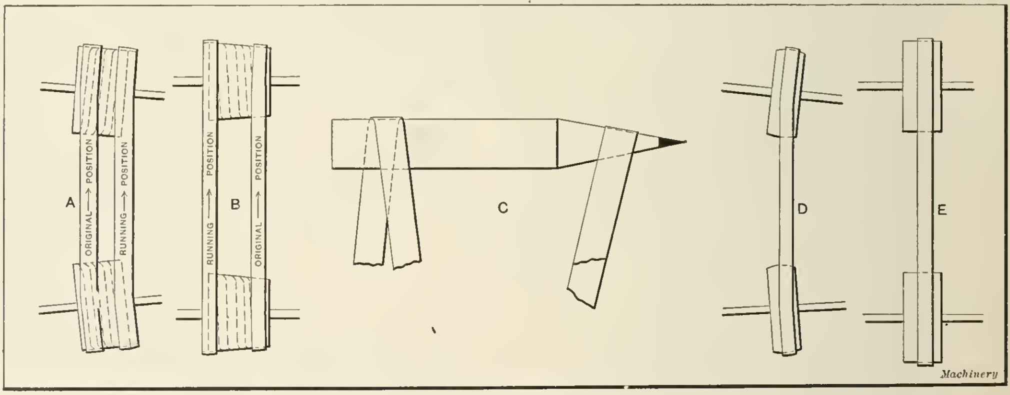
REASONS FOR THE RUNNING OF BELTS

I was interested in reading three recent discussions in Machinery on the "Running of Belts." George P. Pearce's assertions in the January issue, and J. R. Rand's in the February issue are substantially correct, but T. J. C's. assertion in the October issue is diametrically opposite to the others, and in my opinion incorrect. These contradictory assertions remind me of the following incident: A party of tourists were viewing Niagara Falls. "Isn't it wonderful!" they exclaimed. Overhearing this remark, a native replied: "There ain't nothin' wonderful about it; it's 'nater' for water to fall." This man knew that water falls, but he did not explain why. If asked why water falls, he would probably have answered, "Cause it does." The reason why water falls is that water is heavier than air. Everyone realizes this when the fact is brought to his attention. The reason why belts perform as they do is equally fundamental and easily understood when the simple facts governing belts are brought to the student's attention.

It is the purpose of this article to explain the self-evident facts that govern the performance of belts, and to express these facts so simply and clearly that the student may understand why belts perform as they do. He will then be able to regulate conditions to make them run as he desires.

A flat belt running on flat faced pulleys mounted opposite each other on shafts not parallel with each other, if placed on the edge of the pulleys nearer the ends of the shafts that are further apart, as shown by the original position *A*, tends to advance toward the ends of the shafts that are nearer together. Why? Because the belt is guided from each pulley to the other at an angle leaning in that direction. Under these conditions the belt will continue to advance toward the ends of the shafts that are nearer together with almost the precision of a nut running on a screw, until its tendency to advance in this direction meets an opposing tendency caused by the edge of the belt projecting beyond the edge of the pulley, as shown by the running position *A*. When the advancing edge of the belt projects beyond the edge of the pulley, the belt will automatically establish its running position where these opposing tendencies balance each other.

A flat belt placed on the smaller end of a cone-shaped pulley, as shown in the original position in diagram *B* tends to advance toward the larger end of the pulley. Why? Because the conforming of the belt surface to the surface of the cone-shaped pulley (see cone portion of diagram), causes the belt to be guided to the pulley face at an angle which leads toward the larger end of the pulley; also because the larger end of the pulley tends to cause the edge of the belt, there in closest contact, to travel faster longitudinally than its opposite edge, with the result that the belt is further skewed toward the larger end of the pulley. The belt will continue to advance toward the larger end of the pulley with almost the precision of a screw thread, as shown by dotted lines in diagram *B*, until its tendency to advance in this direction meets an opposing tendency caused by the edge of the belt projecting beyond the edge of the pulley. The projecting edge of the belt takes the same form and establishes the same conditions as if the projecting portion were running on half of a cone-shaped pulley having the same taper as that established by the projecting edge of the belt shown in the running position in diagram *B*. Under these conditions the running position of the belt is established by the diameter of the pulleys; the distance between the shafts; the width, thickness, elasticity, and tightness of the belt; and the amount that the belt projects beyond the edge of the pulley.



Diagrams illustrating Reasons for running of Belts under Different Conditions

A belt running on a centrally crowned pulley, equal in diameter at both ends, tends to establish its running position in the center of the pulley. Why? Because each half of the pulley is cone shaped, and the conforming of the belt of the pulley is cone shaped, and the conforming of the belt to the pulley face tends to guide each half of its width toward the center of the pulley. The belt establishes its running position on the pulley where these opposing tendencies balance each other.

A belt running on centrally crowned pulleys of equal diameter at both ends, and mounted opposite each other on shafts that are out of parallel, establishes a running position aside from the center of the pulley. The distance that the running position is off center depends upon the diameter of the pulleys, the amount they are crowned, the amount that the shafts are out of parallel, and the character and tightness of the belt. (See diagram *D*.) Why? Because the tendency of the crowned pulley to cause the belt to occupy the center of the pulley is partially overcome by the tendency of the belt to advance toward the ends of the shafts that are nearer together. The belt establishes its running position where these opposing tendencies equally balance.

A belt that is perfectly straight, flat, and uniform, running on pulleys equal in diameter for their entire width, having faces wider than the belt and mounted opposite each other on shafts that are parallel, will maintain the running position which it occupied immediately after finding its first balance, if it is not forcefully guided from its path. (See diagram *E*.) Why? Because the belt is guided from each pulley to the other at perfect right angles.

To establish and maintain these conditions—perfect belts, pulleys and alignment of the shafts—all of which are necessary to the perfect running of belts, is practically impossible. Therefore, as average conditions are only approximately perfect, pulleys must be slightly crowned to assure a satisfactory operation of the belts running over them. Pulleys should not, however, be crowned more than is necessary, because excessively crowned pulleys destroy belts and waste power. Why? Because excessively crowned pulleys force the belt to become V-shaped in cross-section. When such a belt leaves the pulley, the center and edges of the belt are constantly being stretched and compressed. This action ruins the belt and causes practically the whole width to slip on the pulleys, which action wastes power.

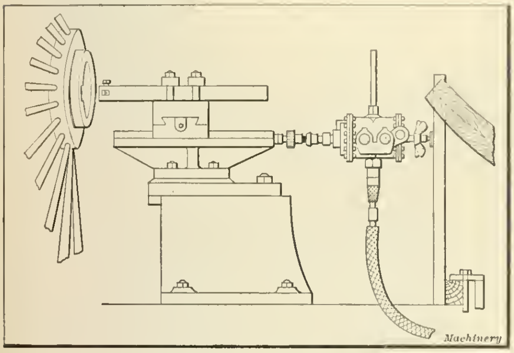
Several of the assertions made in this article may be easily, clearly and conclusively illustrated by winding a strip of paper or tape around the cylindrical or sharpened cone shaped portion of an ordinary lead pencil. Even so simple an experiment is sufficient to prove that the guiding of belts is the law which governs their performance.

Hartford, Conn. Arthur L. Jacobs

CUTTING KEYWAYS IN A LATHE

The accompanying illustration shows a rig which the writer got up to cut keyways in three-rope pulleys, 16 feet in diameter. These pulleys were bored out on a faceplate lathe; the bore of the pulley was 12 inches in diameter, and the keyway was cut 3 inches wide by 11/16 inch deep. The length of the hub was 29 inches. After boring out the hole and facing off the hub, an air drill was connected to the screw of the tool-rest in the manner shown in the illustration. The pulley was still mounted in position on the faceplate of the lathe and a square nosed tool about 5/16 inch in width was placed in the tool-holder. The air drill used to drive the feed-screw was of the reversing type, and a boy manipulated the throttle so that the direction of the rotation was reversed when the tool reached either end of its stroke, thus giving a good imitation of the reciprocating stroke of a slotter. It was necessary to have a boy for this work because the crank of the cross feed was too far away to allow the machinist to handle the reversing of the drill. The drill was operated under 100 pounds air pressure at the compressor, and the cut which it was possible to take in this manner was really surprising.

Before the development of this method we had always cut keyways of this kind by hand, as we did not have a key-seating machine and the slotter in our shop was too small to handle work of this kind. It required about eight days of our best mechanic's time to cut one of these keyways by hand, while the present method enables the work to be completed in less than two days. It is obvious that the keyway will be square with the bore of the pulley because the same setting of the work on the lathe faceplate suffices for both the boring and the keyseating operations. In order to cut a keyway by hand and still have it square requires particular skill on the part of the mechanic working with a hammer, chisel and file.



Method of cutting Keyways in a Lathe

New Glasgow, N. S. John S. Watts

TUBE BENDING DIE

In the manufacture of incandescent lights, we had a number of delicate tube-bending operations to perform, such as shown in Fig. 1. The difficulty of these operations lay in the fact that the tubes had to be perfectly smooth and free from wrinkles. Several different methods were tried, but none of them proved quite successful until the die shown in Figs. 3 and 4 was developed.

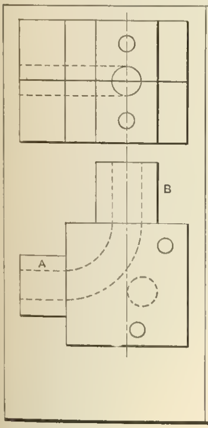


Fig. 3. Finishing Die ready to be mounted in the Press

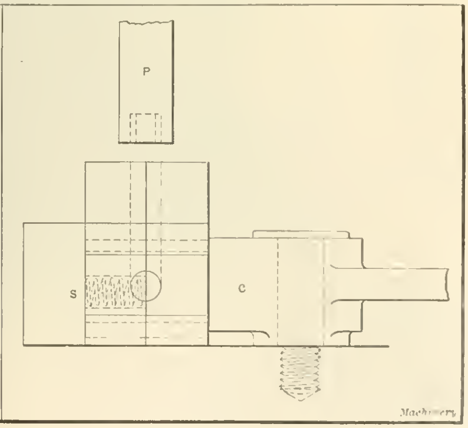


Fig. 4. The Punch and Die showing Method of opening to remove Work

The first step in making the die is shown in Fig. 2. A circular groove was turned in a plate, the width being made equal to the diameter of the tube and the radius equal to the radius to which the tube was to be bent. This plate was parted along line *X–X* and one half was again cut along line *Y–Y*. The two quarters of the plate produced by the second cut were fitted together with dowel-pins as shown in Fig. 3. As the two ends of the tubing had to be perfectly square, the guides *A* and *B* were added to the die. These guides consist of two blocks, through which holes equal in diameter to that of the tube were drilled; the blocks were then split and fastened in position as shown in the illustration. A hole was drilled in one block to receive the spring *S*.

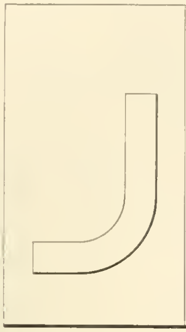


Fig. 1. The Form to which the Tubes had to be bent

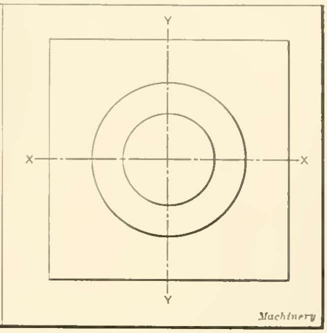


Fig. 2. First Step in the Production of the Die

Fig. 4 shows the assembled die. In bending a tube, the blank is put in at the top of the die and then forced down by the punch *P*. It will be seen that the provision of a cam *C*, turned by a hand lever, provides for releasing the two halves of the die so that they can be forced open by the tension of spring *S*. The finished tube can then be readily removed. This method of bending proved very successful; the tubing came out perfectly smooth, and without wrinkles, and the ends were absolutely square. F. X. Bucher

Jersey City, N. J.

KNURLED NUTS

Knurled nuts on machines and tools do not always seem to be applied in the right place. It is understood that the use of pliers on knurled surfaces is bad practice, yet they are being used in the shop every day to secure a tighter grip on a nut than can be obtained by hand. The knurl might be protected by a piece of brass while using this method, but so many men do not do this that the nut is soon spoiled. Therefore provision for a wrench should certainly be made when the knurled nut cannot be made large enough to enable it to be properly tightened by hand.

Detroit, Mich. Felix Heberlein

TESTS MADE WITH "STELLITE" TOOLS

I noticed a brief article by Mr. William Schellenbach, in the March issue of Machinery, entitled "Comparative Chip Production of Stellite and Steel Tools." Mr. Schellenbach made these statements with perfect fairness and described quite clearly the results achieved by steel tools in a large lathe. I will say regarding tests made with "Stellite" tools that the object was not to determine the amount of metal removed in a given time, regardless of other conditions, but to determine the amount of metal that could be removed in a given time under stated working conditions. In every instance the tools were comparatively small — usually 3/8 inch square. In all cases where rapid cutting is of supreme importance, the depth of the roughing cut is predetermined by the amount of stock to be removed. That is, the roughing cut must remove practically all of the surplus metal, leaving the piece ready for the finishing cut or for the grinder. Under these conditions there remain only two methods of increasing the amount of metal to be cut from the piece in a given time. First: by increasing the feed; second: by increasing the speed. It is by the best combination of these two factors that a given tool is enabled to remove its maximum amount of metal (limited by the quality of the tool) in a given time. If the lathe is not so constructed that it will carry the work under this feed and speed, the tool is naturally unable to perform its full duty.

A practical illustration will probably make this matter clearer. An operator was engaged in turning pistons. With a steel tool he was able to complete the roughing cut in two minutes and six seconds; while with a "Stellite" tool, he finished the same cut in 54 seconds. Now there was no way in which any steel tool could take this cut in much less than two minutes and six seconds, because the edge of the steel tool would be destroyed by an increase of either speed or feed. The "Stellite" tool was only able to remove this cut in 54 seconds because two men applied pressure to the four-inch belt in order to keep the lathe in motion until the cut was completed. Both the speed and the feed were increased. There are cases, of course, in which it becomes a question of removing the greatest amount of metal in a given time, *regardless of all other conditions*, and I can only say that, so far as I know, "Stellite" has never been tested on this particular kind of work. The bar from which the cuts mentioned by Mr. Schellenbach were taken was of a large diameter, and it seems certain that the depth of the cuts must have been considerable; this would necessitate a large tool working under heavy pressure. It would be interesting to know the exact conditions under which this remarkable test was made. Mr. Schellenbach has certainly shown that the lathe achieving these results was a very powerful machine.

Kokomo, Ind. ELWOOD HAYNES

FLANGING BRASS TUBING

The tools shown in the illustrations were designed for use in flanging the ends of pieces of brass tubing to fit them onto similar tubing at an angle of 80 degrees. In order to make these joints fit properly, the ends of the tubing have to be cut to such a shape that a flange could be produced which would fit evenly around the joint. The first cut on the end of the tubing is made with the tool *A*. The end of the tubing is slipped over the elliptical shaped extension on the punch, and when the press is tripped, the lower half of the end of the tubing is sheared to the required shape. The wall of the tube is comparatively thin so that it does not require much pressure for the cutting operation. It will be seen that the upper side of the tubing bears against the punch so that the latter forms an end gage. The tubing is then turned over and a second cut is taken with the tool *B;* this tool is similar to the first one except that the punch is not cut away so much, in order to allow the end of the tube where the first cut was taken to abut against the punch and bring the tubing into the proper position for the second cut. In other respects the punch and the operation performed by it are similar to the punch *A* used for the first operation. It will be evident that the end of the tubing now has two sharp corners where the ends of the two cuts taken in the preceding operations meet. These corners are trimmed off by means of the tool shown at *C;* this tool is arranged so that the second corner may be trimmed off by simply turning the tubing over. It will be seen that the tool is provided with an end stop for locating the position of the cut, and as both cuts are gaged from the upper side, it will be evident that the corners are trimmed off to equal lengths.

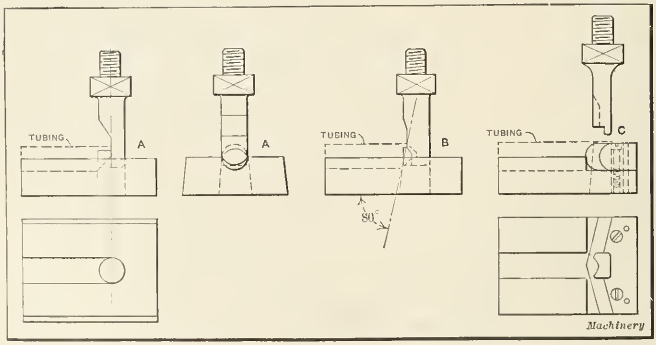


Fig. 1. Tools used for trimming the End of the Tubing

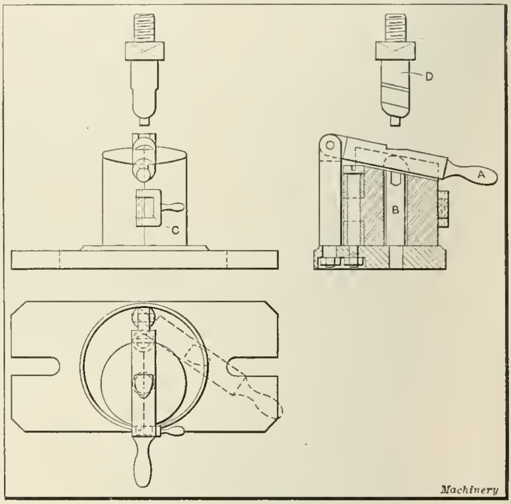


Fig. 2. Punch and Die for forming the Flange

After these trimming operations have been completed, the work is ready for the flanging operation. The tool shown in Fig. 2 is used for this purpose. It consists of two hinged jaws, bored out to fit the tubing which they close around. The center piece *B*, which is turned to a sliding fit in the tubing, is mounted so that it is in a central position between the jaws when the latter are closed. When closed, the jaws are held together by means of the latch *C*. The lever *A* is hinged to an upright piece and can be swung to one side, when necessary, as shown by the dotted lines. This lever locates the tube in the die and also constitutes the finishing punch for the flanging operation. The flange is started with the punch *D*, the operation being as follows: A piece of tubing is placed over the center *B* and the lever *A* is brought down onto its end to bring it into the desired position; the jaws are then brought together and fastened by means of the latch *C*. The lever *A* is now swung to one side and the punch *D* is brought down to start the flange; the stroke of the punch *D* is regulated by a stop set on the press. The lever *A* is then placed in position on the tubing and the punch is again brought down on top of this lever. The jaws are hollowed out so that the flange is finished to the required shape between the space in the jaws and the cylindrical surface of the lever *A*. The work produced in this way was entirely satisfactory, the flanges being perfectly smooth and of an equal width.

Meriden, Conn. JAMES GALLIMORE

ERASING INK MARKS ON TRACINGS

The writer has noticed a number of letters in MACHINERY describing different methods of erasing ink lines from tracings, and in this connection he wishes to say that he has found a sheet of blotting paper particularly useful for this purpose. When it is discovered that a mistake has been made before the ink has time to dry, the greater part of it can be removed with the blotting paper. This leaves only a faint line which can be erased with an ink eraser, leaving the surface of the cloth in good condition. If the ink has had time to dry, it is, of course, a somewhat more difficult matter to remove it. This may be done very successfully with a sharp knife, taking care not to cut the cloth. After the greater part of the ink has been removed in this way, the erasure can be completed with an ordinary rubber on a lead pencil. The writer has used this method for a number of years and can recommend it as being worthy of trial.

Cincinnati, Ohio. E. C. McMeans

CORRECTING DRAWINGS

An excessive amount of work is sometimes necessary when making changes in a design, or rectifying errors on a part that has already been traced. In order to reduce the time necessary to make such changes to a minimum, the following method will be found to give excellent results:

Fill the ruling pen with water and go over the various lines to be effaced—in the case of dimensions use an ordinary writing pen instead of the ruling pen—then proceed to erase. You will be surprised, after you have tried this method, to find that the time consumed in making changes will be very materially reduced.

J. P.

METHOD OF MACHINING ELLIPTICAL CASTINGS ON A LATHE

A plan and sectional view of an elliptical casting for a man-hole cover is shown in Fig. 1. It was required to machine these castings on the flange *A*. The shape of the work made it necessary to devise some special means of machining.

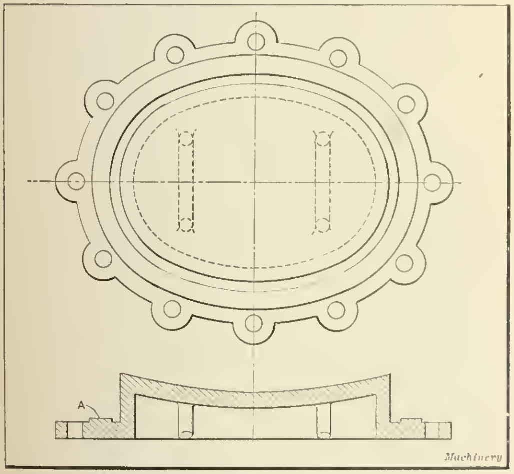


Fig. 1. Elliptical Man-hole Cover with Flange A to be machined

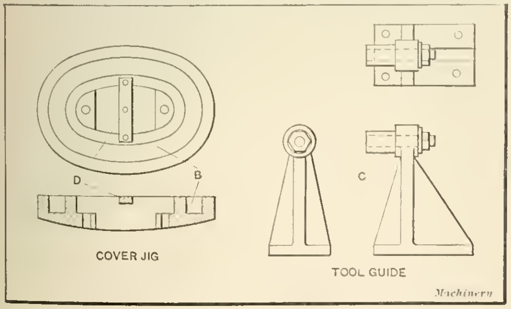


Fig. 2. Jig used for machining Flange A on Elliptical Man-hole Covers

Fig. 2 illustrates the jig which was finally used. It consists of two main parts—the cover jig with an elliptical slot *B* in it, and the tool guide carrying roller *C* which engages in slot *B*. The cover jig is bolted onto the man-hole cover, the latter being bolted to the faceplate of the lathe after centering it by means of the hole in the bar *D* on the center of the cover. The roller frame is bolted to the tool carriage, as shown in Fig. 3, and as the work revolves the roller travels in the elliptical slot *B* and draws the tool back and forth so that it is kept on the flange *A* of the man-hole cover all the time. The same method could be applied in a variety of other classes of elliptical work which have to be turned on a lathe.

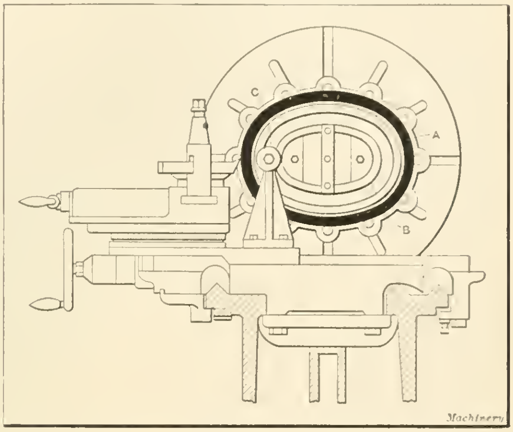
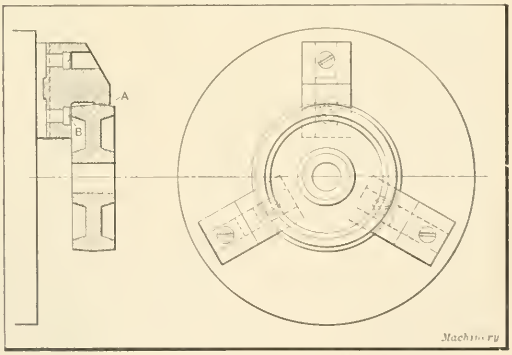


Fig. 3. Jig set up on the Lathe for turning the Flange A on the Man-hole Cover

Philadelphia, Pa. C. W. Carrigan

CHUCK JAWS FOR HOLDING DROP-FORGINGS

In the February issue of Machinery, an article was published, describing a special form of chuck jaws for holding drop-forged gear blanks. In attempting to judge the value of these jaws, one is working somewhat in the dark as the grip depends upon the manner in which the piece is to be machined and this was not explained in the article. The accompanying illustration shows a special form of chuck jaw for holding work of this kind. These jaws are made of case-hardened machine steel and grip the work on the taper *A*. This tends to pull the work toward the chuck where it is backed up against the rim *B*. The chuck jaws are scored to prevent the work from slipping when the cut is started.



Chuck Jaws designed for holding Drop-forged Gear Blanks

Two operations are involved in machining these gear blanks. The first operation is as follows: The work is gripped on the outside diameter and the hole is drilled, bored and reamed. The side of the rim and hub are then faced. The work is then ready for the second operation, for which the work blank is placed on an expanding arbor; the face of the gear is then turned, after which the side of the rim and hub are faced. This completes the lathe work.

Rhode Island

FORMING TOOLS FOR ROUGHING AND FINISHING

In the January issue of MACHINERY Mr. Corwin Lamoreaux described a circular forming cutter for manufacturing ball-bearing cones, and as the writer has had some experience with these wide tools he wishes to criticise a few of the claims which were made for a combination roughing and finishing tool. Considering cutters of this style from the toolmaker's standpoint, they can always be made cheaper and better in two parts owing to the difficulty of cutting the clearance in the groove *A* Fig. 1. This is especially true when this groove is narrow and required to be more accurate than the one described in Mr. Lamoreaux's article. When made in two parts, the sections of the tool are fastened together with screws. From the operator's viewpoint these wide cutters are trouble-makers, as the work heats and binds in the groove, causing from ¼ inch to ½ inch of the tool to be wasted owing to the temper being drawn. For this reason two cutters of simple design, as shown in Fig. 2, will give better results. The cut-off tool *B* forms the hub of the work and holds it accurately to length. The use of the wide tool requires an allowance by the cut-off tool for facing, and this will cause trouble when the cut-off varies longitudinally, as shown in Fig. 1. This condition will cause the work to be formed with a shoulder, and the same variation in cut-off is responsible for the hub of the next piece being too short, although the operator may not suspect that there is any trouble, on account of the form tool apparently facing at *C*.

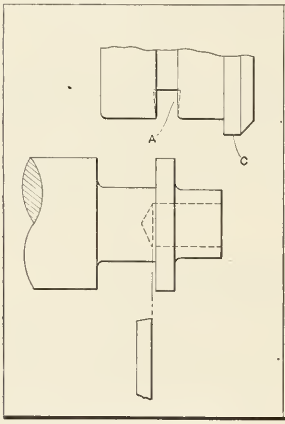


Fig. 1. Wide Form of Tool with Roughing and Forming Sections in One Piece

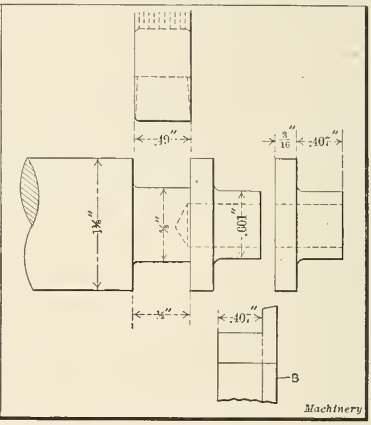


Fig. 2. Two Separate Tools for performing the Same Operation

The layout in Fig. 2 allows both tools to cut simultaneously at one-half the feed per revolution allowed for the wide tool, and in either case the work should be cut off where the stock is 1⅛ inch in diameter and not where it has been reduced to ⅝ inch in diameter, as the cut-off tool is likely to scar the work while being brought to the forward position. In regard to the rate of production, the separate tools will produce over 100 per cent more than the wide tool, when used in automatic machines, as they may be operated simultaneously. This relation of production is shown in the following table.

Number of Revolutions Required with Wide Tool

Form: 0.262 inch travel at 0.0005 inch feed	524 revolutions.
Cut-off: 0.375 inch travel at 0.001 inch feed	375 revolutions.
Total	899 revolutions.

Number of Revolutions Required with Two Tools

Rough form: 0.255 inch travel at 0.001 inch feed (while cutting off)	255 revolutions.
Cut-off: 0.375 inch travel at 0.001 inch feed	375 revolutions.
Total	375 revolutions.

The method of facing described by Mr. Lamoreaux should give better results than when facing from the turret, as in the latter case the cutter must be kept ground to 90 degrees and it is apt to show tool marks. It is not usually considered good practice to drill while forming with a very wide tool, owing to the excessive heat of the cut and the pressure of the wide tool causing the drill to cut large; furthermore the speeds are not always suitable for forming and drilling simultaneously.

ELAM WHITNEY

WEAR IN SHAPER RAM GUIDES

The writer has reason for supposing that the usual method of gibbing the shaper ram is by no means so bad as A. H. makes it appear in his contribution in the November, 1912, issue of MACHINERY. According to his dictum, "where the wear is great, the design presents a great drawback on account of the difficulty of adjustment of the upper strips." Again, objection is raised to the initial cost of fitting and adjusting the slide on a new machine. Moreover, A. H. asserts that the lack of adjustability is a bad feature when the slide has become worn through use.

All these arguments, with the exception of that relating to initial fitting, which is largely a matter of opinion, would be just if the wear of both slide units were uniform throughout their length. But this is not so, as will be readily apparent after a careful examination into the direction of the forces at the cutting edge of the tool, of the forces at the propelling mechanism, and of the gravitational forces. The last named forces result in pressure on the lower surfaces of the ram and on the upper surfaces of the shaper body. At the front end of the slide, the downward pressure is intensified by those cutting forces which tend to pull the tool into the work, and such a condition usually results in "digging in" and consequent vibration. These forces may wholly counteract the gravitational forces at the back end of the ram, thus causing the separation of the bearing surfaces and preventing wear on the bottom surfaces, but intensifying the wear on the upper surfaces. Again, under certain conditions, the tool receives a side thrust which tends to tilt the ram. In fact, conditions vary to such a degree that it is practically impossible to locate the points subject to greater wear with any degree of accuracy. It is, however, absolutely certain that the wear cannot be uniform, and there are points in the slides where the wear is practically negligible. The surfaces of both slides tend to wear rounded. The ram slides are subject to little wear at the ends; in fact it might almost be said that no wear develops at the extremities of the ram slides, since they seldom make contact with the opposing body slides. Personal experience has shown that attempts made to adjust almost any form of slide will result in failure. If the gibs are raised to take up the wear in the frequently used portions of the slide, the absence of wear in the portions that are used less frequently causes binding.

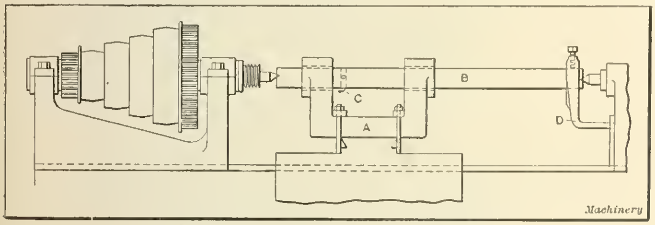
What, then, is the inference when the subject is considered from this point of view? Professor Sweet has stated that surfaces which tend to uniform wear do not wear at all, or, at any rate, are subject to little wear. His remedy to secure this desideratum was to examine the parts after running under normal conditions, then to bodily remove those subject to no wear, and to reduce the area of those subject to little wear inversely as the amount of the wear. This is not at all a bad remedy, providing the conditions of service are known. In general purpose machines, however, conditions are so variable that this method is impracticable. The presence of the shallow grooves produced in removing metal to reduce the surfaces would also permit the penetration of grit between the sliding surfaces. The evident conclusions are: (*a*) It is impracticable to secure uniform wear. (*b*) Certain parts are subject to practically no wear. (*c*) Consequently, the provision of adjustments for wear is unnecessary. This does not debar incorporation of adjustments for the facilitation of construction.

The writer has often been struck by the meagreness of the sliding surfaces in the shaping machine, as usually constructed. Is there any good reason why these surfaces should not be increased? With the surface areas at present in vogue, readjustment is necessary under ordinary conditions of service at least once a year if the quality of the output is to be maintained. Now suppose that all the surfaces were at least doubled in area. Would it not be certain that their durability would be at least twice as great, rendering necessary but a biennial adjustment? In fact, when one considers that present surfaces are so limited as to be within the "cutting" region, it might be stated that the life would be lengthened even more than 2 to 1 by the increase. Wider surfaces would tend to retain the oil, preventing metal-to-metal contact. What the writer wishes to press home is this: If portions of both sliding surfaces do not wear, adjustment can only be effected by scraping; hence, means provided for adjustment other than those convenient for the initial assembly are useless. Even the taper or parallel gib might be dispensed with, if this afforded no convenience in erection. Francis W. Shaw

Manchester, England

CUTTING A KEYWAY IN A LATHE

A simple but novel way of cutting a keyway in a lathe is shown in the accompanying illustration. The work is shaped like the letter U and a keyway is to be cut in each hub. This job could not be conveniently accomplished in the keyseater, as the two hubs were so far apart that it would have been necessary to reverse the work to cut the second keyway.



A Makeshift Device for cutting a Keyway in a Lathe

In the illustration the work *A* is bolted to the saddle of the lathe, while a boring-bar *B*, carrying a cutter *C* and being prevented from turning by the dog *D*, is held on the centers. To cut the keyway, the back-gears are thrown out and the cone is loosened on the spindle, so as to feed the carriage without revolving the spindle. Of course the feed-nut was engaged with the lead-screw and the carriage traversed at the required feed. This is only a makeshift, but it answers the purpose where other tools are not available. W. Alton

SECTIONAL DRAWINGS

In the February number of Machinery, J. M. Henry writes in regard to cross-hatching sectional views of an assembled drawing. To be sure, it is a tiresome method, but is not all labor more or less tiresome? In regard to the use of tinting ink applied to the reverse side of a tracing, the writer believes that unless the tracer is an artist the result will look more like an oil painting by "A. Dauber" than the tracing of a drawing. Also the bluish-white color for representing sections on a blueprint is likely to cause trouble, for that same bluish-white may be produced by a tracing which has become spotted with water—a thing which happens quite frequently where the sun exposure method of printing is used.

The writer is employed in a shop where a great deal of special machinery is built, so that he has had ample opportunity to examine blueprints made in other shops; and if the tinting method should become standard practice, a great number of these prints would show nothing but sectional views. It has been the writer's experience, that the pencil layout and details are clearer to the detailer and tracer when sections are represented by different colored crayons and the final tracing is neatly cross-hatched, for the expense of the tracer is practically nothing, compared with the results, if that print is to be used to help sell a machine.

Dexter, Me. E. W. Tate

IMPROVED GAGE FOR TWENTY-NINE DEGREE THREAD TOOLS

In the February issue of Machinery, Everett Chipman describes a gage which is theoretically an improvement, but the writer trusts that the author does not believe that it is commercially possible to produce a hardened worm that does not vary more than 0.001 inch. He also states that it is a common error to set the top of the thread tool parallel with the axis of the worm. The writer would like to ask if the same assertion would prove true in the case of U. S. standard and square threads, and if Mr. Chipman could draw the outline of a tool that would be used in cutting a worm or square thread of 6- or 8-inch lead?

Dexter, Me. E. W. Tate

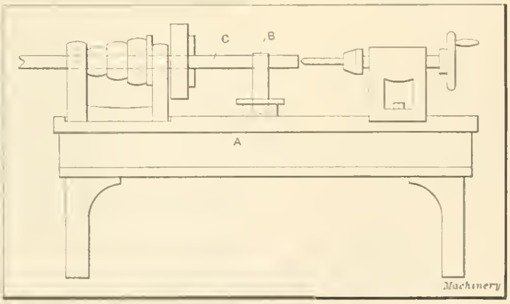
COMPARISON OF SELLING METHODS

In the February issue of Machinery, Mr. J. F. Winchester comments on my article on the subject of "Selling Methods," which was published in December. He asks whether thirty, sixty or ninety days is not considered cash payment and whether we use "twentieth century methods" in offering to pay cash. There is a discount of two per cent offered for cash in ten days, which is always taken advantage of by "live" concerns, and it was this kind of cash payment that I made reference to. Some people may consider it a cash payment when they settle their bills in one, two or three months, but most firms make a practice of allowing an extra cash discount to those who discount their bills within ten days of their presentation. In the case mentioned, our firm was willing to pay for the machine at once, but the sellers wished us to use it for ninety days and then pay for it at the usual discount, and if anything in the machine proved unsatisfactory, it could be shipped back to them at their expense. This is the reason for differentiating between a cash payment and a ninety day trial offer.

New Britain, Conn. J. M. Henry

COOLING A DEEP-HOLE DRILL

The following is a method of cooling a deep-hole drill which is not original with the writer although he has never seen it used before. Any mechanic will readily understand this method by referring to the illustration, which shows a small pan *A* that is set on the lathe shears and partly filled with water or oil. An endless belt *B* dips into this pan—a woven belt will be found most satisfactory for this purpose, as it has a greater power of absorbing the liquid—and as the belt rotates water or oil is carried up onto the work and keeps it cool during the drilling operation. The pan can be moved along the lathe bed so that the belt will run above the point



Method of cooling Work when drilling Deep Holes in a Lathe where the drill is working. The writer saw this method in use in drilling deep holes in copper bars; this work formerly became exceedingly hot, but the application of this method enabled the heat of the cut to be so effectually dissipated that no trouble was experienced. WHIP

A LATHE CENTER OILING DEVICE

The illustrations show a useful device for oiling a lathe center, which consists of a cylindrical piece *A* screwed onto the center and having another cylindrical piece *B* revolving in it. This piece is made to revolve by means of a hard rubber washer *C* which is fastened to it by four countersunk screws. When the oiling device is screwed onto the center, this rubber washer is pressed against the work, and is carried around by friction. A ring *D* is turned on the inside of the sleeve *B*; this ring keeps passing through the oil or lubricant and carries a portion of it around and drops it on the center. The revolution of *B* is facilitated by means of four small rollers *E* which fit in a groove turned in the sleeve. These rollers are carried by studs as shown, and in addition to the reduction of friction which they effect, they serve the purpose of making the oiling device self-contained when it is not in position on the lathe center. The rubber washer also tends to keep the oil from leaking out when it is pressed in position against the work. *F* is an oil hole for refilling the device when necessary. A modification of this design could probably be made for use in different classes of work.

Manchester, England. W. R. OAKES

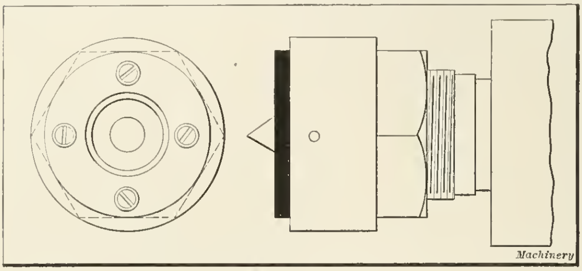


Fig. 1. A Lathe Center Oiling Device

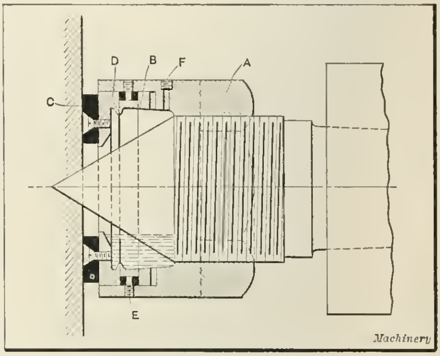
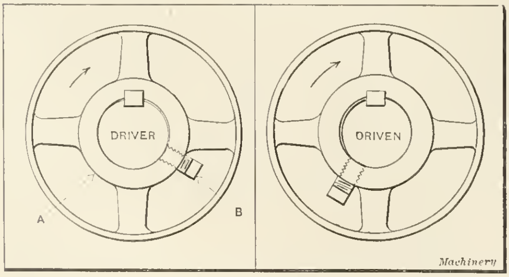


Fig. 2. Cross-sectional View showing Construction

LOCATION OF KEYS AND SET-SCREWS

Pulleys and gears are customarily secured to the shaft by means of a key and set-screw as shown in the accompanying illustration. That it makes a great difference in stability to have the set-screw on the proper side of the key is sometimes overlooked, and the accompanying diagram is shown to make clear how they should be located. Any hub that is not forced on its shaft with some pressure and that is secured by a driven taper key, or by a set-screw, or by a straight key with set-screw on top of it and a second set-screw at ninety or one-hundred twenty degrees from the key, assumes the position shown exaggerated in Fig. 1; *i. e.*, the hub is forced away from the shaft at the key and at the set-screw and bears hard on the shaft at the point *A*. Now if this shaft is a driver through the pulley in the direction indicated, it is in the position it would assume when power is applied, if no set-screws were used. As the key is the only connection between the pulley and the shaft in such a case, the pulley would swing to the left to whatever extent the bore would allow. It being desirable, however, not to have any lost motion between the pulley and shaft, the set-screw shown at *B* serves the useful purpose of preventing lost motion, and it is not called upon to do more than this. The hub assumes a wrapping position around the shaft, being secured to it by the key, and has a bearing for the full length of the hub at the key and also at the point *A*. Now if this shaft is rotated in the opposite direction, the same wrapping action takes place on the opposite side of the key, with the result that nothing but the point of the set-screw and the key have a bearing on the shaft. When put together in this way, the set-screws will soon wear into the shaft and become loose, and there will be lost motion between the pulley and the shaft which will inevitably cause trouble. For such a case, the set-screw should be at the point marked *A*, while the pulley will bind at the point where the key is shown. Fig. 2 shows the proper position for the key and set-screws where the pulley drives the shaft in the direction indicated.

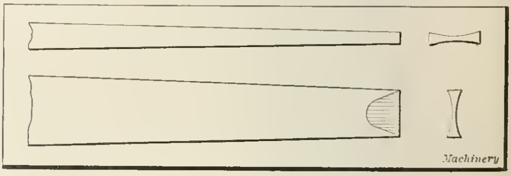
Watervliet, N. Y. MARTIN H. BALL



Proper Location of Keys and Set-screws for Different Directions of Rotation

FITTING A SCREW-DRIVER FOR UNIVERSAL SERVICE

It is a common sight to see the point of a screw-driver ground down to a knife edge, in an attempt to make it take the place of different sized tools for use in various sized screw slots. The practice of grinding a screw-driver in this way, generally means that it is ruined for efficient work, because the sharp edge tends to slip out of the slot as soon as the screw begins to turn hard. This spoils the slot in the screw head.



Screw-driver fitted for Universal Service

A good way to fit the point of a screw-driver to make it suitable for use on various sized screws is shown in the accompanying engraving. This illustration shows four views of the point, from which it will be seen that the center has been slightly hollowed out so that it will take small sized screws, while enough metal is left at each end of the point to give it sufficient size and strength for driving home large sized screws. The method will be readily understood, as the small sized screws have narrower heads and narrower slots, and require a thinner edge to enter them. This method of grinding does not impair the efficiency of the screw-driver nor the strength of the point for use on larger sized screws.

Upton Works, Mich. L. J. WATSON

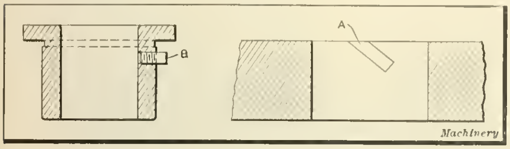
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

TO HOLD SLIP JIG BUSHINGS IN PLACE

The writer has found the following method for holding slip jig bushings in place a very good one: Drill and tap a ¼- or ⅜-inch hole in the side of the jig bushing, as indicated in the engraving. After the bushing is hardened and ground, screw in a pin and cut it off, so that it projects about 3/16 inch outside of the bushing, as at *B*. Chip out a slot in each hole in the jig as indicated at *A*, the hole being chipped in the direction of a spiral. By engaging the projecting pin in this slot, the bushing is prevented from turning and from rising out of the hole. At the same time it can be easily gotten out when required, and there is no projection on the jig of any kind that can be broken off while handling. The writer has used this method on very heavy jigs.



It is not always necessary to tap a hole for the pin in the jig bushing. A plain drilled hole is sufficient when the bushing is at least ⅜ inch thick. If the wall of the bushing is thinner than this, the pin cannot be driven in tight enough to stay in place securely.

Akron, Ohio H. C. Armstrong

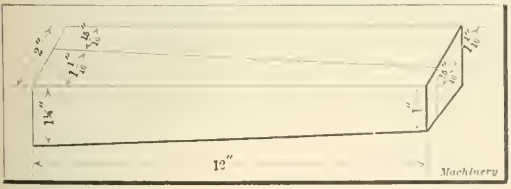
A HARDENING KINK

When hardening stamping dies or other tools having holes or sharp corners and projections, it is sometimes necessary to fill the holes and sharp corners with fire-clay to prevent the cracking of the tool in the bath. When the tool is put into the furnace, the clay dries and shrinks away from the steel, and sometimes drops off before the piece is removed from the furnace. A satisfactory method for overcoming this difficulty is to apply the clay as usual, and then heat the article enough to dry the clay somewhat, so that it starts to shrink; then some thin fireclay is applied to the tool as a paste to cement the clay to the steel. This fireclay should be of about the consistency of cream. A little practice will give good results.

Aurora, Ill. C. Lamoreaux

KEY FOR A REPAIR JOB

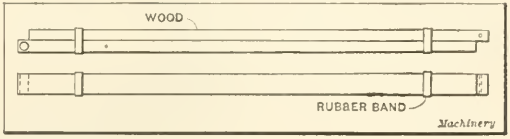
The writer has had to take care of the repairs of a 50-horsepower gas engine, provided with a clutch and driving a lineshaft connected to a flange on the flywheel, which had a solid hub. After putting in several keys that all came loose, a key was made as shown in the accompanying engraving, and this key has met the requirements. One part of this key was first driven in fairly tight, and then the other part was driven alongside of it, thus providing a tight fit the entire length of the keyway.



W. K. M.

HOME-MADE BEAM COMPASS

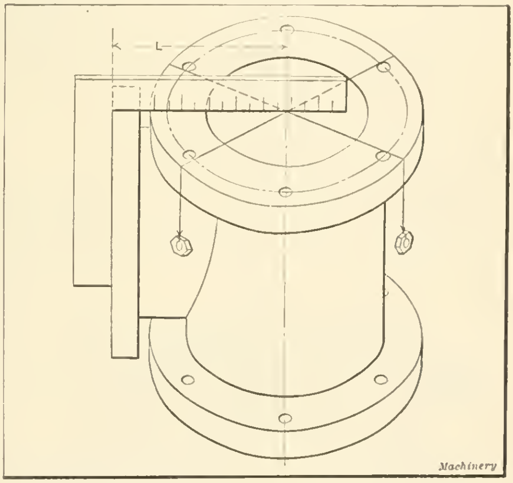
The following is a description of a home-made beam compass which worked very satisfactorily. Two pieces of soft pine, ⅝ by ¾ by 16 inches, were fastened together by two strong rubber bands, thus allowing any desired adjustment. A hole was drilled in the end of one piece to receive the leg of the dividers, while another hole was drilled in the other piece to receive either pen or pencil as desired. The results were fully as good as with a high-priced instrument, and the advantage over the ordinary home-made beam compass was in the large range and the accurate adjustment that it was possible to obtain.



Erie, Pa. Thorvald Petersen

MEASURING RIGHT-ANGLED FITTINGS

Probably no person accustomed to sketching right-angled fittings has failed to find difficulty in getting the distance from the face of one branch to the center of the other, particularly if there are no facing strips. Usually it is impossible to measure to the bolt circle, as the holes are generally drilled off center. Both the inside of the fitting and the rim of the flange are left unfinished, and unless one goes to the trouble of inserting a wooden center, the measurement is largely a matter of guess-work.



The following method has the advantage of great accuracy, and permits of reading the measurement directly. Place one of the faces in a horizontal position. Lay two threads, weighted at the ends, tangent to opposite holes, as shown in the engraving, being careful to keep to the same side of the holes all the way around. The intersection of these threads will then be the center of the face. By holding a square against the other face, the required dimension can be read off directly. This method, of course, cannot be used when the number of holes is uneven. V. C. Blackett

Glace Bay, Nova Scotia

TURNING A PIECE TO TWO DIFFERENT DIAMETERS

A piece turned from the solid to two different diameters, making a square shoulder, will be most liable to break in the corner. By making the piece in two parts, breakage may be prevented. A sleeve the same size as the large diameter is driven or shrunk onto a piece of the same diameter as the smaller part to form the shoulder. This eliminates the sharp corner or starting point of a fracture.

Norwich, Conn. George W. Armstrong

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

IMPRESSIONS FOR BOSSES IN DROP-FORGING DIES

O. L. B.—Why are the impressions for bosses on drop-forgings preferably put in the upper die?

A.—Because an impression in the upper die fills with metal more readily than in the lower die. The reason for this has been ascribed to inertia of the metal being formed, but this seems to be a hardly adequate explanation. Explanations from readers are invited.

POWER REQUIRED TO DRIVE PROPELLERS

H. R.—Is there a formula for finding the horsepower required to drive a propeller of a certain pitch and diameter? For example, suppose the diameter is 28 inches, the pitch 29 inches, and that the propeller is driven at 500 R. P. M.

A.—A formula is given by Kent in his "Mechanical Engineers' Pocket-Book," as follows:

$$D = 20{,}000\sqrt{\frac{\text{I. H. P.}}{(P \times R)^3}}$$

in which

D = diameter of propeller in feet;

I. H. P. = indicated horsepower;

P = pitch of propeller in feet;

R = revolutions per minute.

This formula can be transcribed into the form:

$$\text{I. H. P.} = \frac{D^2 \times P^3 \times R^3}{20{,}000^2}$$

From this we find by inserting the values given in the example above:

$$\text{I. H. P.} = \frac{2.33^2 \times 2.42^3 \times 500^3}{20{,}000^2} = 24\text{, approximately.}$$

DEFLECTION OF ANGLE IRONS

L. M.—Will you give me the calculations showing how much a 2- by 1½- by ⅛-inch cold-rolled 0.15 carbon steel angle will deflect when a load of 300 pounds is suspended from it in the manner shown in Fig. 1? We have been able to get figures for hot-rolled sections, but cannot seem to find consistent figures for cold-rolled angles.

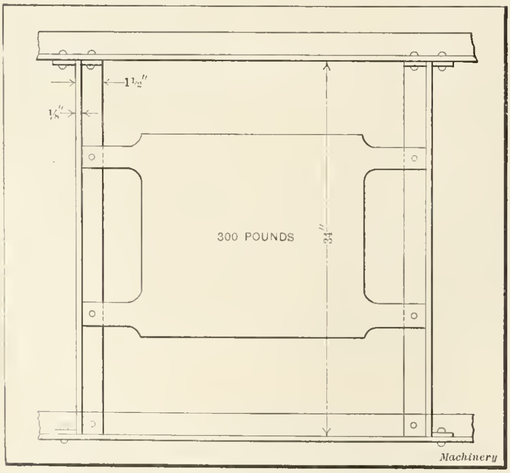


Fig. 1. Diagram showing how Load is supported on Angle Irons

Answered by William L. Cathcart

The total load—300 pounds—has four points of support between which it is assumed to be equally divided, making 75 pounds at each point and 150 pounds on each angle. It is further assumed that these points are all at the same distance a, Fig. 2, from the middle of the unsupported part of the angle. Allowing one inch for the left support, each angle may be considered as a "restrained beam" (one with fixed ends) of length $l = 34 - 1 = 33$ inches, sustaining two equal loads $P = 75$ pounds, each at a distance a from the middle of the beam. The left-hand load may, for convenience, be taken as distant $b = k \times l$ from the left support, k being the fraction $\frac{b}{l}$. Since the loads are symmetrically set, the maximum deflection y will be at the middle of the beam and will be double that caused by one load P. If, therefore, we find the deflection at the middle of the beam due to either of the loads P, and multiply it by 2, we shall have the maximum deflection y. For the left-hand load, the deflection at the middle is

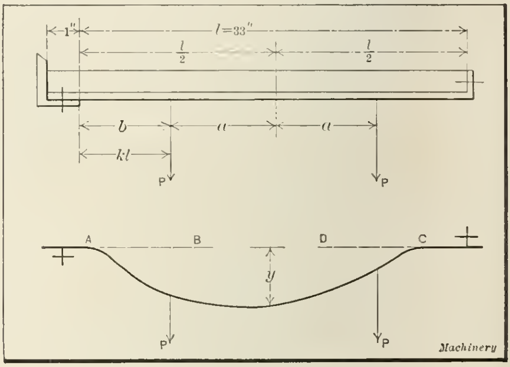


Fig. 2. Diagram illustrating Method of determining Deflection of Angle Irons

$$y_1 = -\frac{Pl^3}{EI}\left(\frac{4k^3 - 3k^2}{48}\right)$$

in which E is the coefficient of elasticity of the metal and I the moment of inertia of the cross-section of the angle about an axis passing through the center of gravity of that section and parallel to its shorter leg. For this angle the value of I is 0.17. There will be no material error, if E be given its general value for steel, *viz.*, 30,000,000 pounds per square inch, since the percentage of carbon and the physical treatment of the metal have very little effect on the value of E, as compared with their effect on the ultimate strength, the percentage of elongation, and the reduction of area. The positions of the points of application of the loads P are not given. Let these loads be 5½ inches from the middle of the angle or 11 inches from the left support. Then $b = 11$ inches, and $k = b/l = 11/33 = 1/3$. Substituting the values of P, E, I and k in the equation given above, we have:

$$y_1 = -\frac{75(33)^3}{30{,}000{,}000 \times 0.17}\left(\frac{4(\frac{1}{3})^3 - 3(\frac{1}{3})^2}{48}\right) = 0.002\text{ inch.}$$

where y_1 is the deflection at the middle of the angle due to one load P. The total deflection at the middle, caused by both loads, is twice this amount, or 0.004 inch.

In this solution it has been assumed that the loaded angle is a restrained beam, that is, that the tangents AB and CD to the elastic curve at the supports of the angle are horizontal, which is not strictly true. Further, the accurate value of E for this case would probably lie between 29,000,000 and 30,000,000 pounds. The results are, however, sufficiently accurate for all practical purposes.

* * *

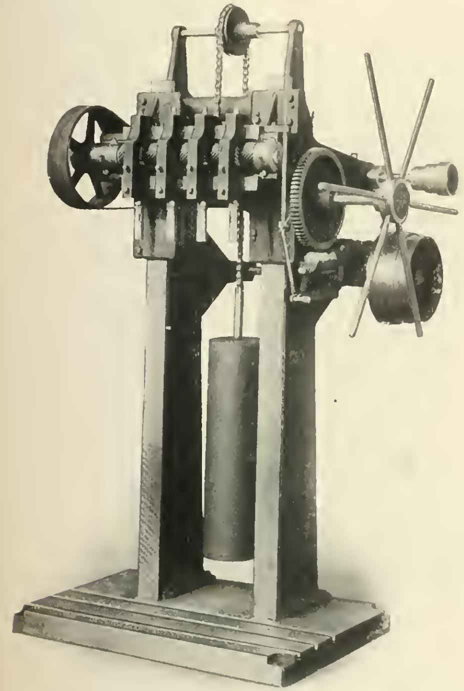
Regular machine taps often work badly when used for tapping brass. The teeth lack support and are likely to "hog in," catch and break. Two-flute taps are recommended for tapping tough brass. The lands of two-flute taps are broad and the flutes narrow, thus providing plenty of support for the teeth and preventing "hogging in." Very smooth threads can be cut with such taps if properly made.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

MOLINE MULTIPLE SPINDLE DRILL

The illustration presented herewith shows a new type of multiple spindle drill which has been placed on the market by the Moline Tool Co., Moline, Ill. It will be seen that this machine is driven by the regular arrangement of spiral gears which has been adopted by this company, and that it is built without a table, the idea being to drill work set on the extended base.



Machine built with Extended Base on which Work is mounted

The rail is of the hollow box form provided with long bearing surfaces and is securely gibbed to the columns; it is counterweighted and provided with two ways on which the heads are mounted. The main spiral gear is cut from high carbon steel; it has a helix angle of 45 degrees and is 3½ inches outside diameter. This gear is supported for its entire length in an accurately machined groove in the rail and runs in cast-iron bushings; the end thrust is taken on ball bearings, and the gear is driven by a belt provided with an idler to adjust its tension. This gear is furnished in three different pitches: a 16-pitch gear is furnished when it is desired to use the Nos. 7 and 8 heads for very light drilling or wood boring at ⅞ or 1 inch centers; a 10-pitch gear is supplied where medium drilling is to be done and Nos. 10 and 12 heads are used at centers of 1¼ or 1½ inch; and a 5-pitch spiral gear is regularly furnished unless otherwise specified, this gear being used for regular lines of work where the closest center distance is not less than 2 inches, and heads from No. 16 up are used. The heads are accurately fitted to the ways on the rail and each head is secured by two clamps. The heads may be readily removed or set at any desired point by simply loosening the clamps.

The machine shown in the illustration is built without a table and is intended for handling high work set up on the extended base. The same machine is also built with vertical T-slotted faceplates secured to the face of the columns, or with a regular table mounted on the knees and provided with vertical adjustment by means of elevating screws. When the regular table is furnished with an oil groove, it has a working face five inches wide and two T-slots. When a plain table is used it is twelve inches wide and may be furnished either with or without T-slots.

The columns have wide square ways on which the rail slides, and are securely bolted and doweled to the base of the machine to secure perfect alignment. The base is wide and heavily ribbed to prevent it from springing, and when the machine is built without a table or with vertical faceplates, the surface of the base is finished, extended forward from the face of the columns and provided with T-slots. When the machine is equipped with a table, the base is made in the form of an oil pan with a raised rib extending entirely around the outer edge.

The feed is transmitted by a rack and pinion driven by powerful worm-gears. The racks are cut from cold-drawn steel and mesh with pinions cut directly in the feed shaft. A pilot wheel is provided to operate the quick return, and the machine is also equipped with automatic stops. Three changes of feed are provided by cone pulleys which are made in sizes to provide any feed within the range of the machine.

BROWN & SHARPE NO. 00G AUTOMATIC SCREW MACHINE

The customary method of driving single spindle automatic screw machines is to employ two or more belts from an overhead countershaft: one for the feed mechanism, and one or two for the spindle drive, with sometimes an extra belt for the oil pump. The overhead works usually consist of two countershafts, one constant-speed driven from the main lineshaft, and one variable-speed driven from the constant-speed shaft by a belt on suitable cone pulleys. The feed mechanism is belted to the constant-speed countershaft and the spindle to

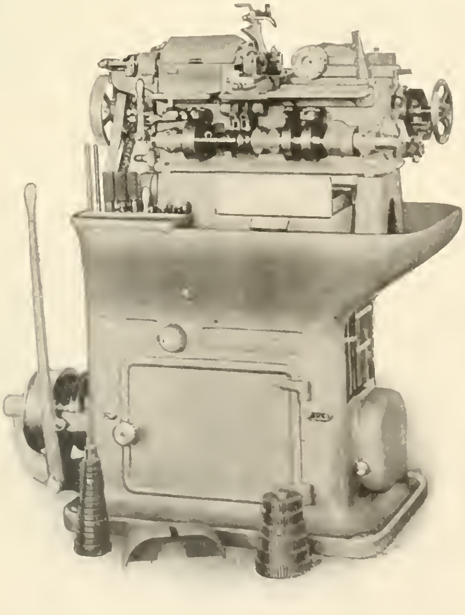


Fig. 1. The Brown & Sharpe No. 00G Automatic Screw Machine with Constant Speed Drive

the variable-speed shaft, all spindle speed changes being made by shifting the short connecting belt on the cone pulleys. Such a system of overhead works for each machine requires a large amount of space on the ceiling, and leads to considerable expense in the installation and maintenance of a number of loose pulleys, hangers and belting. Furthermore, the shifting of the cone pulley belt for speed changes is an unhandy operation, owing to the shortness of the belt, and the manner in which it has to be done.

A recent departure in screw machine design, with a view to eliminating these difficulties, has been made by the Brown & Sharpe Mfg. Co., of Providence, R. I., in the design of their No. 00G automatic screw machine. This machine, as shown in Fig. 1, is of the constant-speed drive type; it will handle bar stock up to 5/16 inch in diameter, and turn any length up to 1¼ inch. The pulley is located at the extreme left of the machine, and the speed changing mechanism is enclosed within the base of the machine. As the driving pulley is equipped with a friction clutch, the machine can be driven from either the main line or a jack shaft, as preferred. It is, in addition, particularly well adapted for the application of a motor drive, any standard motor being employed, with the full efficiency available at all times.

Fig. 2 is a section through the base, parallel to the floor, showing the arrangement of the main driving shaft and speed change gears. A vertical section through the base is illustrated in Fig. 3, showing the arrangement of the spindle driving belts and pulleys. The pulley *A*, which is bronze bushed and runs loosely on the shaft *C*, transmits the power to the machine. The friction clutch located within this pulley is operated by the long lever shown at the left end of the machine in Fig. 1. This clutch engages or disengages the pulley *A* with the sleeve *B*, which is keyed to the shaft *C*, thus starting or stopping the machine. An important feature is the provision of an adjustable screw in the side of the starting lever, so that when the lever is moved to disengage the clutch, the screw slides upon the swinging brake shoe *T* which is faced with leather, and bears against the tight pulley *R*, thus serving as a brake to stop the spindle quickly, and a lock for the mechanism when removing the speed change gears. None of the pulleys or gears are fast to shaft *C*, except the gear *N*, meshing with gear *M*, which, in turn, drives the shaft *L* and the two gears *J* and *K* keyed to it. The pulleys *E* and *F*, and also the clutch *P*, are keyed to a sleeve *W* on which the gears *G* and *H* run free, the whole sleeve being loose on the shaft *C*. Thus, engaging the clutch *P* with the smaller gear *H* drives the pulleys at high speed, while shifting to drive by the larger gear *G* gives a slow speed in the same direction. The pulleys *E* and *F*, as shown in Fig. 3, are connected to the spindle by an open and a crossed belt, respectively. *X* and *Y* are idler pulleys which serve to guide the belts and act as tighteners, adjustments being made by sliding the round shanks of the pulley brackets backward or forward through their bearings in the bed, and clamping them in position with set-screws. *D* is a guide pulley.

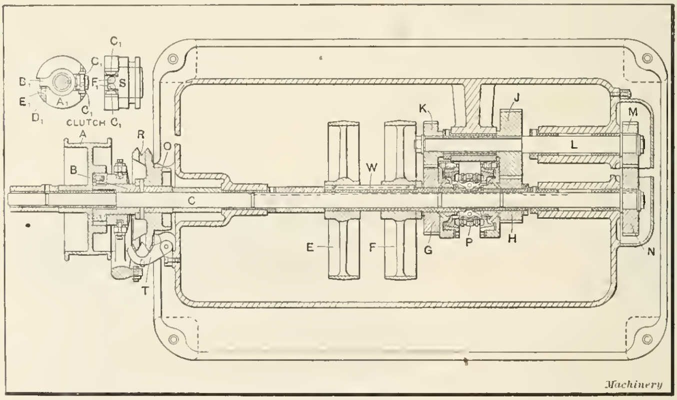


Fig. 2. Horizontal Section through Base of Machine showing Driving Shaft and Speed Change Gears

The spindle pulleys are free on the spindle, and are engaged or disengaged by a clutch similar in design to *P*, Fig. 2. Throwing in this clutch reverses the spindle, while the operation of the clutch *P* changes the speed from fast to slow, or *vice versa*. This combination of automatic spindle reverse and automatic speed changes is especially advantageous in threading, drilling with small drills, or turning work having large and small diameters, where the best results are obtained by using a slower or faster speed on certain operations than on the remainder of the work. The variations of spindle speeds are obtained by removing the two gears *M* and *N*, Fig. 2, which are held in place by nuts, and substituting pairs of different ratios. Being on the end of the base, they are readily accessible, and are completely shielded by a hinged cover when running. A large door is also provided in the base, allowing easy access to the driving mechanism. The placing of the spindle drive belts in the base of the machine allows the spindle drive pulleys and clutch to be completely shielded by a hinged cover, enabling the operator to work from any position around the machine in adjusting tools or inspecting work with comparative safety. Also, as the belts are enclosed in a guard within the base, they are thoroughly protected from the bad effects of the cutting lubricant. The cabinet type base, which contains the entire spindle driving mechanism, adds greatly to the rigidity of the machine, reducing to a minimum any vibration which might be caused by the rapidly revolving spindle.

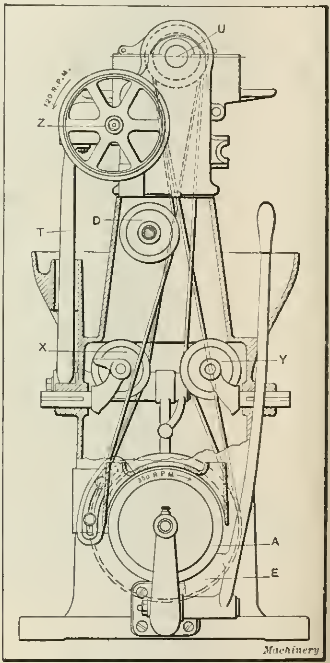


Fig. 3. Vertical Section through Base of Machine showing Spindle Driving Belts and Pulleys

The feeds and movements of the machine, other than the revolution of the spindle, are driven from the constant speed shaft *Z* at the back of the machine. This shaft is rotated by a belt from the pulley *O*, and may be stopped by the small lever at the left-hand side of the machine near the spindle, which disengages a positive clutch between the shaft and pulley, thereby stopping the entire feed mechanism. The front or timing shaft is driven from the constant-speed shaft in the rear through a worm and worm-wheel and change gears, which positively regulate the duration of the cycle of operations. The timing shaft carries the cams feeding the cross-slides, and also three carriers on which adjustable dogs are mounted. These dogs trip levers extending under the bed, causing them to engage positive clutches on the constant-speed shaft at the rear, which, in turn, drive gearing or cams for performing the various operations. The clutches automatically release after either a whole or half revolution.

The clutch *P* in Fig. 2, controlling the spindle speed change, is automatically shifted by a lever at the back of the base, which is thrown backward and forward by a cam on the feed shaft, revolved by a clutch as previously described. The first half revolution of this cam clutch throws the lever for one speed, and the second half revolution shifts the lever for the other speed.

The construction of the friction clutch in the main driving pulley, which is also shown in detail in Fig. 2, is of an entirely different design from those usually employed in constant-speed drive pulleys. The split friction ring A_1 is expanded within the driving pulley by means of two hardened rollers F_1, carried in the outside sliding sleeve S. The two rollers bear against the hardened shoes C_1 of the friction ring, the bearing surfaces of the shoes being arcs of circles. The inside sleeve B is keyed to the drive shaft and is connected to the split ring by the extension of a section of the sleeve into a recess in the ring, shown at B_1. As the sleeve S is moved toward the friction ring by means of the fork on the operating lever, the rollers are forced between the shoes, thus expanding the ring sections and clamping the pulley to the shaft. As the sliding sleeve transmits no power, it is free from all tendency to bind. When in position the sleeve is locked, since the rollers lie beyond the center line of the arcs. Also the rolling contact, while giving a powerful expansion, requires very little effort to operate it. The amount of friction is adjusted by the screw D_1 held in place by the setscrew E_1.

As may be seen from the sectional views, the entire mechanism has been carefully designed with ample proportions to withstand the most severe service to which a machine of this size and capacity should be subjected. All bearings in the spindle drive are bushed with phosphor-bronze, and wherever it has been considered advisable, the shafts are hardened. The main drive belt is provided with an adjustable guard over the pulley, there are hinged covers over the feed shaft on the back of the machine and over the spindle drive on the top, and the operator has been protected from injury and the machine from dirt and chips in all possible ways.

NEWTON RACK-DRIVEN SLOTTING MACHINE

The illustrations show a 32-inch rack-driven slotting machine which has recently been placed on the market by the Newton Machine Tool Works, Inc., Philadelphia, Pa. The cutter bar carries a relief tool apron with vertical and horizontal steel faced clamping surfaces; this bar is counterweighted and driven by a coarse-pitch steel rack. Referring to the illustrations, it will be seen that two dogs are mounted on the cutter bar, these dogs being adjustable along the bar to control the length of the stroke. When these dogs come into contact with the tripping pawl, which is connected to the master switch, they reverse the drive. It will also be seen that a lever is provided for controlling the drive by hand. The cutter bar has square lock bearings in the adjustable support, which, in turn, is bolted to the upright; and the drive is transmitted from the motor pinion through intermediate gearing to the bull-gear which connects with the cutter bar rack. The feed is taken from this gearing and carried through the machine to the patented reverse box which is arranged to give a variable stroke to the pawl controlling the reversing, circular, in-and-out, and cross feeds.

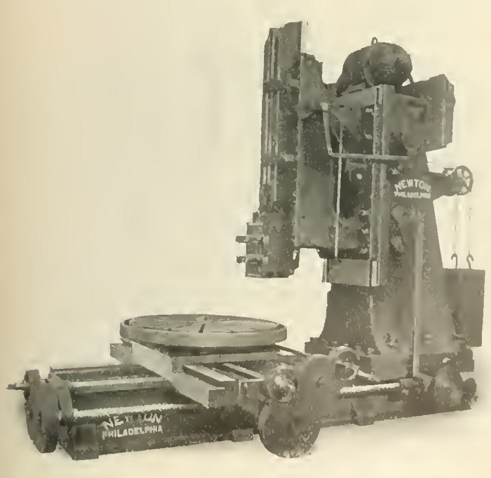


Fig. 1. Newton Rack-driven Slotting Machine

The circular table is surrounded by an oil pan which is cast solid, and the exterior of this pan is graduated into 360 degrees. The circular table is held to the cross saddle by means of corner clamps. The cross-slide has gibbed bearings on the base and all adjustments are made by means of taper shoes. Any of the table movements can be controlled by hand, and the motions are independently controlled by removable feed gears. By referring to the illustrations, it will be seen that particular care has been taken to protect all exposed parts of the mechanism so that the operation of the machine is made as safe as possible. The maximum length of the stroke is 33 inches, the length of the in-and-out feed is 40 inches, the length of the cross feed is 40 inches and the approximate weight of the machine is 46,000 pounds.

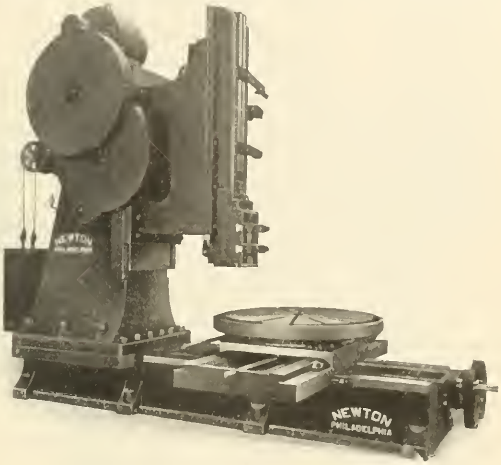
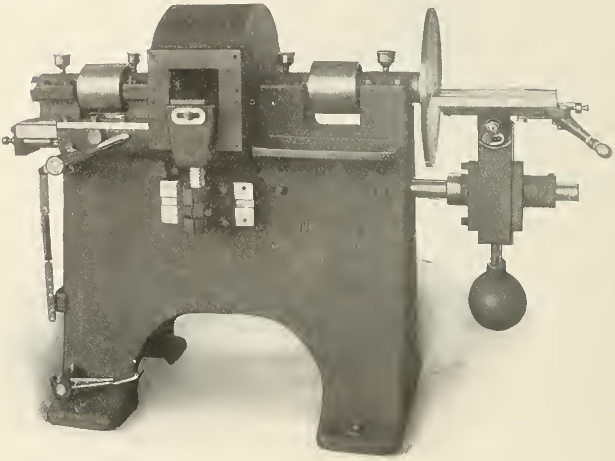


Fig. 2. View of Slotting Machine from Opposite Side

GARDNER DISK GRINDER

The accompanying illustration shows one of the latest machines which has been brought out by the Gardner Machine Co., Beloit, Wis. It is known as the No. 120 combination disk grinder and is equipped with three steel disk wheels 18 inches in diameter. The right-hand end of the machine is equipped with a rocker shaft and universal feed work table which is used in conjunction with the single disk wheel for grinding one surface at a time. The pair of disk wheels located at the center of the machine are used for grinding two parallel sides of a piece at the same time. The right-hand one of these two disk wheels is fixed and the left-hand wheel is mounted on a spindle carried in a movable head. By this means the distance between wheels can be adjusted so that parallel sides of pieces of varying widths can be finished. This movable head is mounted on a planed way on the machine base and is moved toward or away from the fixed wheel by means of a rack attached to its under side, which engages with a gear on the hand lever shaft. The forward travel of the head is regulated by a finely threaded stop-screw which is graduated to 0.001 inch, and this micrometer stop-screw can be set to enable the operator to produce accurate duplicate pieces. An adjustable back-stop regulates the backward travel of the head so that it only need be moved far enough to release the piece from between the wheels. This device is of special importance in grinding thin pieces, as too great an opening would make it possible for the work to be caught between the wheel and the work rest. The hand lever shaft is connected to the foot lever shaft, so that either means of applying pressure to force the movable wheel against the work may be used, or both hand and foot pressure may be applied at the same time. A coil spring assists in the backward travel of the head.

The bearings are of high-grade babbitt metal bored, reamed and scraped to an accurate fit and lubricated by compression grease cups. The end thrust on the spindle in the movable head is always in one direction and is taken on hardened and ground steel thrust collars. Means of taking up any end play have been provided in such a way that should the length of the spindle be increased through heating, it will loosen instead of sticking in the bearings. This is also true of the spindle construction in the right-hand or fixed head, except that provision is made for carrying thrust in both directions. Different width work rests are provided with each machine and a cast-iron dust hood, which is hinged at the back, completely covers the pair of wheels at the center of the machine. The front opening in the hood can be varied in size by the use of sheet-metal slides. Abrasive ring wheels held in chucks can be used on this machine in place of the disk wheels, and with this equipment, a water attachment consisting of a water pump and connections is furnished. This machine is also made in the plain type, *i. e.*, it is the same machine throughout except that the single disk wheel at the right-hand side of the machine has been omitted, together with the rocker shaft and work table.



Gardner Disk Grinder for finishing Parallel Sides of a Piece at One Operation

WALCOTT & WOOD CRANK SHAPERS

The Walcott & Wood Machine Tool Co., Jackson, Mich., has placed on the market a line of crank shapers of the cone and gear-box drive types, which have many interesting features. As far as practicable, these machines are built on the unit system which gives free access to all working parts, and facilitates the removal of all driving gears and shafts without the necessity of disturbing the positions of the ram and rocker arm.

Fig. 2 shows a side view of the machine known as the 24-inch high-duty crank shaper, equipped with a cone-drive pulley having four steps. The gear-box crank shaper is identical in construction with the cone-drive type, except that the cone pulley is replaced by a quick-change gear box, driven by a single constant-speed pulley and friction clutch, as shown in Fig. 5. Fig 1 shows a front view of the 24-inch shaper, and gives a good idea of the massive and rigid construction of this machine.

Cross-rail and Table Details

The cross-rail on these machines is fastened to the column with the same type of bearings that are used on heavy-duty milling machines. This construction provides suitable compensation for wear and insures the cross-rail being clamped square with the column, making this machine especially suitable for the production of high-grade work. The cross-rail is of box design, rigid in construction, and has a long, wide bearing on the column. It is elevated by a screw which is provided with a ball thrust bearing to facilitate its operation. The vise furnished with these machines has a graduated base and can be swiveled and set to any angle. The base of the vise has a wide bearing surface, and is located close to the table, thus making it very rigid and capable of withstanding severe duty. The feeding mechanism for the table on the cross-rail is of simple design, positive in action, and can be quickly adjusted and reversed while the machine is in operation.

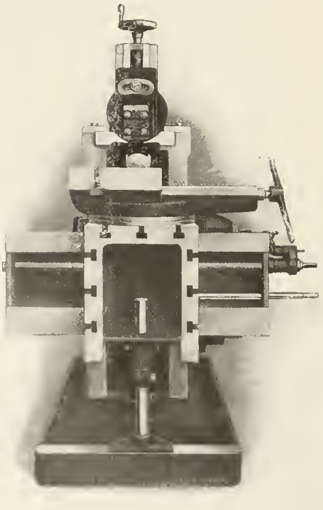


Fig. 1. Front View of Walcott & Wood High-duty Crank Shaper

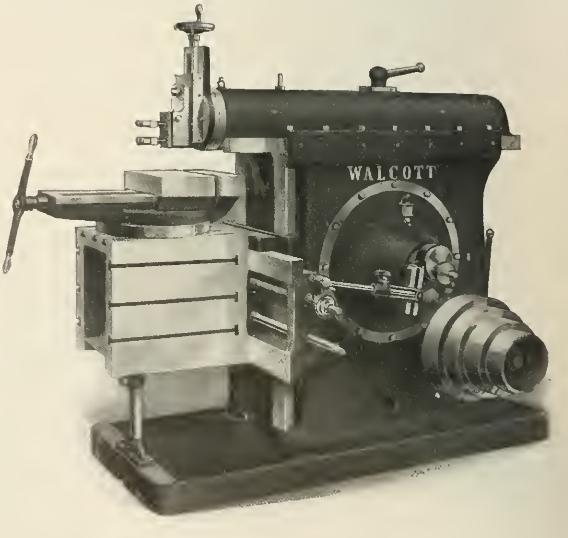


Fig. 2. Side View of Walcott & Wood 24-inch High-duty Crank Shaper

Ram, Rocker Arm and Bull Gear

The ram and rocker arm used in these machines are semi-steel castings, which greatly increases their strength and effects a corresponding reduction in weight. This permits of a greater number of cutting strokes per minute and lengthens the useful life of the machine. The bull gear pinion is made of high-carbon steel, runs loose on a high-carbon steel hardened and ground shaft, and is bronze bushed. This bushing is oiled by a large oil chamber passing through the center of the pinion shaft. The bull gear is made from a semi-steel casting, while all of the other gears used in these machines are of steel. They are of coarse pitch, wide face, and are accurately cut to insure quiet running. These features provide maximum wearing qualities and freedom from breakage under severe shock, when operating at high speed and under heavy cuts.

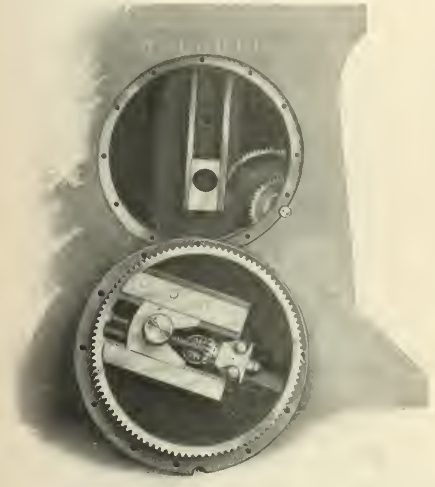


Fig. 3. Bull Gear Unit removed showing Rocker Arm and Back-gears

Fig. 3 shows the bull gear unit removed from the machine, exposing to view the rocker arm and back-gears. This illustration also shows the driving crank and its bearings which are of unusually massive construction. The housing carrying these members is accurately fitted into a recess bored in the column and is strongly bolted in position; this housing is well ribbed and is as stiff as the column itself, which is also ribbed internally. Oil is supplied to the driving crank journal by a sight-feed oiler on the main bearing, which insures the proper lubrication of this important part.

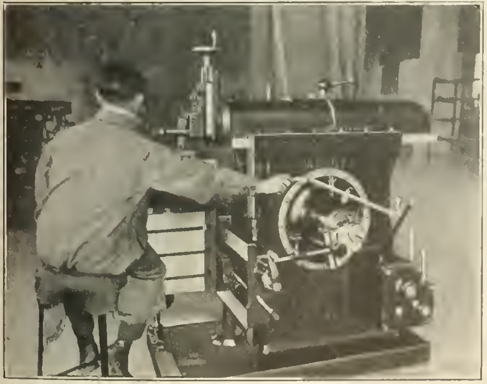


Fig. 4. Walcott & Wood High-duty Shaper equipped with Gear-box Drive

Gear-box Drive and Friction Clutch

The gear-box drive type of crank shaper built by the Walcott & Wood Machine Tool Co. is illustrated in Fig. 4. All the gears and shafts in the gear box are hardened and ground and run in oil. Four speed changes are obtainable by shifting the levers on the gear box, and these speeds are multiplied by the sliding gears inside the column of the machine—as previously mentioned—thus providing for eight speeds of the ram in geometrical progression. The end view of this machine, shown in Fig. 5, illustrates the friction clutch and single pulley constant-speed drive. The clutch is of the well-known expanding brake type, and is operated by the lever which passes through the column of the machine. An extension arm attached to this lever, as shown in Fig. 4, is provided so that the operator can engage or disengage the clutch, thus stopping the operation of the machine, without moving from his position at the vise. This feature is commendable in that it is possible for the operator to stop the movement of the ram at any point of its travel.

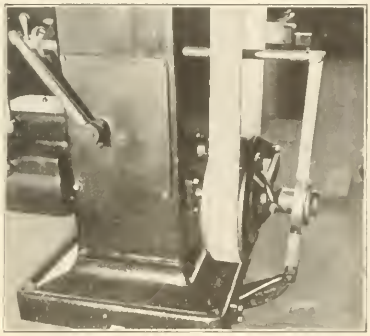
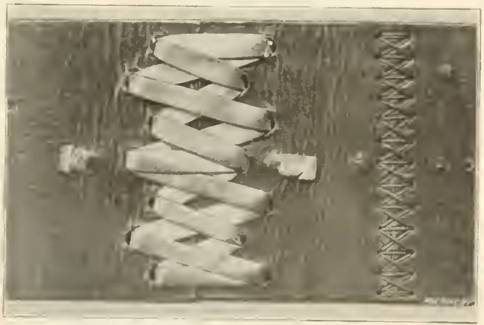


Fig. 5. Rear View of Gear-box Drive Crank Shaper showing Friction Clutch and Single Pulley Drive

Power to the tool head may be furnished, if desired, and each machine is regularly equipped with a vise, table support and all necessary wrenches. The gear-box drive type of shaper is built in 16-, 20- and 24-inch sizes.

TWISTED RAWHIDE BELT LACING

The accompanying illustration shows two methods of lacing leather belting. The first of these will be recognized as the familiar form of flat rawhide lacing which has found wide application. This method of joining the ends of a belt has two drawbacks, one of which is that the holes punched in the belt are so large that its strength is materially reduced, and the other that the bulkiness of the lacing at the joint has a tendency to cause the belt to jerk as the joint passes over the pulley. The other joint shown in the illustration is laced with twisted rawhide belt lacing which is being distributed in the United States by the George W. Southwick Co., 35 Warren St., New York City. This lacing consists of rawhide which is twisted into a cord, made in three sizes—14, 15 and 16 gage—and is equal in service to flat leather lacing 1/4 to 5/8 inch in width. The advantages of this method of joining a belt are: that it is only necessary to punch small holes for the lacing, so that the strength of the belt is not materially reduced; that the lacing is not bulky, so that it does not interfere with the smooth running of the belt on the pulley while the lacing is in contact with it; and that the tensile strength of the lacing is relatively high. In joining a belt with this form of lacing, it is claimed that the result approaches



Belt laced with Twisted Rawhide Lacing and with Flat Lacing a cemented splice as closely as it is possible for a laced joint to do. The tendency for the belt to jerk or jump when the lacing comes into contact with the pulley is practically eliminated and this greatly reduces the strain on the belt, so that the cost of maintenance is materially reduced.

Recent tests made at the Pratt Institute on belts laced with flat lacing and with twisted rawhide lacing showed the following results: A 3-inch single leather belt (laced by an expert) with a 3/8-inch flat rawhide belt lacing showed an opening of 1/8 inch at the abutting ends when a tensile strength of 200 pounds was reached; at 760 pounds, the opening between the ends was 1/2 inch; and when a stress of 810 pounds was reached, the belt broke at the lacing holes. A 3-inch single leather belt (taken from the same section of belting), laced with twisted rawhide lacing showed an opening of 1/16 inch at the abutting ends when a tensile stress of 900 pounds was reached; at a stress of 1460 pounds, the opening between the ends was 1/8 inch; and when a stress of 1800 pounds was reached the strands of the lacing broke. None of the lacing holes had "pulled out" or broken, and as a matter of fact the belt could have been relaced through the same set of holes. As there is no metal in this lacing, there is no danger of accidents from projecting ends.

WISCONSIN MOTOR-DRIVEN HAND MILLER

The Wisconsin Miller Mfg. Co., Milwaukee, Wis., is now building hand millers equipped with individual motor drive as shown in the accompanying illustrations. The problem of mounting an individual motor on so small a machine as a hand miller has been satisfactorily solved by providing an opening in the box shaped base at the front of the machine to receive the motor. A smaller opening is also provided in the frame at the rear to permit oiling and adjusting; this special box shaped base is also provided with the usual oil pan for receiving oil drippings and chips. The frame covering the opening into which the motor fits, is arranged with a shelf which extends into the base of the machine and supports the motor, and this shelf may be adjusted vertically to take up any slack or wear in the chain. The frame with the motor in place is bolted to the machine and forms a complete unit, the opening being covered with fine mesh brass screen which serves to keep out any dirt but allows a perfect circulation of air around the motor so that there is no tendency for it to heat up. A Westinghouse Electric & Mfg. Co. 1½ horsepower, direct-current, variable-speed motor, with speed control obtained through a type "H" starting and speed adjusting rheostat, is used, and connection between the motor and spindle of the miller is made with a roller chain of the type manufactured by the Diamond Chain & Mfg. Co. The spindle speeds obtainable through this arrangement vary from 260 to 780 revolutions per minute.

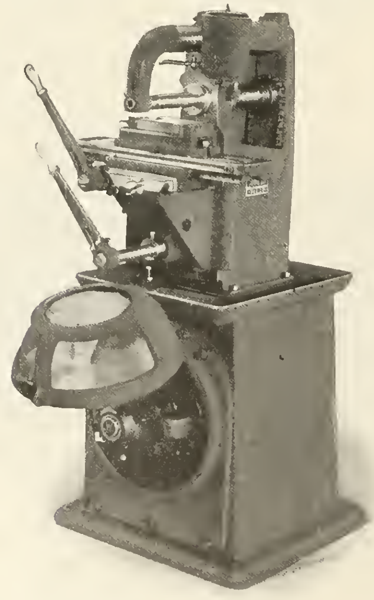


Fig. 1. Wisconsin Hand Miller showing Chain Drive to Spindle

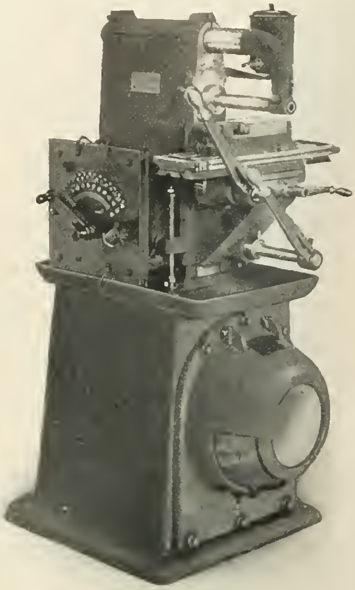


Fig. 2. Left-hand Side of Miller showing Electric Controller

The spindle is made of a special steel; it is ground absolutely true and has an 11/16 inch hole through it. The taper at the front end is No. 9 B. & S. The arbor hole is ground in absolute alignment with the spindle bearings, and both the front and rear bearings are of liberal dimensions and run in self-oiling bronze boxes. The front bearing is tapered and the rear bearing cylindrical, suitable means being provided to make adjustment for wear. The arbor is made of tool steel, ground to size, and has accurately spaced arbor collars. The pilot at the end fits a bronze bushing in the arm so that ample support is provided. The arm is of the gooseneck type and fits into a hole in the column of the machine.

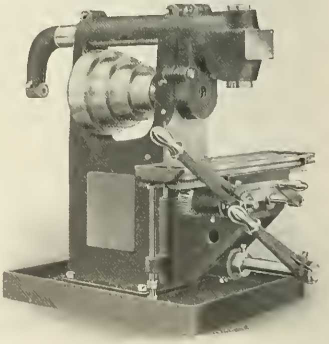


Fig. 3. Machine equipped with Vertical Attachment

The knee is of box section, has strong internal ribs, and is provided with a wide bearing on the column. The knee, saddle and table are counterbalanced by a weight inside the column which makes vertical adjustment an easy matter. The knee can be readily clamped to the column in any position. The saddle has a large bearing surface on the knee and table, and is provided with a cross feed of 4½ inches by means of a screw and crank handle. The saddle can be clamped in any position. The table has a large working surface with oil pockets at each end, and is provided with adjustable stops for stopping the feed. A steel rack securely doweled in place below the table, provides a steady and regular table movement through either the large lever or crank. The table has a working surface of 5 5/16 inches by 17 inches. The vise is of the flanged type and has ⅝ inch slots at right-angles in the bottom; it is arranged for mounting on a swivel base. The jaws are of steel and are made removable to permit special shaped jaws to be substituted when necessary.

All of the bearing surfaces are accurately scraped and are provided with means of adjustment. The gears and shafting are all accurately machined and ground to size. The column of the machine is designed to provide for the use of a vertical attachment, as shown in Fig. 3, which has a very simple and effective drive running entirely in oil. The design is such that it is possible to use the vertical and horizontal spindles at the same time, the vertical spindle being arranged to give a greater range from the top of the table than the horizontal spindle. This is found to be an important advantage in certain classes of work.

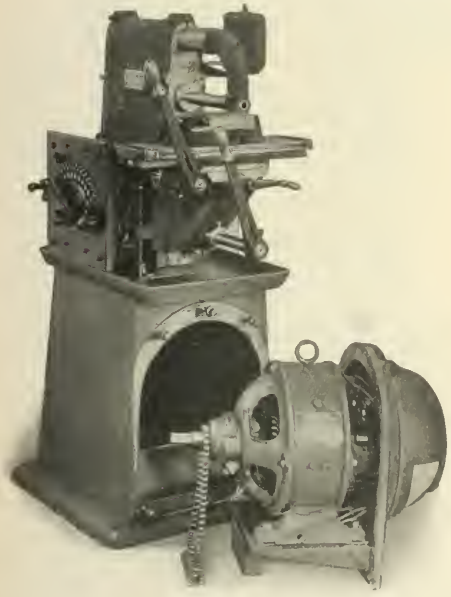
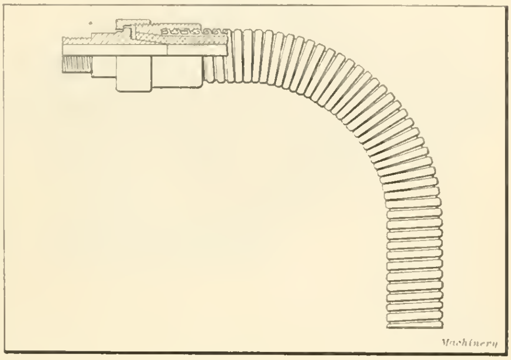


Fig. 4. Motor Unit removed from Frame of Miller

JOHNS-MANVILLE FLEXIBLE ARMORED HOSE

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, has recently place on the market a flexible armored hose, adaptable for use on pneumatic tools, for steam connections and other classes of service. It is claimed that the design and construction of this hose is such that it will not kink, flatten, puncture or collapse. It consists of a durable rubber hose which is protected against injury from the outside by a stout metal armor. This armor is made in the form of a ribbon with crimped edges which interlock with one another and form a flexible spiral. The interlocking construction of this armor restricts curvature and thus protects the inner rubber tubing from sharp bends, kinks or from being flattened out. As a result, the hose is always wide open and the maximum flow of compressed air or steam is always passing through the connecter.

An idea of the strength of this hose in resisting pressure from the outside is obtained from tests which show that it will resist a crushing stress of from 300 to 800 pounds to each four turns of the spiral, the amount depending upon the size of the hose. The armor is also of great assistance in strengthening the hose against damage resulting from internal pressure, the armor itself being capable of withstanding the highest internal working pressures. As a result the application of this armor enables a much lighter rubber hose to be used than would ordinarily be suitable for a given class of service. As the edges of the armor interlock with one another, the rubber hose is protected against stretching, all such strains being borne by the armor itself. Experiments show that a pull of from 1000 to 2000 pounds can be supported in this way.



Flexible Armored Hose suitable for use on Pneumatic Tools

Specially designed couplings of malleable iron or brass are furnished with each length of hose and these couplings are virtually a union of three pieces. The metal armor is riveted to an outer sleeve, which is tapered on the inside to receive the nipple and threaded on the outside to enter the lock or binding nut. This nut serves to wedge the nipple well into the inner tube and hold it securely against the walls of the sleeve. This type of hose can be furnished in any length and in any inside diameter up to 12 inches.

ATHOL VISE WITH SWIVEL BASE

The Athol Machine Co., Athol, Mass., has recently placed on the market, a new vise which combines two valuable features in its design. The first of these is the construction of the handle which connects with the head of the screw by means of a clutch that is normally held in engagement by a spring. After the vise has been tightened on a piece of work, the mechanic can disengage the clutch by pulling the handle out against the tension of the spring, and it is then possible to set the handle in any convenient position, where it will not interfere with the work upon which he is engaged. This feature will be readily understood by referring to Fig. 3.

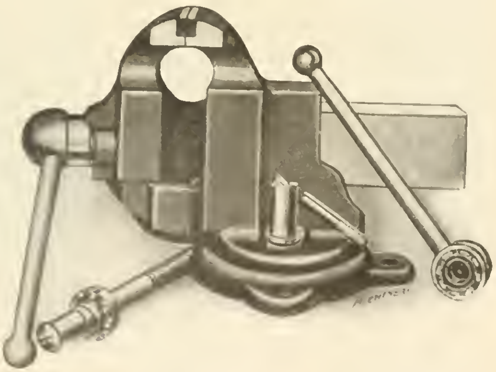


Fig. 1. Athol Vise, showing Connection between Handle and Screw

where it will be seen that the handle has been thrown down so that it does not interfere with the operator's hands when filing the piece of work clamped in the vise. Where a man is handling repetition work he can set the clutch so that the handle will come into a convenient position when the vise is tightened on the work. This means a considerable saving of time, as he always has the piece set in the vise so that he can work to the best possible advantage. As the handle does not slide through the head of the screw, it cannot drop through and pinch the workman's hand.

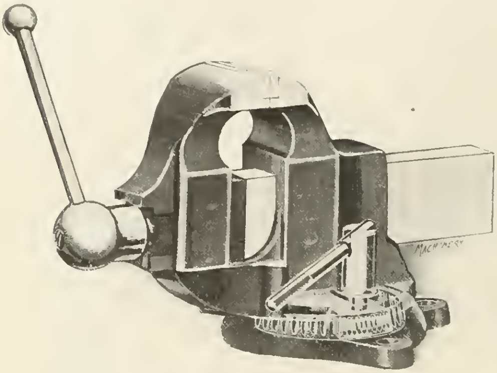


Fig. 2. Swivel Base Vise, showing Construction of Base

The second feature referred to consists of the stationary base upon which the vise swivels. This base has an annular slot cored out in it, and a nut carried on the end of a bolt attached to the vise body fits in this slot. The side of the slot is laminated to mesh with corresponding laminations on the nut when the bolt is tightened. In this way a secure grip is obtained and the vise is held firmly in any desired position. This clamping nut is operated by means of the small lever shown in the illustration. A quick adjustment can be secured by setting the lever in a vertical position and twirling it between the thumb and finger, the final grip being secured by swinging the lever down into the position shown, where the necessary leverage is secured. The use of this device makes it possible to set the vise in the most convenient position and then clamp it securely in place. These vises are also made with the improved style of handle previously described, but without the swivel base.

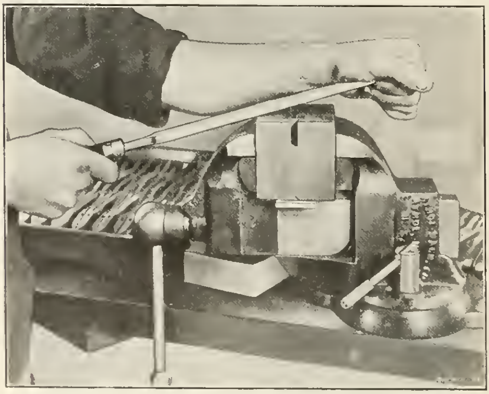


Fig. 3. Vise with Handle swung down out of Operator's Way

VERTICAL ATTACHMENT FOR STANDARD AUTOMATIC GEAR-CUTTERS

The Standard Mfg. Co., Bridgeport, Conn., has recently brought out a vertical attachment to be applied to any of its gear-cutting machines. The primary object of this attachment is to provide for cutting teeth on the flat sides of disks or wheels. The machine illustrated in Fig. 1 and the details of the attachment which appear in Fig. 2 show the design used for cutting the teeth on face milling cutters. The primary difference between this type of gear-cutter and the ordinary gear-cutter is that the work-holding spindle is in a vertical plane. By referring to the detail illustration, Fig. 2, in connection with the general view, Fig. 1, it will be seen that the blank in which the teeth are to be milled is shown in part at *A*. The attachment is composed mainly of three brackets, *B*, *C* and *D*, which are fastened to the under side of the bed of the gear-cutting machine. These brackets support two longitudinal shafts, one of which is shown at *E*; the second shaft is hidden, being parallel and directly behind the shaft *E*. Both of these shafts are arranged so that they may be moved longitudinally by means of plunger cams, one of which is shown at *J*. These plunger cams are, in turn, operated by cams upon the back shaft of the machine. The function of shaft *E* is to operate the pawl *F* which engages with a feed ratchet upon the work holding shaft. A better view of this pawl is shown in Fig. 1. The second shaft, which is not visible, is so situated that a lock on its end engages the ratchet wheel on the work spindle, thus preventing the work from turning while the tooth is being cut. The two cams on

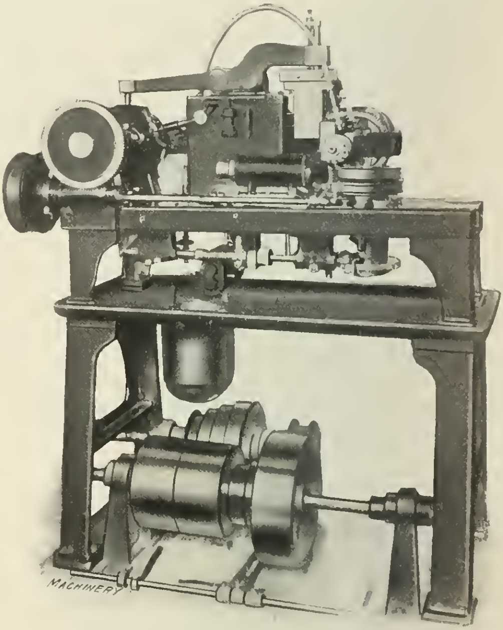


Fig. 1. Standard Gear-cutting Machine equipped with Vertical Attachment

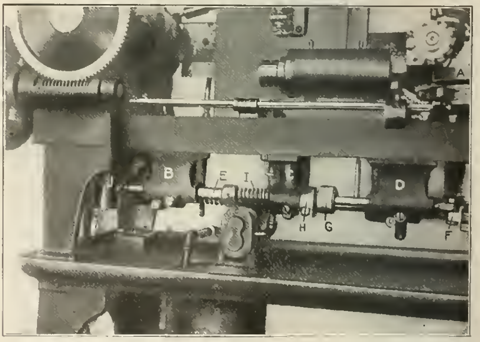


Fig. 2. Details of Vertical Attachment for Gear-cutting Machine

the back shaft, which operate the lock and index pawl, are adjustable in position and so timed that the plunger cam which operates the ratchet wheel lock relieves its pressure on the lock just before plunger cam *J* descends and forces the feed pawl against the ratchet wheel for a sufficient length of time to index the blank properly. As soon as the work is indexed, the lock drops into position in the ratchet. Means of adjustment is provided on shaft *E* by the nut *G*. To make this adjustment, the check nut *H* is first loosened and the nut *G* is then turned in the proper direction to shorten or lengthen the shaft *E*. A spring *I* serves to keep the shaft *E* back against the plunger cam.

The work holding arbor is provided with a faceplate, and by setting a stop, the feed may be thrown out at any desired position of the circle. There is also an index pin which may be readily engaged with the faceplate on the work arbor to lock the table while changing the work. This vertical gear-cutting attachment may be quickly removed and the machine transformed into the ordinary type of gear-cutting machine at a few moments notice.

KEMPSMITH LINCOLN MILLER

The Kempsmith Mfg. Co., Milwaukee, Wis., has recently made an addition to its line of millers by bringing out a machine of the Lincoln type designed for the manufacture of heavy duplicate parts, and several interesting features of this machine are shown in the accompanying illustrations. The machine shown in Fig. 1 is of the constant speed drive type, all changes of spindle speed being effected through change and sliding gears. For each change of spindle speed there is a corresponding change of back-gear ratio, this ratio never falling below 1 to 2.15 and running as high as 1 to 13 on the slowest speed, thus adapting the machine for taking the stiffest possible cuts with high-speed steel cutters. This feature, combined with the unusually large bearing surface of the saddle and table, and the essentially rigid construction, enables the machine to be used on a wide range of both light and heavy work.

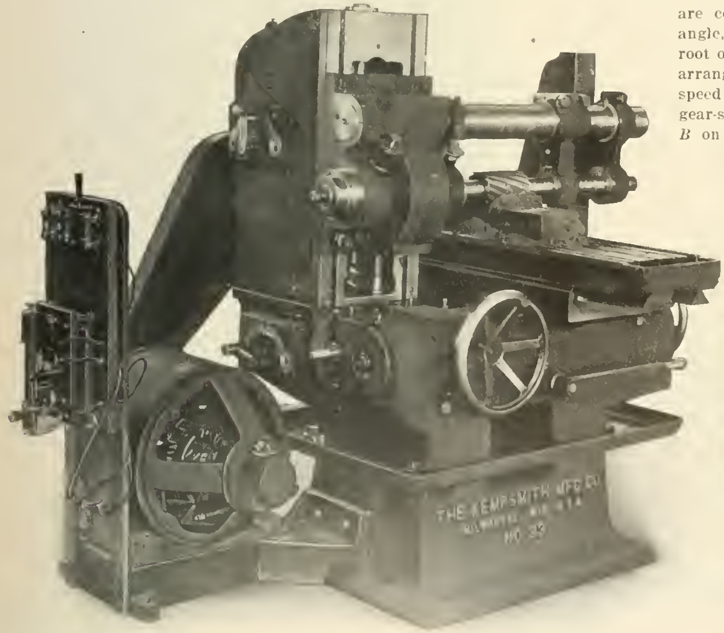


Fig. 1. Kempsmith Lincoln Miller equipped with Motor Drive

The single driving pulley, shown in Fig. 2, is 15 inches in diameter; it is flanged and carries a 4-inch double belt, the pulley running at a constant speed of 250 R. P. M. This pulley may be belted direct to the lineshaft, if desired, and this arrangement also lends itself readily to the application of motor drive as shown in Fig. 1. This driving pulley is keyed to the main driving shaft which runs in a pair of Standard roller bearings. The driving shaft is connected to the gear train through a clutch which is so designed that it starts on friction and throws in a positive three-tooth hardened steel clutch. The starting and stopping of the entire gear train and, consequently, of the spindle, is controlled by either one of two levers located at each side of the bed of the machine. To start the spindle, the operator raises the starting lever; when the lever is in its lowest position the clutch is out, so that it is impossible for jar or vibration to throw the clutch into engagement. When the clutch is engaged, the power is transmitted to the spindle driving shaft by means of a train of spur gears mounted on short, heavy shafts running in Standard roller bearings. As the changes in speed are secured entirely through sliding gears, it has been possible to make these gears of large diameter and wide face. The teeth are coarse pitch with 20-degree pressure angle, which gives great strength at the root of the teeth. With the gears *A* and *B* arranged as shown, three changes of spindle speed are obtained by shifting the sliding gear-set *C*. By interchanging gears *A* and *B* on their respective shafts, three other changes of spindle speed are obtained by shifting the gear-set *C*.

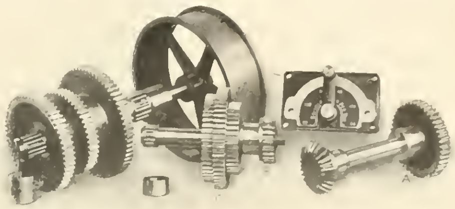


Fig. 2. Pulley, Driving Shaft and Gearing of Kempsmith Lincoln Miller

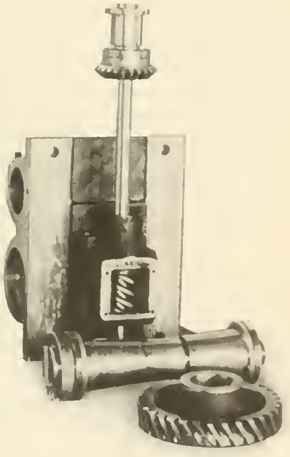


Fig. 3. Headstock showing Worm Drive to Spindle

The spindle shown in Figs. 3 and 4 is driven by means of a worm and worm-gear. The worm is of hardened steel and is carried by a vertical shaft running in roller bearings, the end thrust being taken by ball bearings. The worm-gear is made from a large bronze casting and is mounted between the spindle bearings. This construction is of considerable advantage, since it reduces the torsional strain on the spindle to a minimum. The worm and worm-gear run in a completely enclosed case containing an oil bath for lubrication of the drive. The spindle is made from a crucible steel forging and both the bearings and inside taper hole are accurately ground. It runs in special phosphor-bronze bearings which are provided with means for making adjustment for wear without disturbing the alignment of the spindle. The principal dimensions are length 18 inches, diameter of rear bearing 2¾ inches, largest diameter of front bearing 4¼ inches, and diameter of nose 4 inches; the hole at the front end of the spindle is No. 11 B. & S. taper, and is slotted to provide positive drive for the arbor. A draw-in rod is also supplied for firmly seating the arbor in the taper hole of the spindle. The headstock in which the spindle boxes are mounted is provided with oil pockets, and sight-feed oilers show at all times the amount of oil in these pockets, thus insuring adequate lubrication of the spindle bearings.

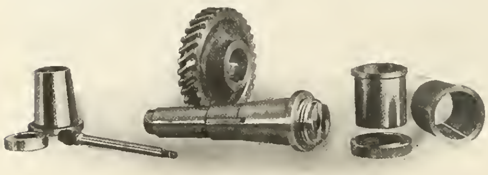


Fig. 4. Parts of the Miller Spindle

The head frame is of massive box type construction and is braced internally to resist all possible strains. The face to which the headstock is bolted is of ample dimensions, the headstock being secured by four bolts. A heavy boss on the headstock fits accurately into a corresponding slot in the head frame, thus preserving the vertical alignment. In addition to the spindle, the headstock carries one end of the heavy overhanging arm which is 4 inches in diameter and made of solid steel, accurately ground and polished, and supported at its outer end by a substantial outboard support. This overhanging arm is furnished with an intermediate arbor support which is bronze bushed and can be used close up to the cutter. This arrangement provides positive alignment of the arbor and prevents it from being forced out of line under heavy cut. When not in use the over arm can be pushed back out of the way. Vertical adjustment of the headstock is obtained by means of a shaft projecting from the front of the bed below the head frame, instead of at the top of the head frame as in former models. This shaft is provided with a dial, graduated to thousandths of an inch, and also with a handwheel.

The table is only provided with power longitudinal feed, and the changes in the rate of feed are secured in the same manner as the spindle speeds are obtained. The mechanism is simple and durable, with very little possibility of getting out of order, and is totally enclosed within the bed of the machine. There are no knuckle joints and all parts are readily accessible. The power feed is controlled by means of one lever at the front end of the body, the feed at all times being engaged, released or reversed by means of this lever. The position of the lever always indicates the direction of feed. If the lever is in an upright position, the feed is not engaged, while if it is inclined to the right, the table travel will be to the right, and if it is inclined to the left the table travel will be to the left. Six changes of table feed are provided, ranging from ⅞ inch per minute to 15 inches per minute. Quick return of the table is provided through a handwheel, giving two inches of table travel for each turn of the wheel.

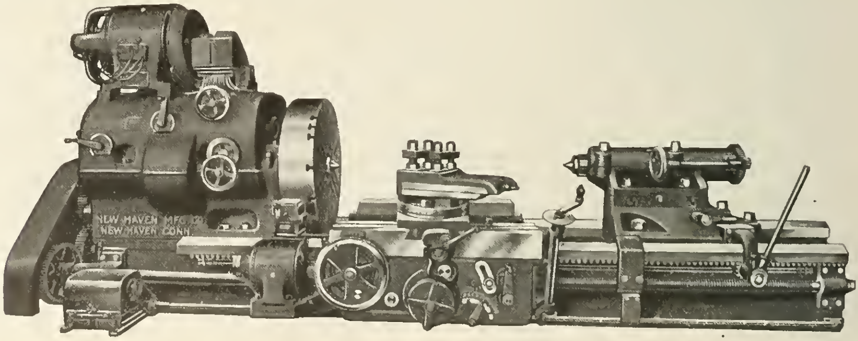
The massiveness and rigidity of this machine are especially noticeable in the construction of the saddle and table and in the wide bearing of the saddle upon the bed. These are all of such dimensions that a table considerably larger than the one regularly furnished can be placed on this machine without altering the saddle or bed or impairing the efficiency in any way. The table has three deep T-slots ⅝ inch in width, and is provided with ample means for returning the flow of lubricating compound. The base of the machine has a large oil pan fully protecting the floor from any dripping oil or other lubricant. To provide for the lubrication of cutters, the machine is regularly furnished with a geared oil pump running at a constant speed and driven by a Diamond roller chain. The regular equipment includes the necessary wrenches; a plain vise with jaws 7⅛ inches wide, 2 inches deep, and with a maximum capacity between the jaws of 4½ inches; and an arbor 1½ inch in diameter by 28½ inches in length from the shoulder to the nut.

NEW HAVEN FORTY-FOUR INCH LATHE

The 44-inch engine lathe shown in the accompanying illustration is a recent product of the New Haven Mfg. Co., New Haven, Conn. This machine is equipped with single pulley drive and an all-geared head. The headstock is designed to constitute a complete housing or cover for all of the gears, and it also collects all oil dripping from the bearings in the bottom of the pan; this oil may then be drawn off through a drip-cock. The headstock is 58 inches long on the bed and bolted to it with 1½ inch bolts. The spindle is made of hammered crucible steel and runs in bronze boxes equipped with sight-feed oilers. The front spindle bearing is 9 by 14 inches in size and the rear bearing 7 by 11 inches. The spindle speeds range from 0.88 to 62 revolutions per minute. Sixteen changes of spindle speeds are available with a constant speed motor.

The tailstock spindle is 7 inches in diameter by 36 inches long; it is arranged with a handwheel and gears, and has a traverse of 16 inches. Two spindle binders are provided, one at the end and one half way back on the tailstock barrel. It will be seen from the illustration that the tailstock is provided with a pawl engaging in the rack cast on the bed and a spring ratchet lever for moving the tailstock along the bed. The length of the tailstock base on the bed is 30 inches.

The carriage bearing on the ways is 48 inches long and the width of the carriage bridge 20 inches. The compound rest has power cross, lateral and angular feeds of 20 inches. Wipers are attached to the ends of the carriage to protect the ways. The apron is of the double wall type and is cast in one piece.

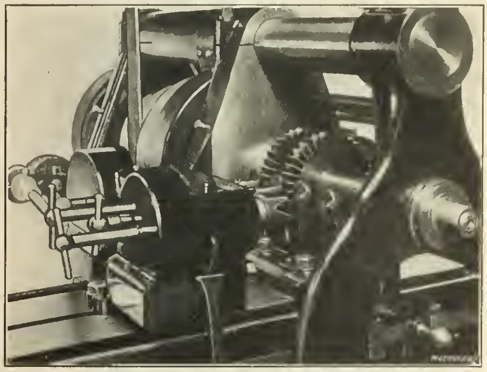


New Haven 44-inch Lathe with All-geared Head and Single Pulley Drive

All of the studs and shafts have bearings at both ends and are bronze bushed, and all of the gears in the apron are of steel. The rack pinion is made of forged steel and is 3-pitch with 3½ inch face. The reverse for all feeds is controlled from the front of the apron in a manner which makes it impossible for turning and screw cutting feeds to be engaged at the same time. If a quick traverse is required for the carriage, a small motor for this purpose can be mounted on a bracket at either end of the apron. The feeds for the carriage range from 0.010 inch to 1 inch per revolution, and the range of threads is from ½ to 16 per inch. The machine swings 46 inches over the bed and 30 inches over the carriage. With a 16-foot bed, the weight of the machine is 31,000 pounds.

BICKFORD TAP SQUARING FIXTURE FOR FLUTING MACHINE

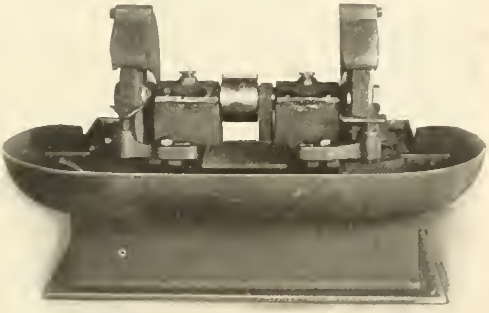
In the New Machinery and Tools department of the February, 1912, issue of MACHINERY, the No. 3A fluting machine made by the Bickford Machine Co., Greenfield, Mass., was illustrated and described. This machine will flute taps and reamers up to two inches in diameter. The illustration below shows the application of this machine for tap squaring between centers. A special tail fixture with off-set center disks to hold the shank ends of the taps is used for this purpose, and the other ends of the work are held by special driving dogs having sharp corners which project inward and grip the work. These dogs are tightened up by means of the T-handle screws shown at the left-hand side of the illustration. The illustration shows only two cutters and taps in position, the other two having been removed to show the tail fixture and the method of attaching the center disks. These disks are reversible on the fixture which is arranged to be attached to the table of the machine in two positions, so that whichever way the disk is placed, the center will be in line with the head spindle. This arrangement is for the purpose of using both sides of the squaring cutters.


Bickford No. 3A Fluting Machine equipped with Tap Squaring Fixture

A special advantage of squaring taps and similar work on centers, is found in the possibility of securing absolute uniformity of corners. Only one side of the work is squared at a time, and as four pieces are being operated upon simultaneously and the return of the table of the machine and indexing is effected automatically, the operation is economical as regards its production.

DOUBLE-WHEEL STERLING TOOL GRINDER

The illustration shows a double-wheel tool grinder which has been brought out by the Sterling Emery Wheel Mfg. Co., Tiffin, Ohio. This machine is fitted with two 10 by 1 inch grinding wheels and can be used as either a wet or dry grinder according to the class of work upon which it is engaged. The grinder is of simple construction having no pump or other complicated devices to cause trouble. A water device inside the frame of the machine keeps the wheels wet when the machine is in operation, and as soon as it stops this water drains off the wheels leaving them dry and in balance at all times. This arrangement is more simple than the usual form of pump and cannot get out of order, so that there is no cost of maintenance. By throwing off the small belt at the right-hand end of the driving pulley, this water device will be stopped and the machine can then be operated as a dry grinder.


Sterling Tool Grinder equipped with Two 10- by 1-inch Wheels

This machine was designed to meet the demand for a small tool grinder for universal grinding on such work as small drills and tools. The machine is also adapted for grinding operations involved in the manufacture of small mechanical devices, such as cash registers, sewing machines, typewriters, addressing machines and similar classes of work.

GARVIN BARREL AND FACE CAM CUTTING FIXTURES

It is frequently necessary to cut cams when the quantity is not large enough to warrant buying a cam-cutting machine. To meet the requirements of such classes of work, the Garvin Machine Co., Spring & Varick Sts., New York City, has designed the attachments shown in the accompanying illustrations, which will fit all standard knee type milling machines. These attachments have power feed and are made reversible.

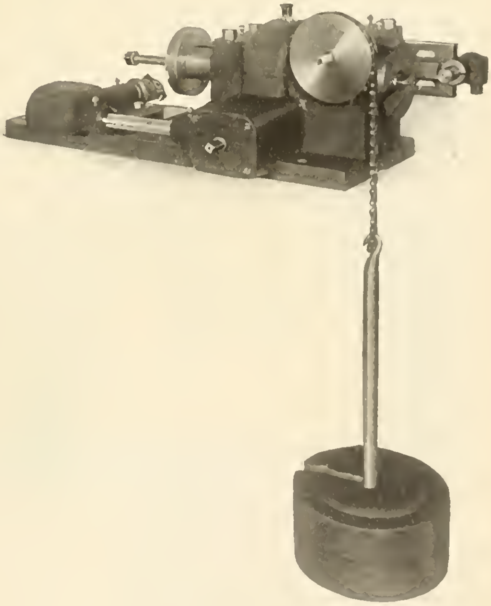


Fig. 1. Attachment for cutting Barrel Cams on a Milling Machine

The universal joint feed rods are brought to the attachment from either the front or rear side of the milling machine frame. Fig. 1 shows the attachment for cutting barrel cams and Fig. 2 the attachment for cutting face cams. Both attachments have a capacity for cams ranging from 1½ inch to 6 inches in size. The weight of the attachments is about 225 pounds.

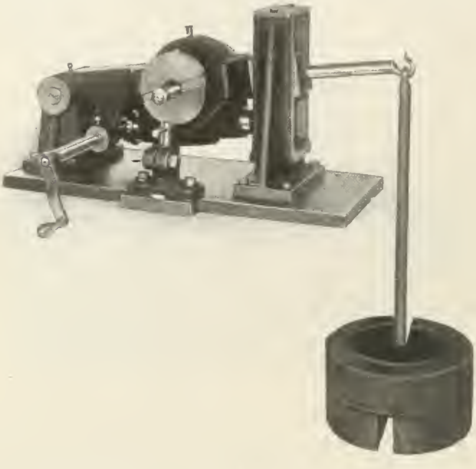
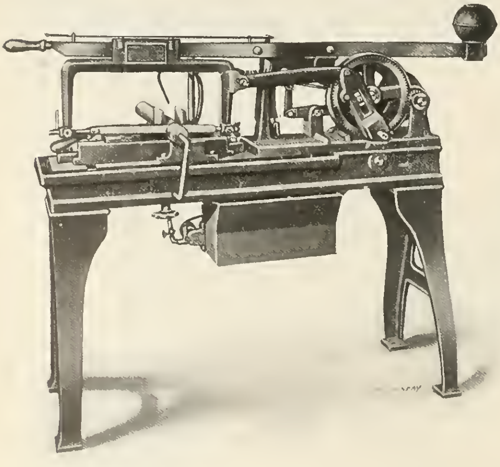


Fig. 2. Attachment for cutting Face Cams on a Milling Machine

WEST HAVEN UNIVERSAL HACKSAW MACHINE

The universal hacksaw machine here illustrated is a recent product of the West Haven Mfg. Co., New Haven, Conn. The special features of this machine may be briefly outlined as follows: The blade is lifted entirely free from the work during the return stroke and this quick return stroke is in the ratio of 3:1. The machine is arranged for two fixed strokes of five and seven inches. The mechanism which provides the automatic lift for the blade on the return stroke is provided with means for making adjustment for wear. All parts of the machine are made interchangeable, and, as a result, immediate shipment of any duplicate part can be obtained. Referring to the illustration, it will be seen that the machine is equipped with a pan and pump for lubricating the work and a movable vise, each jaw of which is adjustable, thus making it possible to cut angular as well as square work. The machine has a capacity for sawing work up to six inches in diameter or width and runs at a speed of 240 revolutions per minute. Twelve- or fourteen-inch saw blades are used. The machine occupies a floor space of 52 by 16 inches and has a net weight of 425 pounds.



West Haven Universal Hacksaw Machine

GLEASON TEMPERING MACHINE

The illustrations show a machine for tempering automobile bevel driving gears, which is the invention of Leon Slade and Alton Slade, and is manufactured by the Gleason Works, Rochester, N. Y. Although this machine was designed for tempering automobile bevel gears, it could also be used to advantage on a variety of work which has a tendency to warp when tempered in the usual way.

A general view of the machine is shown in Fig. 1. Briefly speaking, this machine may be said to consist of a plunger operated by compressed air. The gear to be tempered is placed on a lower die which is counterbalanced by a weight of one ton. A split bushing fits the bore of the gear, and when the plunger descends a pilot enters this bushing and expands it to keep the bore of the gear in shape. The face of the gear enters the upper die carried by the plunger and is held in shape by this means. The pilot automatically locates the gear to enter the die, and when the pressure in the air cylinder has reached the required figure, the ram forces the die and gear down into the oil reservoir and holds it there until the work has been thoroughly cooled.

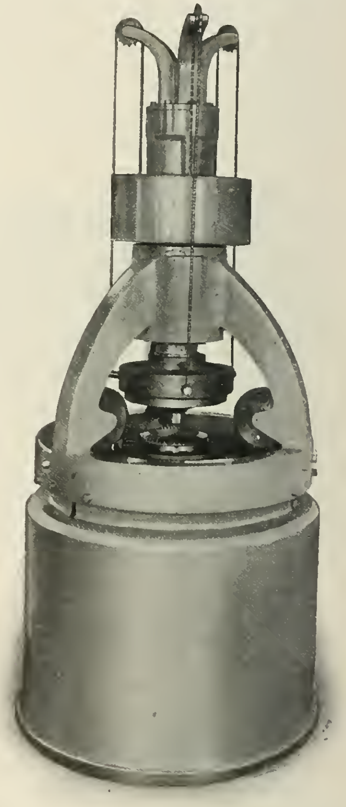


Fig. 1. Gleason Tempering Machine

Referring to the illustrations shown in Figs. 2 and 3, the operation of the machine may be outlined as follows: The work is placed in position on the lower die and when the pilot end of the plunger enters the split centering bushing it brings the bore into almost the required central position. A tapered sleeve or expander on the plunger then enters the tapered bore in the split centering bushing and spreads it sufficiently to fit the bore of the gear when it is expanded by heat, thus providing for having the work accurately centered. The application of further pressure causes the springs above the expander to be compressed, thus applying pressure to the bore of the gear to prevent it from going "out of round." As the ram descends the upper die comes down to bear on the face of the gear and on the web, and holds the work from warping out of shape. The pressure in the air cylinder then increases until it is able to lift the circular weight which counterbalances the lower die plate. The gear is then forced down into the oil and held there until it is cold. The air pressure applied on the plunger which carries the upper die is controlled by a hand operated valve of the type used on an air hoist.

Both the upper and lower die plates are cored out and provided with grooves in their surfaces to allow a free circulation of oil. The result is that the gear is cooled quickly on all sides and comes out uniformly hard and of the same degree of hardness that it would have if dipped in an open tank. The capacity of the machine ranges from 15 of the largest sized bevel driving gears to 30 of the smallest sized gears per hour. Of course, gears of heavy section take longer to harden than lighter ones of the same diameter, but the figures mentioned are a conservative estimate of the machine's capacity.

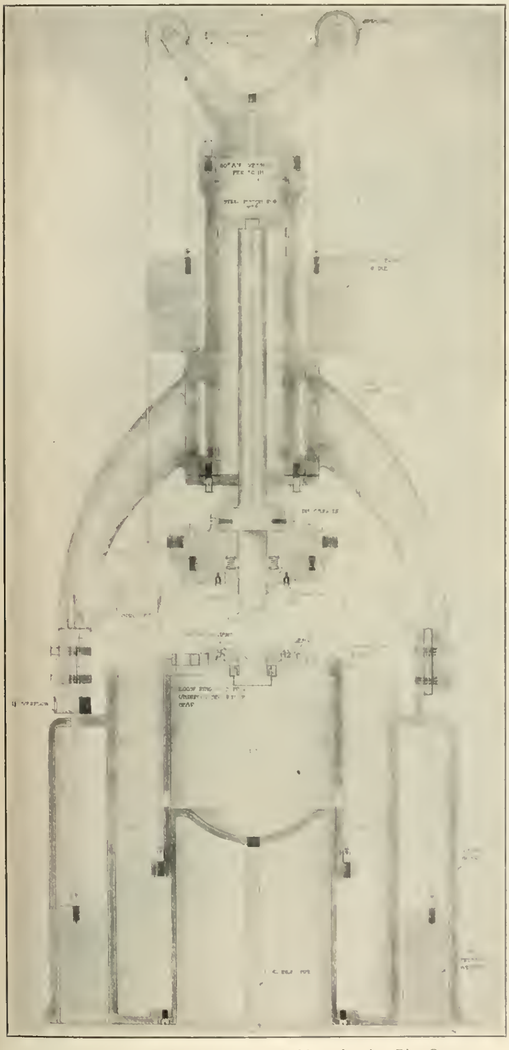


Fig. 2. Cross-Sectional View of Machine, showing Dies Open

Pipe connections are arranged to bring the oil into circulation from an outside reservoir or cooling system, and the use of a power house water heater fitted up as a radiator for cooling the oil is recommended. In the hardening room of the Gleason Works, fuel oil is circulated through the outer jacket of the radiator but water may be found more convenient for this purpose under average conditions.

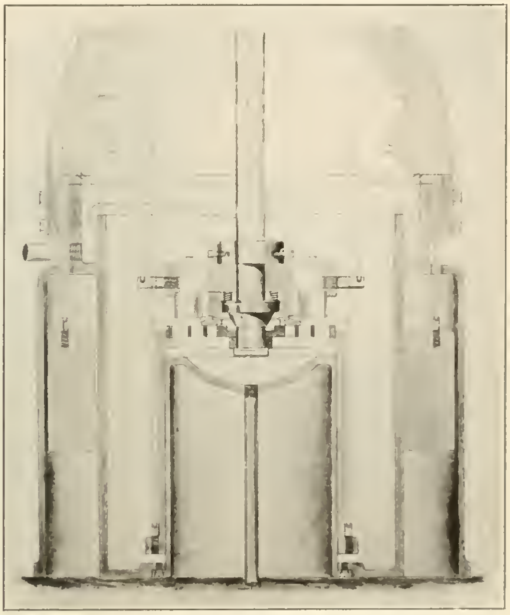


Fig. 3. Cross-Sectional View of Machine with Work Immersed in the Oil

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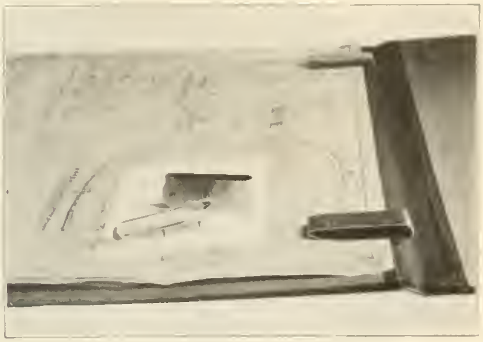
DUPLEX SPRING CLIP FOR TRACING FILES

The accompanying illustration shows a spring clip for tracing files, blueprint files and various kinds of loose-leaf devices, which has recently been put on the market by George G. Dana, 2311 Washington Ave., Racine, Wis. The double or duplex spring of this clip applies sufficient pressure on the contents of the file to prevent it from slipping out while the portfolio is being handled. It also prevents tracings from becoming curled or folded on the upper edge, rendering them worn or creased and hard to handle when making blueprints.


Duplex Spring Clip for Tracing Files

From a glance at the illustration it will be seen that the clip is so shaped that a tracing or blueprint may be easily slipped into its place or removed from the portfolio as desired. The spring holds the outer sheets from slipping about or curling up and any sheet may be removed when desired, without disturbing other sheets in the portfolio. These clips are made of polished steel and are attached to the back cover of the portfolio by clinched rivets.

BROWN & SHARPE PLAIN GRINDING MACHINES

A distinct departure from previous practice in the design of grinding machinery is illustrated in the accompanying views of two plain grinding machines which were recently built by the Brown & Sharpe Mfg. Co., of Providence, R. I. These machines are two of the largest in their line, the No. 12 taking work up to 8 inches in diameter by 36 inches long, and the No. 16 having a capacity up to 10 inches in diameter by 72 inches in length. These machines are intended primarily for manufacturing purposes and embody several new and important features in grinding machine construction, all of which increase the ease and economy of operation, resulting in greater production, without in any way impairing the accuracy of the product. The noticeable feature of these machines is the method of obtaining in the machine the speed changes for the wheel spindle and headstock, and also the feeds for the table, which, in common practice, are usually obtained by shifting belts on three sets of cone pulleys on three shafts in the overhead works. The construction has been considerably simplified in this design by eliminating one of the shafts and all of the cone pulleys, the speed and feed changes being made by gearing in the machine.

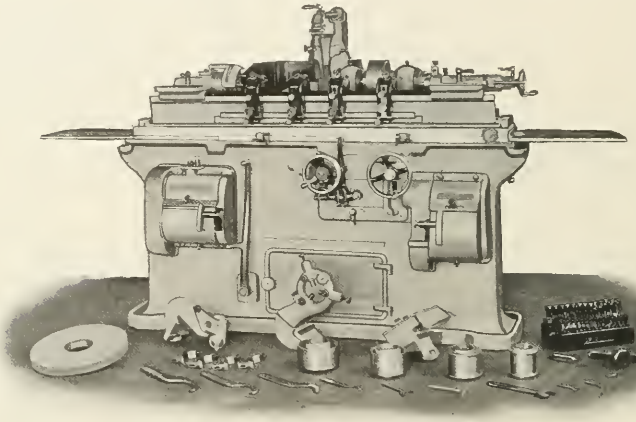


Fig. 1. No. 12 Plain Grinding Machine taking Work up to 8 inches in Diameter by 36 inches Long

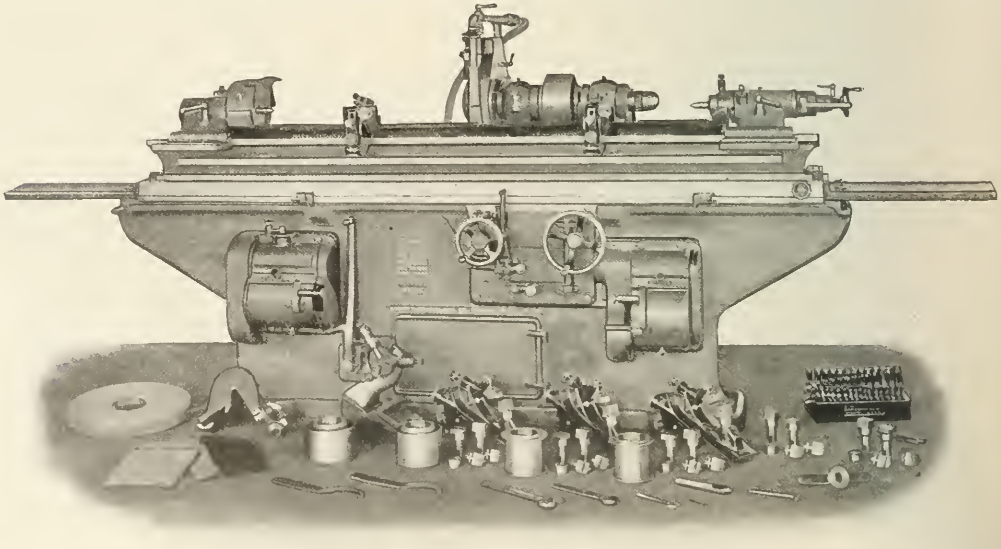


Fig. 2. No. 16 Plain Grinding Machine with a Capacity for Work up to 10 inches in Diameter by 72 inches Long

A simple countershaft is driven from the lineshaft at constant speed, carrying two tight pulleys, one of which drives the wheel spindle and the other the driving pulley *B*, shown in the horizontal section of the machine, Fig. 3. The pulley *K* transmits power to the quick change gear box *G* on the front of the bed at the left, where the changes of speed for rotating the work are made. Thence the power is carried to the pulley *C* through the shaft *D* on the rear of the machine to the pulley *E*, and from there to the overhead drum, which carries the belt for revolving the headstock. The pulley *F*, on the right-hand end of the driving shaft *A*, which receives power from the pulley *B*, is connected to the quick change gear box *H*, where the table feed changes are made. The gearing in this box is directly connected to the front plate *M*, which carries all the mechanism for the table feed and reverse, and also for the transverse feed of the wheel slide. This plate, with all the gearing attached, can be easily removed, giving ready access to the parts. The water pump is driven from the pulley *J* fastened to the driving pulley *B*. The lever *L* on the front of the machine operates a friction clutch within the driving pulley *B*, thereby disengaging the shaft from the pulleys *B* and *J*, thus enabling the operator with one motion to stop the table and work, without stopping the water pump.

The wheel spindle is driven directly from the countershaft, which runs at constant speed. A set of split pulleys of several diameters is provided for the self-aligning wheel spindle, the different speeds being obtained by changing the pulleys, which is accomplished without removing the belt, thus giving wheel speed changes directly on the machine. The slack of belt, due to changing of the pulleys and the different positions of the wheel slide, is automatically taken up and an even tension maintained by a spring actuated idler pulley on the countershaft.

The complete separation of the work speeds and table feeds enables the highest efficiency to be obtained at all times, as any combination of speed and feed in the entire range is instantly available, the variations being effected by gearing controlled by the simple adjustment of index slide and levers. The gear cases are located on the front of the machine and the gears are hardened. The case on the left gives the work speed changes in revolutions per minute, and the right-hand case gives table feed changes in inches per minute. Each case consists of a cone of gears, with a swinging idler arranged to mesh with a long pinion and any one of the gears in the cone with which it is firmly locked. The teeth on the idler and cone gears are of a special pointed form, so that they always drop into mesh when thrown in any position. To change the feed or speed, the locking pin of the lever on the side of the gear case is withdrawn and the lever moved down as far as possible; the index slide is next moved along until it is under the column on the index plate containing the required feed or speed. The large lever is then moved up as far as it will go, the locking pin drops into the correct hole and the proper gears are in mesh. Two series of speeds for the work are provided, one fast and one slow. These are regulated by the simple movement of the lever *N* on top of the left-hand gear case. A fast and slow table feed in the ratio of 3½:1 is instantly available in each setting for roughing and finishing work, the change being made by shifting the lever behind the table handwheel.

The table reversing mechanism is unusually rigid and accurate, and permits of work being ground close to a shoulder. The table handwheel is automatically disconnected and does not rotate when the power feed is in use. By pressing the knob in the center of this handwheel at any time during the table travel, the feed is stopped at the reversing point and the handwheel is engaged. This enables the operator to grind a shoulder on the work, by using the handwheel to adjust the table, then by pulling out the knob to again engage the automatic table feed and disconnect the handwheel. The arrangement for disengaging the transverse feed mechanism from the wheel slide by means of the small lever at the bottom of the front plate is an especially convenient feature, as it allows a quick movement of the slide by means of a handwheel for the purpose of lubrication, or adjustment when setting the wheel to the work. Provision is also made for locking the pawl in the transverse feed ratchet, so that when used with the stop-pin it insures a positive stop.

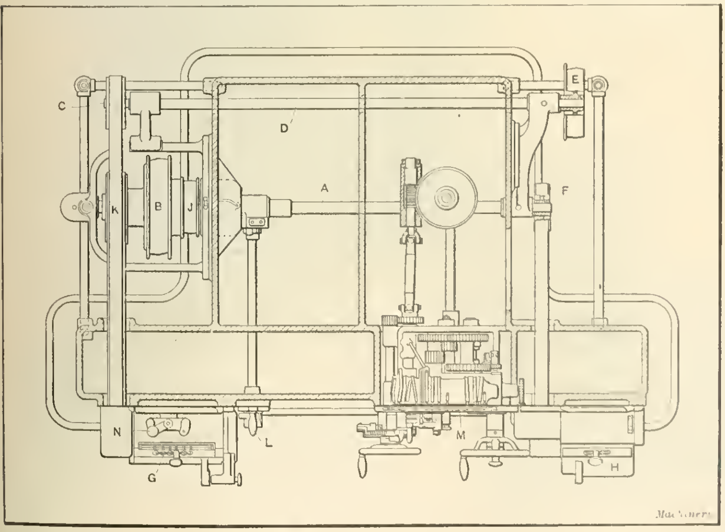


Fig. 3. Horizontal Section of Plain Grinding Machine

The beds of these machines are one-piece castings, constructed with rigid internal cross bracing and with no overhang of the ways on the smaller machine, all of which is conducive to stability, which is an important requirement in the production of accurate ground work. The base has a rim cast around it, which keeps all waste oil and water off the floor. The scale for setting the swiveling table to grind tapers is graduated in degrees, in per cent (metric) and in inches of taper per foot. Special attention is called to the concentration of control resulting from this new design. All levers and handles are within easy reach of the operator, without moving from his position.

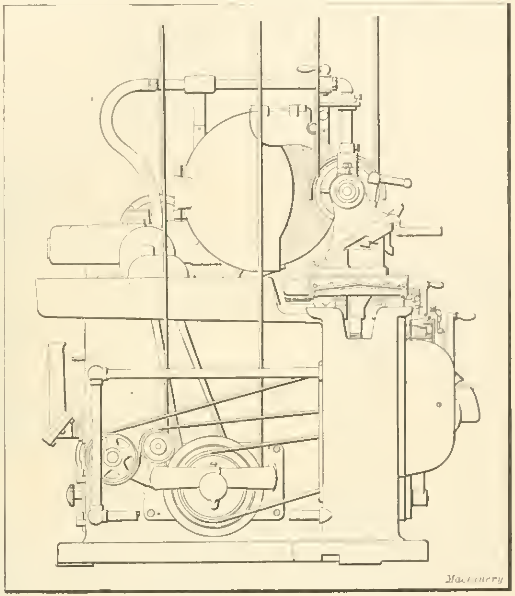


Fig. 4 End Elevation of Plain Grinding Machine

LANGELIER SHELL DRILLING MACHINE

The machine shown in Figs. 1 and 2 was recently designed by the Langelier Mfg. Co., Providence, R. I., for simultaneously drilling four holes 3/32 inch in diameter and 90 degrees apart through the walls of a brass shell. These shells are 0.410 inch in diameter by 2 1/16 inch in length, and the holes are drilled at a distance of ½ inch from the end of the shell. During the tests to which this machine was subjected before being shipped, a production of 15 shells per minute each drilled with four holes was obtained, which would mean an output of 9000 shells during a ten-hour day if this rate could be maintained.

The machine consists essentially of four spindles which work simultaneously; each of these spindles is located at 90 degrees from the adjacent spindle on each side. The drill spindle frames are carried by four arms of a cruciform casting, which also supports a trunnion shaft at the rear on which the four-segment edge-cam which actuates the spindle frames is mounted, together with the driving belt idler pulley brackets. The four spindles are fed to the work simultaneously by depressing the foot treadle at the right of the machine. This treadle imparts a quarter revolution to the edge-cam, which engages a roller on each drill spindle and, by so doing, draws in the four spindles simultaneously. The return of the spindles is effected by the tension of a spring located inside each drill frame. Each of the spindles is hardened and ground and provided with two splines for balancing it at high speed. A cast-iron belt guard is provided over each spindle pulley to prevent injury to the operator in case of the belt breaking. The lower vertical spindle is completely protected from chips or dirt by means of a metal hood which is clearly shown in Fig. 1. The spindles are relieved of the pull of the belt by having the spindle bushings in the drill frame bearings extend to a position midway of the width of the pulleys, so that only the width of the driving key is left uncovered by the bushings. The hub of each spindle driving pulley runs on the projections of the bushings, thereby relieving the spindles themselves of all belt tension. This construction is virtually equivalent to having each spindle of the floating type, insuring great sensitiveness of feed and return, and complete freedom of movement at all times, even when the belt is unusually tight. Each spindle is equipped with a No. 11 Skinner chuck for taking drills up to 7/32 inch in diameter if desired. A single endless leather belt, guided by suitably placed idlers, drives all four spindles of the machine. This belt is kept at the proper tension by adjusting the large idler pulley at the left of the machine and clamping it in place by means of a single cap-screw. This arrangement will be readily understood by referring to Fig. 1. A cork insert driving pulley is used to obtain the greatest possible transmission efficiency. The pulleys on the countershaft are designed to run at 575 revolutions per minute and this provides a speed of about 2700 revolutions per minute for the spindles. Special care has been given to the provision of ample lubricating facilities for efficiently oiling all of the bearings in the machine.

The work holding bushing is mounted at the front of the cruciform casting. This bushing is of hardened and ground steel and, in addition to holding the work while it is being drilled, it acts as a guide for each drill. The shell projects out of the bushing for a sufficient distance, so that it can be readily handled by the operator.

The principle on which this machine is built might readily be modified to adapt it for a variety of classes of service. For instance, instead of having only four spindles, a greater or smaller number might be spaced around the work to drill the required number of holes simultaneously. In case it was necessary to stagger the holes, some of the spindles could be set further in or out from the frame of the machine, thus permitting some holes to be drilled at a greater distance than others from the end of the piece. Instead of single spindles, the machine might also be provided with multiple drilling heads, of the type regularly made by this company, and a large number of holes could then be drilled with each spindle. The machine shown in the illustration stands 69 inches high and the work is at a height of 56 inches from the floor. The machine occupies a floor space of 24 inches wide by 28 inches long and weighs 570 pounds. It could, of course, be built in larger or smaller sizes to meet the requirements of different classes of work.

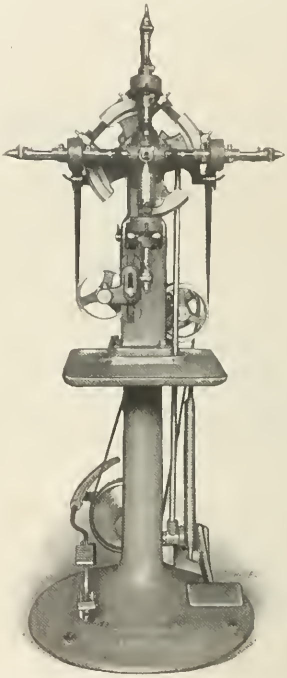


Fig. 1. Front View of Machine showing Spindles and Work Holder

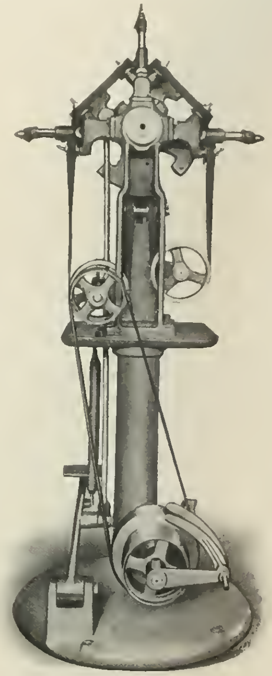


Fig. 2. Rear View of Machine showing Arrangement of the Drive

NEWTON COLD-SAWING MACHINE

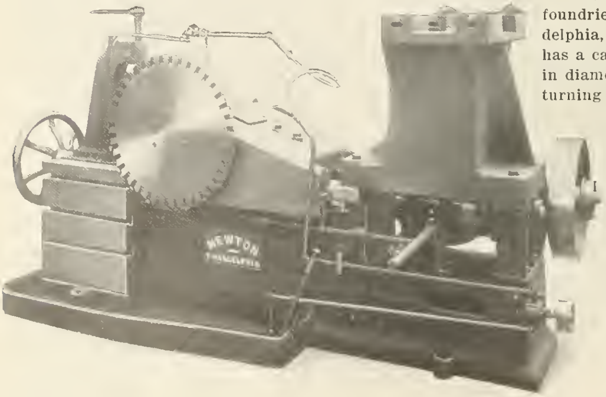


Fig. 1. Front View of Newton 26-inch Cold Saw

A 26-inch cold-sawing machine designed for use in steel foundries by the Newton Machine Tool Works, Inc., Philadelphia, Pa., is illustrated in Figs. 1 and 2. This machine has a capacity for cutting off gates or risers up to 8½ inches in diameter at a single cut, or larger sizes can be handled by turning the work. It is equipped with one of the Tabor Mfg. Co.'s new type of high-duty blades, 28 inches in diameter, which has a tempered steel body with hardened teeth and retaining wedges. This equipment enables the machine to take feeds of ⅞ inch to 1 inch per minute.

The design of this machine conforms with the standard Newton construction. The spindle is supported on both sides of the machine by cap-bushed bearings, and the driving spur gears are of high-grade hammered steel with the driving pinion teeth cut from the solid worm-wheel shaft. The driving worm-wheel is machined from a solid bronze casting and the driving worm is of hardened steel. The shaft supporting the driving worm has a bearing on each side of the worm and the thrust is taken on roller bearings. The saddle is equipped with lock bearings on the base with underlocking gibs cast solid, adjustment being provided by means of taper shoes. The work table has T-slots milled from the solid metal and the entire base, including the oil pan and work table, is one solid casting. The feed-screw is supported on both ends to insure having it operate under tension at all times and the control levers are conveniently located at the front of the machine. The friction feed has a range of from ½ inch to 2 inches per minute. The machine is ordinarily driven by a 10 H. P. motor mounted on the top of the high bracket, providing an ample distance between centers. The saddle has power quick return and by the use of a reversing motor or double throw of switch, fast power traverse is available in both directions.

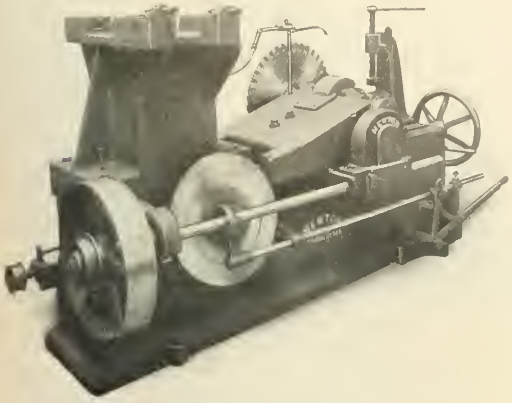
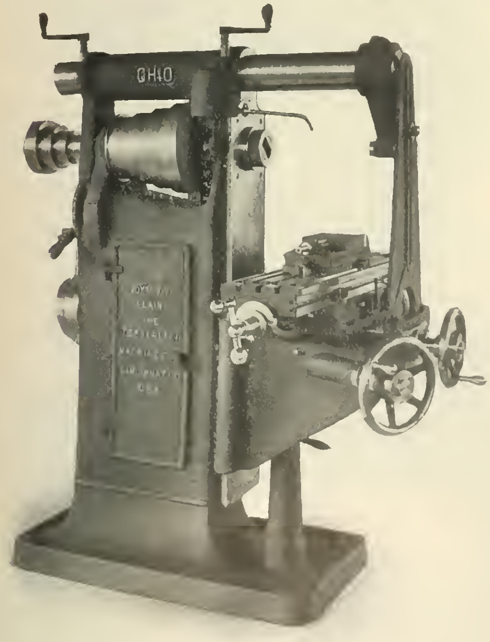


Fig. 2. Rear View of Machine showing Drive to Spindle and Feed

THE OESTERLEIN NO. 20 PLAIN MILLING MACHINE

The Oesterlein Machine Co., Cincinnati, Ohio, has just placed on the market a No. 20 plain milling machine which is identical with the No. 20 universal machine built by this company, except in the design of the saddle.



Oesterlein No. 20 Plain Milling Machine

These machines have an improved type of cone which provides a larger belt contact than that customarily found on machines of this size. The back-gear is placed inside the column of the machine below the spindle, so that it is completely enclosed. The column is provided with oil wells from which the spindle is lubricated. The knee is locked with a taper sliding gib; it is clamped along the entire face of the column, and operated by means of a single lever. The arbor is driven by means of a clutch at the front of the spindle, and the design of the spindle nose duplicates that on the larger sized machines built by this company, so that all tools and cutters are interchangeable.

MOTOR DRIVE FOR CINCINNATI GRINDER

The accompanying illustrations show a new style of motor drive which has been developed by the Cincinnati Grinder Co., Cincinnati, Ohio, for application on all sizes of its standard universal machines. Referring to the illustrations it will be seen that the motor is placed on the floor at the right-hand end of the machine and that the overhead works are supported by pedestals bolted to the floor. This arrangement enables a crane to be used for lifting work on or off the machine, and also provides the required clearance to enable a crane to pass over the machine.

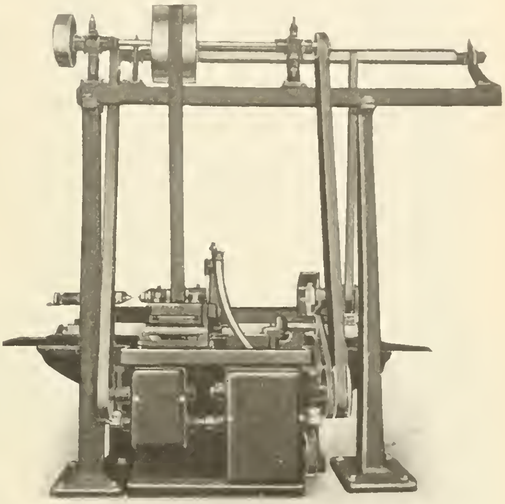


Fig. 1. Cincinnati Grinder showing Drives to and from Gear-boxes

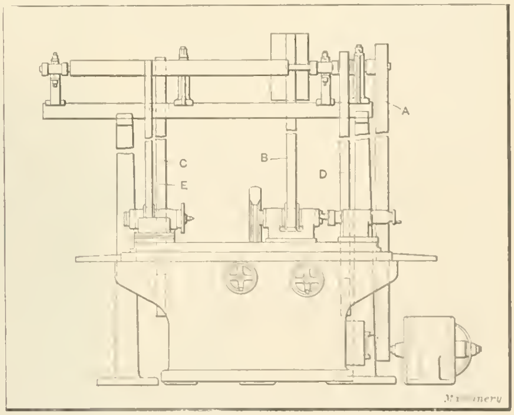
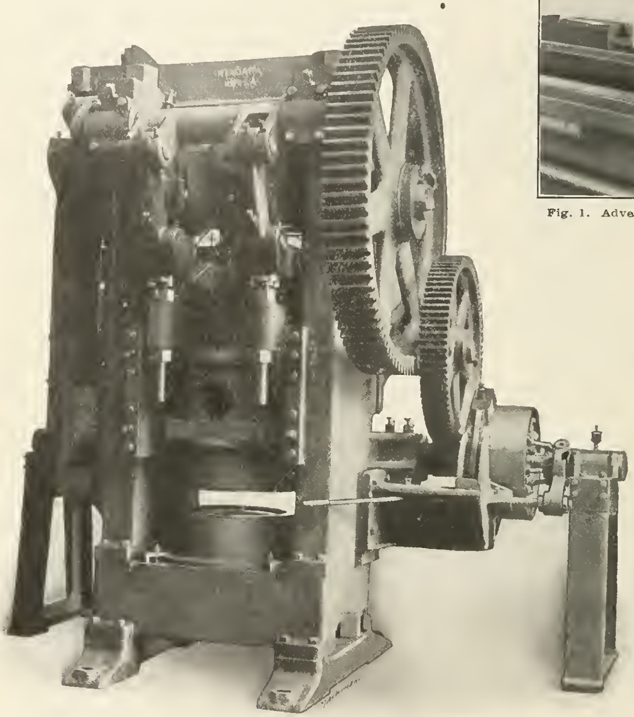


Fig. 2 Arrangement of Motor Drive for Cincinnati Grinder

Referring to the illustration Fig. 2, the single-speed double belt *A* transmits power from the motor to the driving pulley on the overhead works. The single belt *B* runs over a drum on the driving shaft and transmits power to the wheel spindle. The single belt *C* connects with the feed-box at the rear of the machine, as shown in Fig. 1, and the changes of feed obtained from this box are transmitted by a second belt running through to the front of the machine.

Direct connection is made between the feed- and speed-box as shown in Fig. 1, and the changes of speed at which the work is rotated are transmitted to the driving drum on the overhead works by means of the belt *D;* power is then taken down to the work spindle by the belt *E*. An advantage of the speed changes secured by the gearing on the machine lies in the fact that the travel of the table is entirely independent of the work speed, or speed of the wheel, so that the work may be traversed the full width of the wheel face at each revolution. This feature is of particular value when the machine is required to remove metal as rapidly as possible.



Niagara Double-action Drawing Press

NIAGARA DRAWING PRESS

The machine illustrated herewith is a double-action toggle drawing press which was recently built by the Niagara Machine & Tool Works, Buffalo, N. Y. This press is of particularly massive construction and is adapted for a large variety of heavy work of the kind met with in factories engaged in the manufacture of automobile parts, enameled iron ware, and other articles of a similar nature.

The frame of the machine is of the built-up type held together by four steel tie rods. The blank holder is operated by four powerful toggles which receive their rocking motion from a pitman and slide on the left-hand side of the machine. The two horizontal rocker shafts are made of steel and are timed to give the blank holder the required "dwell" during the drawing period. The plunger or inner slide receives its motion from a pitman from the main shaft. The press is equipped with a powerful friction clutch actuated by a hand lever which provides for stopping and starting the machine at any time during the stroke. This clutch is of the multiple disk type and has proved to be particularly suitable for use on presses of this class. The outboard bearings for the pulley shaft are provided with a double wedge adjustment to obtain perfect alignment when mounting the press on its foundation. The press has a capacity for blanks up to 30 inches in diameter and a maximum depth of 8½ inches. The stroke of the plunger is 18 inches and the weight of the machine about 41,000 pounds.

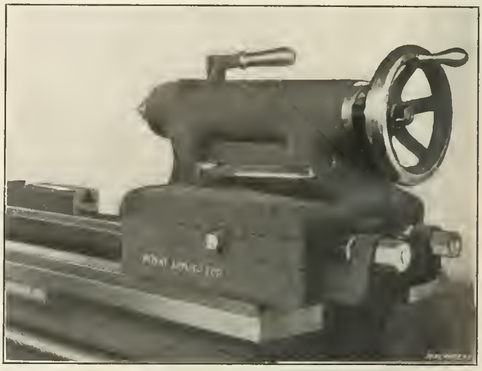


Fig. 1. Advance Tailstock with means of adjusting for Wear in Vees

ADVANCE ADJUSTABLE TAILSTOCK

In the patented tailstock made by the Advance Machine Tool Co., 591 Twenty-second St., Milwaukee, Wis., and shown in the accompanying illustrations, means have been provided for making vertical adjustment to compensate for wear in the tailstock vees. Referring to the illustrations, it will be seen that a taper wedge is placed beneath the tailstock, and that there are two studs inserted at the back of this wedge. Two lugs are cast to the end of the base, through which the studs move freely, and two nuts are provided on each stud, one nut being at each side of the lugs through which the studs pass. These nuts serve the double purpose of obtaining the desired adjustment of the tailstock by means of the wedge, and locking

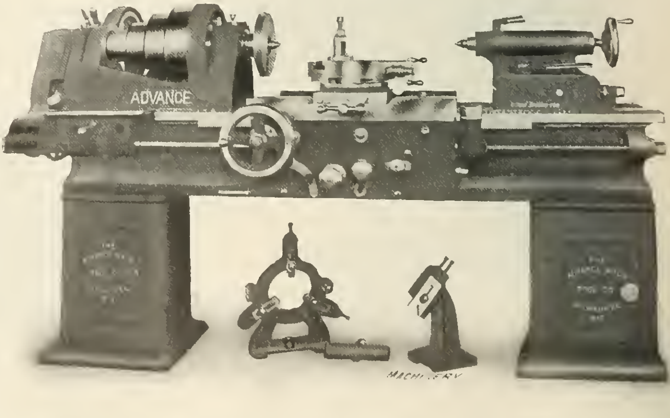
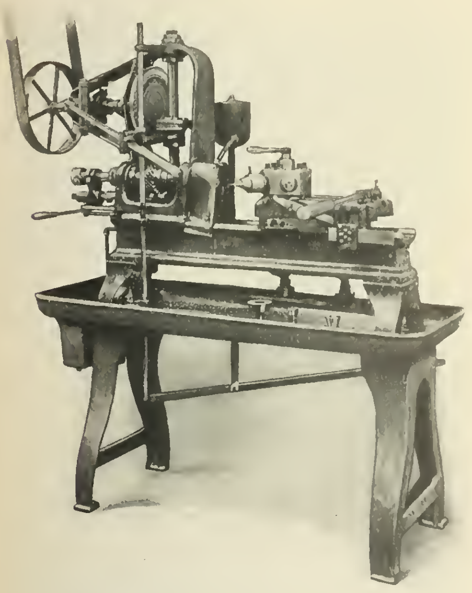


Fig. 2. Advance Lathe equipped with Adjustable Tailstock

the wedge in place when this adjustment has been obtained. A tongue and groove maintain alignment between the base and the wedge, and the rigidity of the tailstock is not impaired in any way through the provision of this means of adjustment. A vertical adjustment of ⅛ inch is available by this method, the taper wedge and base having a taper of ½ inch to the foot. A new style of single back-geared lathe of this company's manufacture is shown in Fig. 2 equipped with one of these tailstocks. The same type of lathe is also made with double back-gears.

WELLS FRICTION HEAD HAND SCREW MACHINE

A hand screw machine equipped with friction drive, which has recently been placed on the market by F. E. Wells & Son Co., Greenfield, Mass., is illustrated herewith. The arrangement of the friction drive on this machine will be readily understood by reference to the accompanying illustration, where it will be seen that the power from the single pulley is transmitted through the friction disks to a spiral gear on the spindle of the machine. The advantages which the manufacturers claim for this machine may be briefly outlined as follows: Quick changes may be made from one speed to another, and quick reverse for running off when the machine is engaged in tapping or threading operations. The friction drive makes it possible to get a greater variety of speeds and to make the changes more quickly than can be done by any other method. The machine is driven by either a plain countershaft or direct from an electric motor.



Wells Hand Screw Machine with Friction Head

NEW MACHINERY AND TOOLS NOTES

Flexible Coupling: Francke Co., New Brunswick, N. J. A flexible coupling which is similar in appearance to the regular flange type but with the flanges connected by flexible pins instead of rigid bolts. This arrangement enables the coupling to adjust itself for slight errors in shafting alignment.

Knee Drilling and Tapping Machines: Sloan & Chase Mfg. Co., Newark, N. J. Drilling and tapping machines in which the height of the table is regulated by the knees, leaving both of the operator's hands free to operate the machine and handle the work.

Set-Over Turret: Acme Machine Tool Co., Cincinnati, Ohio. A set-over turret designed for outside turning, facing, boring and recessing with a single point tool. The set-over movement is operated by a ball crank and screw which is provided with a micrometer dial.

Portable Steel Hoist: Lafayette Engineering Co., Lafayette, Ind. A portable hoist constructed of standard structural steel sections, which has a height of 8½ feet and an overhang of 3½ feet from the upright to the hook. This hoist is especially adapted for handling all kinds of work met with in a machine shop.

Shear Blade Grinder: Springfield Mfg. Co., Bridgeport, Conn. A shear blade grinder which has a capacity for work up to 130 inches long by 8 inches wide and 3 inches thick. The knife holder is supported by bearing brackets at intervals of 30 inches and is locked at each end. Positive locking stops are provided to facilitate resetting the holder.

Engine Lathe: Reed Hardware & Mfg. Co., Cairo, Ill. This company has improved its engine lathes, making the design heavier throughout. A set-over screw and feed pinion have been applied to the tailstock, and the tool block and compound rest have been improved to make them better suited for heavy classes of work.

Belt Driven Grinding and Polishing Machine: Excelsior Machine & Tool Co., East St. Louis, Ill. This company has recently added to its line three types of swing frame grinding and polishing machines and a surface grinding and polishing machine. Two of the swing frame machines are designed for motor drive, while the third is a belt-driven machine.

Vertical Air Compressor: Ingersoll Rand Co., New York City. A line of small vertical compressors provided with an automatic lubricating device, simple plate and ring valves, and enclosed dust-proof construction. The machines are built in several different sizes, one of which is adapted for portable service when mounted on a truck designed for this purpose.

Portable Air Compressor: Brunner Mfg. Co., Utica, N. Y. A portable air compressor designed for cleaning machinery and for other general classes of shop use. This compressor is driven by an electric motor which can be operated from any lamp socket. It has a sufficient capacity to enable it to operate for from 10 to 20 minutes from the storage supply.

Portable Shear: Danville Foundry & Machine Co., Danville, Pa. This company has recently modified the design of the "Little Giant" portable shear. It is operated by one horsepower motor and the speed can be regulated from forty to sixty strokes per minute. This shear has a capacity for round stock up to ¾ inch or plates 4 by ⅜ inch.

Motor Driven Lever Feed Disk Grinder: Chas. H. Besly & Co., Chicago, Ill. This company has recently made a number of improvements in its regular line of disk grinders. These include the addition of a geared feed table and electric motor drive, which makes the machine essentially a manufacturing tool adaptable for use in a great variety of metal- and wood-working industries.

Swing Grinder: W. D. Pratt Co., Canton, Ohio. This machine is suspended from the ceiling and the wheel swings on an arm so that it can be readily brought into position. The wheel is located at the side of the operator for safety. In addition to its use as a grinder, the machine can be fitted with a wire brush for cleaning castings and similar classes of work.

Ring Wheel Grinder: Springfield Mfg. Co., Bridgeport, Conn. A ring wheel grinder equipped with a pump and water shield to provide for wet grinding. The machine is driven by a belt on the grinder spindle and the table has a quick rack and pinion hand feed which is operated by a pilot wheel. The cross and vertical movements are operated by smaller handwheels.

Motor Drive for Engine Lathes: Nordberg Mfg. Co., Milwaukee, Wis. This company has recently developed two methods of mounting a motor on an engine lathe for single pulley and cone pulley drive. The motor is supported above the lathe headstock and although the distance between centers is necessarily short, an efficient means of adjusting the belt tension is provided which gives very satisfactory results.

Portable Boring, Drilling and Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine is driven by an Otis Elevator Co. 7½ horsepower motor running at from 300 to 1200 R. P. M., which gives spindle speeds varying from 8.1 to 150 R. P. M. and feeds of 0.0045 inch. 0.0094 inch and 0.0124 inch per spindle revolution. The machine is particularly adapted for drilling motor frames and other classes of work where it is desired to drill a number of holes at different levels.

Herringbone Gear Planer: Fawcus Machine Co., Pittsburg, Pa. This machine marks a wide departure from preceding equipments for machining herringbone gears. Two tools operate on two halves of each tooth at the same time and the cutting strokes are from the edges of the gear blank to the middle of the face. By this arrangement, the pressure of the tools is neutralized by the gear itself. Any practical helix angle can be cut and the profiles of the teeth are obtained from formers in the same manner as for spur gears.

* * *

When a man begins to be afraid that some other fellow is going to beat him out of his job, he confesses that he is too weak to hold it.

REVERSING MOTOR PLANER DRIVE

APPLICATION OF THE TRIUMPH-MONITOR REVERSING MOTOR DRIVE TO PLANERS

Planers have been driven by individual electric motors for several years, but the motor instead of being directly connected to the planer driving shaft, is generally connected to it by belts. Several electrical motor concerns have been experimenting and developing planer drives which could be directly connected to the planer and be capable of reversing automatically without excessive shock. The Triumph Electric Co., Cincinnati, Ohio, began a series of experiments several years ago with a view of developing special apparatus to meet the requirements of a self-contained motor drive. The controller was first designed to operate the motor used in driving the planer, and afterward special motors were built to suit both the controller and planer.

At present there are what might be called two distinct types of reversing motor planer drives, the difference between them consisting in the method used in reversing the motor. In the first type the motor is started automatically in the usual manner, stopped at the end of the stroke by dynamic braking and then reversed by applying reversed power, this cycle being repeated at the end of each stroke. In the second type, which is that used in the "Triumph" equipment, dynamic braking is dispensed with, and the planer is stopped and reversed by disconnecting the motor and immediately applying reversed power. The advantages claimed for this method are: Increased speed of reversal, greater uniformity in length of stroke and decreased wear on both motor and controller.

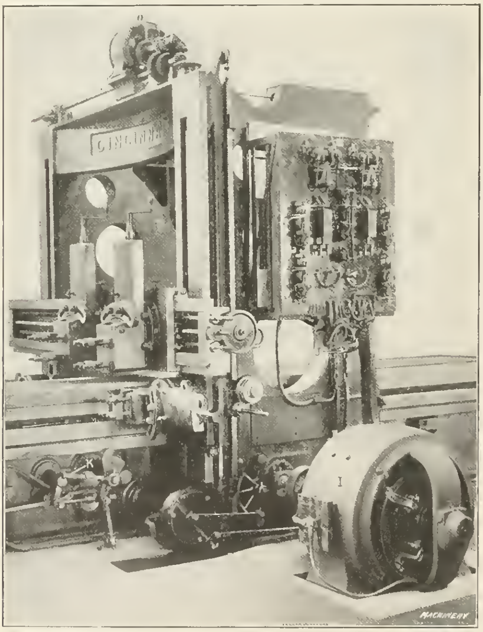


Fig. 1. "Triumph-Monitor" Reversing Motor Drive applied to a 76-inch Planer

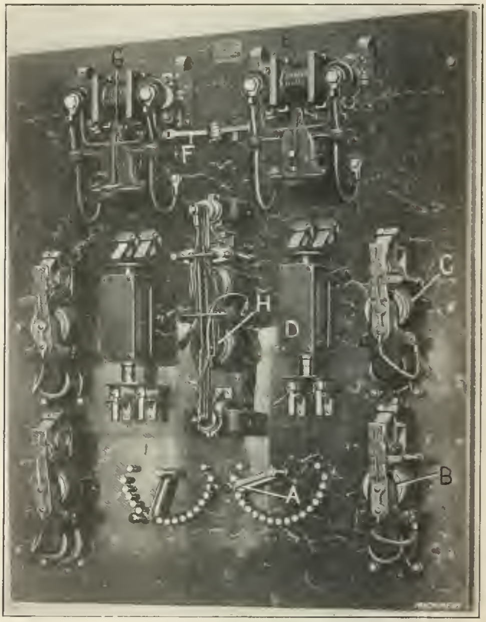


Fig. 2. The "Triumph-Monitor" Controller

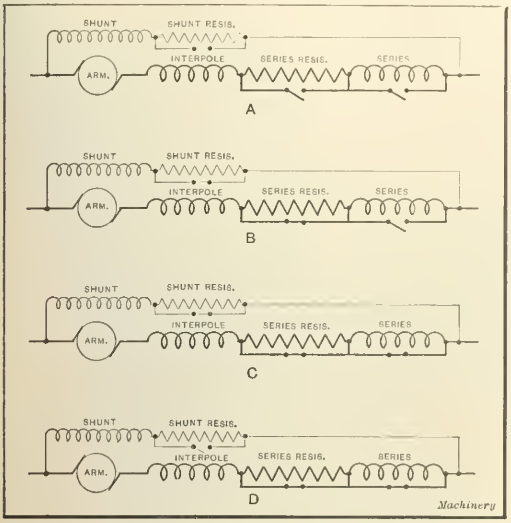
Operation of Monitor Controller

One of the chief points of interest in connection with this reversing motor planer drive is the controller which is shown in Fig. 2. This large panel carries the apparatus for automatically accelerating the motor to predetermined speed in the desired direction, and for starting and stopping it at every cycle. It also contains the rheostat handles which control the cutting and return speeds. The right-hand side of the panel carries all the apparatus for operating the planer on the return stroke, while the left-hand side carries the apparatus for controlling the motor for the cutting stroke. Referring to Fig. 2, *A* is the speed regulating rheostat for return stroke, *B* and *C* armature resistance short circuiting switches, *D* accelerating switch for return stroke and *E* switch supplying power to motor for return stroke. The mechanism on the left side performs the same functions for the cutting stroke. The lever *F* prevents the "returning" and "cutting" switches *E* and *G* from operating at the same time. The mechanism *H* in the center of the panel is the main circuit breaking switch.

The complete equipment is shown in Fig. 1 applied to a 76-inch Cincinnati planer. The main driving motor *I*, which in this case is a 30 H. P. compound interpole variable speed motor, drives the planer platen in either direction through the planer gear mechanism. The shaft, connected through gears with the bull wheel, is flexibly coupled direct to the motor armature. This insures that the power generated by the motor is transmitted to the driving mechanism of the planer with the least possible loss of power.

In operating the apparatus, the main line switch *J*, see Fig. 1, is closed; this connects the control panel with the line, but does not start the motor. To start the planer it is necessary to operate the master switch *K*, which replaces the regular tumbler handle used on the belt-driven machines. When this switch is turned toward the "start" position the motor starts. Then as the platen moves in either direction, the stops throw over the tumblers, and these through the table reversing switch *L* operate the switch on the control panel, stopping the rotation of the motor and immediately applying reversed power to rotate the motor in the opposite direction. The planer is stopped by turning the master switch in the "stop" direction. This master switch operates the motor so quickly that it is possible, by turning the switch to the "start" and immediately to the "stop" position, to transmit a movement to the table of ½ inch. The length of the stroke does not vary more than ⅛ inch on cuts of any length or at any speed. This feature is very desirable when planing in pockets and close to ledges.

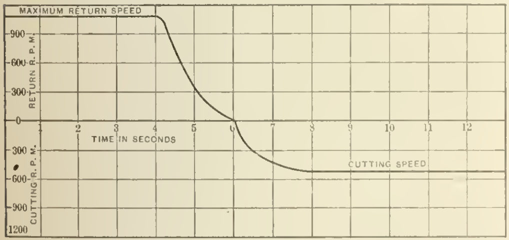
The sequence of controller operations when starting the motor is illustrated diagrammatically from *A* to *D* in Fig. 3. When the master switch handle is turned to the "start" position, power is thrown on the motor armature with resistance in series. The resistance is then short-circuited and the motor operates as a compound interpole machine with full field strength. Short-circuiting the series field converts the motor into a shunt interpole machine still retaining full shunt field strength. The shunt resistance short-circuiting switch is then opened, see *D* Fig. 3, which causes the motor to attain its predetermined speed. When the dog on the planer platen throws the tumbler, all switches return to their initial positions and power is immediately applied in the reversed direction. As the platen traverses back and forth this sequence of operations is repeated.



Machinery

Fig. 3. Sequence of Controller Operations on Starting Motor

The sequence of steps just outlined follows so rapidly that only one second elapses between the throwing of the tumbler, and the last switch operation for reversed rotation. At any point in the cycle a reversed movement of the master switch trips all the switches on the controller panel and the planer is stopped promptly. This service is difficult for the motor, but the motors have been so designed that sparkless commutation for the complete cycle results; in fact the commutator attains that blue-black polish which indicates entire absence of sparking and perfect commutation.



Machinery

Fig. 4. Curve of Motor Speed on Reversal with Dynamic Brake Equipment

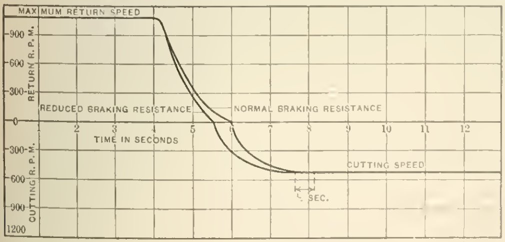


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Fig. 5. Curves of Motor Speed on Reversal, Dynamic Brake Type, showing Effect of Reduction of Braking Resistance

Efficiency of the Dynamic Brake as Compared with the Method of Applying Reversed Power

As previously mentioned two methods are in use for stopping and reversing the motor at the completion of the stroke, and what follows is a comparison of the efficiency of the two methods. The accompanying oscillograph curves illustrated in Figs. 4 to 9 inclusive, show wherein the method of applying reversed power to the motor through resistance for both braking and reversing shows a gain in time over the method of employing a dynamic brake for this purpose. The curve plotted in Fig. 4, is taken with the dynamic brake equipment, and shows the motor speed in R. P. M. when reversing from maximum return to moderate cutting speed. The curves plotted in Fig. 5 show the effect on the speed of reversal by decreasing the dynamic braking resistance which causes a gain in time of reversal of ½ second.

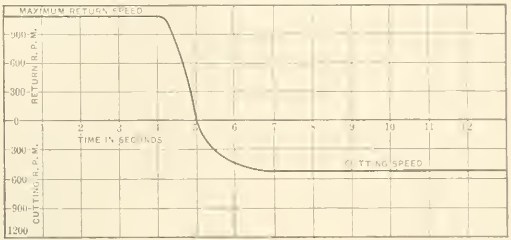

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Fig. 6. Curve of Motor Speed on Reversal, "Triumph-Monitor" Equipment

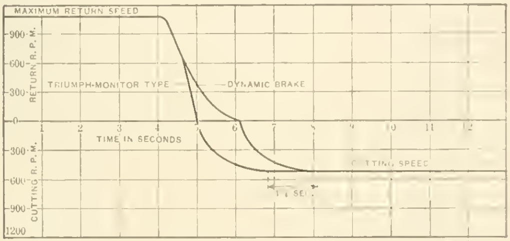

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Fig. 7. Comparison of Curves plotted in Figs. 4 and 6 showing Gain in Reversal over Dynamic Braking

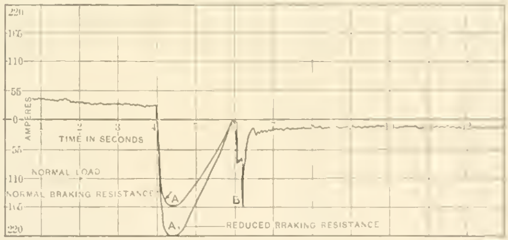

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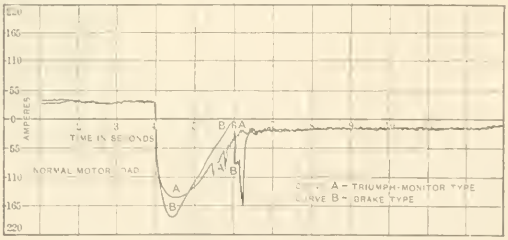
Fig. 8. Curves of Current Consumption on Reversal, showing Effect of Reduction of Braking Resistance



Machinery

Fig. 9. Curves showing Comparison of Current Consumption on Reversal with Dynamic Brake and "Triumph-Monitor" Equipment

In Fig. 6 is shown the curve obtained from the "Triumph-Monitor" equipment, and in Fig. 7 the curves plotted in Figs. 4 and 6 are arranged together for ease of comparison. As the time graduations are in seconds, the difference of 1¼ second on the time of reversal is easily observed. In Fig. 8 two curves are plotted to show the corresponding effect on current rush at the setting of the brake, with normal and reduced braking resistance. The peak *A* is raised from 165 to 200 amperes, which latter value is 100 per cent overload for the motor. The second shock *B*, also shown, is due to application of reversed power. The curves illustrated in Fig. 9 show the current required to operate the two types of reversing motors under the conditions indicated in Fig. 7. The two motors which were tested were of the same make, of the same size and rating, and operated under identical conditions.

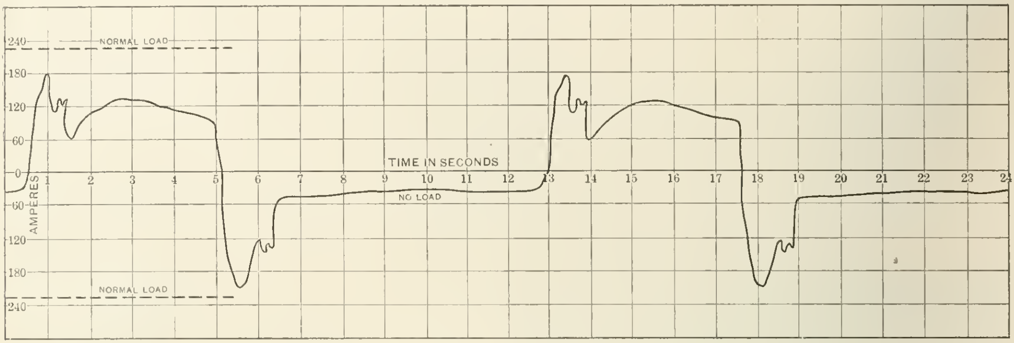


Fig. 10. Curve of Test made on a 30 H. P. "Triumph" Reversing Motor applied to a 46-inch by 30-foot Gray Planer running Light

Record of Tests

The Triumph Electric Co., has made many tests to determine the capacity and capabilities of the reversing type of motor drive and some of these will be given in the following. A test which shows some interesting facts was made on an 84-inch Pond planer with a "Triumph," 40-horsepower, 230-volt motor, operating from 250 to 1000 R. P. M. The controller was 40 H. P. capacity, 230 volts. The material cut was two 0.50 carbon steel billets. Two tools were used with a depth of cut of ¾ inch at ⅛ inch cross traverse feed, and at a cutting speed of 25 feet per minute. The following table gives the data obtained from power readings taken under the conditions specified and also with tools removed.

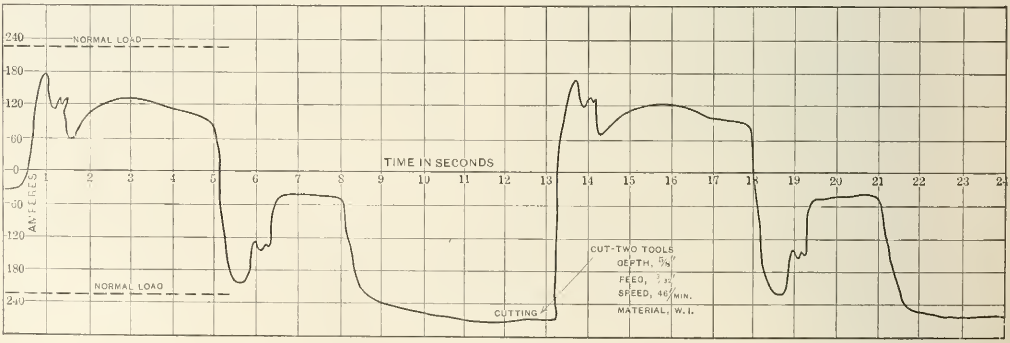


Fig. 11. Curve of Test made with Same Equipment as in Fig. 10 under Cut

	Volts	Amperes	Watts	H. P.
Total input on cut	220	150	33,000	44.3
Input, running idle (no cut)	220	16	3520	4.7
Apparent power for cutting	...	...	29,489	39.6
Motor load losses	...	...	1190	1.6
Net power for cutting	...	...	28,290	38.0

The material removed at this rate was 56.3 cubic inches per minute, or 16.3 pounds. The power required to remove a section of one square inch at 25 feet per minute cutting speed would be 203 H. P. The cut is approximately the maximum that should be taken with this equipment, an intermediate cast-iron gear having been broken shortly after the readings were taken.

Another cutting test, which was performed on a 46-inch by 30-foot Gray planer, is charted in Fig. 11. The motor in this case was a "Triumph" 30-horsepower, 115 volts, and operating from 275 to 1100 R. P. M. The controller was a 30-H. P., 115-volt "Monitor." The material cut was wrought iron; depth of cut, ⅝ inch; cross traverse feed, ⅜ inch; and cutting speed, 46 feet per minute. The chart given in Fig. 10 shows the same equipment with the load removed and gives some indication, when compared with the curve in Fig. 11, of the actual power required to take the cut with two tools in operation on separate bars at the same time.

Reversing Motor Drive Compared with Ordinary Belt Drives

There are several points of superiority claimed for the reversing motor drive over the ordinary belt drive, among which may be mentioned the following: Quantity and quality of finished product, flexibility, appearance, quietness, and cleanliness.

There is no doubt that this type of drive is capable of transmitting more power than the usual belt type, and will remove more metal in a given time, provided the planer is designed to stand the maximum cut. It is stated that the work shows a smoother, cleaner cut because of reduced vibration on the planer housings. The vibration is minimized by placing the motor on the floor instead of five or eight feet above the work. It is also claimed that the reversing motor drive gives a much more uniform length of stroke, and enables planing to a line ⅛ inch wide completely across the platen. Edging may also be accomplished in ½ inch strokes.

As to efficiency, it is claimed that on planers above 30 or 35 inches width the reversing motor drive shows a perceptible gain, while for planers below these sizes the efficiencies of the belt and reversing motor type of drive are about equal. Where the motor drive shows the greatest efficiency is on heavy work, and it is capable of taking tremendous cuts, the strength of the planer being the limiting factor. This type of drive is also being applied to vertical slotting machines with good results.

BRISTOL RECORDING DIFFERENTIAL PRESSURE GAGE

A line of recording differential pressure gages has been developed by the Bristol Co., Waterbury, Conn. Some of these recorders have been in service continuously since the preliminary models were first sent out in 1908, and the design and construction of the instruments that are now being placed on the market is based on results obtained in actual service during the last four years. These recording differential pressure gages are designed for use in connection with venturi meters, pitot tubes, orifices, combinations of orifices, etc., to record velocities and volumes of air, gas, steam, water and other liquids flowing through mains and pipes. These recorders may also be used to advantage for recording differences and variations of liquid level in steam boilers, pressure tanks, filter beds, process kettles, etc.

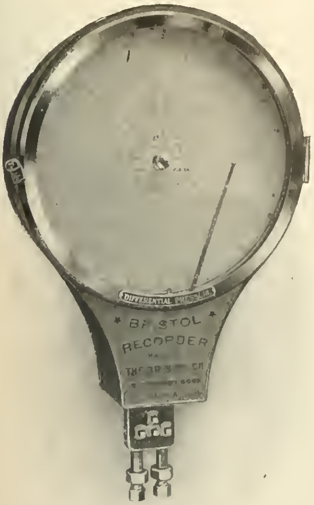


Fig. 1. Bristol Recording Differential Pressure Gage

Patents have been granted to W. H. Bristol, president of the Bristol Co., covering novel features resulting from his work in developing differential recorders. The fundamental principle employed in the construction of these differential pressure gages is that one pressure is applied to the inside of the operating tube, while the other is applied to the outside of the same pressure tube within a closed casing. In order to record the movement of the pressure tube, it becomes necessary to transmit its motion to the outside of the pressure tube casing. As the differential pressure to be recorded is usually small, as compared with the static pressure, the operative force is correspondingly small, and it is quite evident that it will be impractical to use a stuffing-box around a shaft passing through the pressure-casing on account of the friction which would be produced. To avoid the use of a stuffing-box, a unique frictionless sealing device is employed, as described in detail below.

Fig. 1 shows the exterior of one type of these recorders. Figs. 2 and 3 show part of the interior construction of the spring tube type of differential recorder. In Fig. 2, the pressure tube *A* is of the helical type which has been successfully used for many years in Bristol recording pressure and vacuum gages. One of the pressures, the difference of which is to be recorded, is applied to the interior of this tube through the pipe *B* and the other pressure is applied to the exterior of the tube through the pipe *C*. It will be noted that the pressure tube *A* is entirely enclosed in the pressure tight casing *D*, and that the movement of the pressure tube will be in proportion to the difference between these two pressures. This motion is transmitted to the recording pen arm *E* (outside of the pressure casing), by means of a small shaft *F* passing through the long tubular sleeve *G*. The capillary action of the oil or liquid between the sleeve and shaft makes this joint both frictionless and pressure tight.

In Fig. 3, *A* is the pressure tight casing enclosing the diaphragm pressure tube *B*, and in a similar way one pressure communicates with the interior and the other pressure with the exterior of this tube, and its motion is transmitted by means of the rotating shaft through the sleeve *C* to the recording pen arm *D*. The length of this sleeve is many times the diameter of the shaft passing through it, differentiating it from an ordinary bearing. This ingenious device permits re-

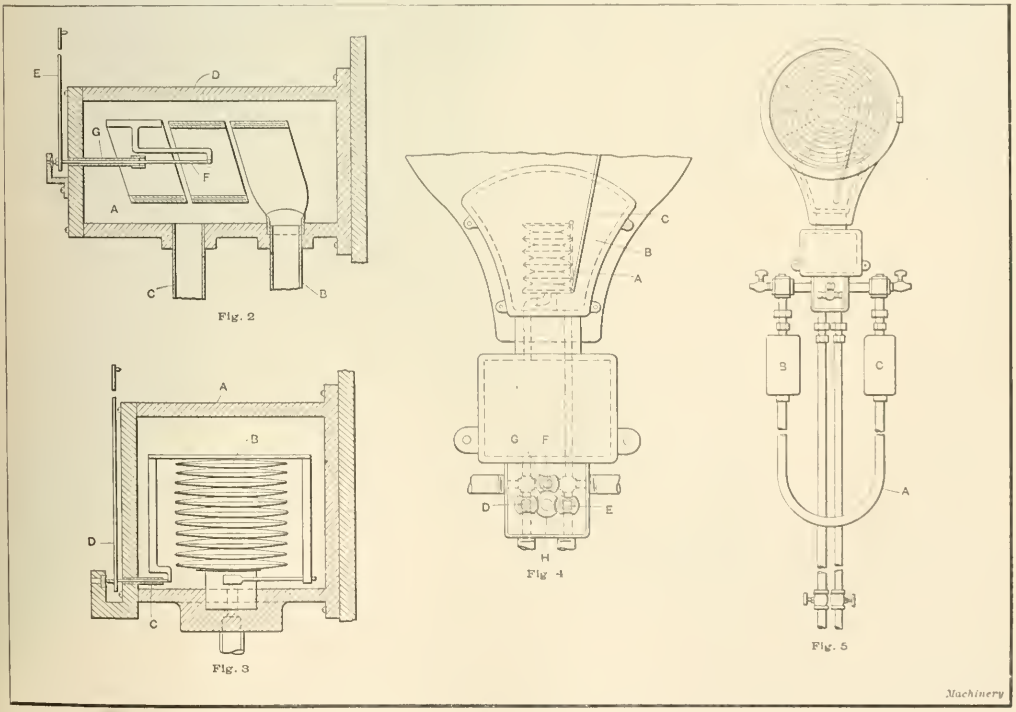


Fig. 2. Mechanism of the Helical Pressure Tube Type of Gage. Fig. 3. Mechanism of the Diaphragm Pressure Tube Type of Gage Fig 4 Diaphragm Pressure Tube Gage, showing Connections. Fig. 5. Safety Device for Differential Recording Pressure Gage

cording extremely small differences between the respective pressures existing inside and outside of the pressure tube. It has been found that the simple frictionless sealing sleeve through which the pen arm shaft passes does not produce appreciable resistance to the rotation of the shaft, and at the same time capillary attraction and adhesion prevent leakage of even high pressures from the pressure casing.

In Fig. 4, the diaphragm tube *A* is shown in the pressure chamber of the casing *B*, directly connected to one end of the rotating shaft which passes through the pressure sleeve, and has its other end directly connected to the recording pen arm *C*. This diagram also shows a set of interlocking valves *D*, *E* and *F*, which constitute a device for adapting recording differential pressure gages to practical operating conditions. The cross valve *G* is shown in an open position connecting the two pressure pipes. Valves *D* and *E* in the pressure pipes are shown closed. Both of these valves *D* and *E* can be opened, allowing the static pressure from either pipe to be applied simultaneously to the inside and the outside of the pressure tube of the actuating mechanism. The interlocking member *H* can then be turned through an angle of 90 degrees, thus making it possible to close valve *G* which completes the connections, so that the difference in pressures is recorded.

Fig. 5 shows a patented safety device consisting of a "U" shaped tube *A* partly filled with a suitable liquid, such as mercury or water. This tube has enlargements *B* and *C*, each having sufficient volume to accommodate the quantity of liquid contained in the "U" tube. The length of the tube varies with the range of the gage so that the greatest possible head of the liquid contained in the tube corresponds with the total range of differential pressure that the gage is designed to record. Should the full static pressure be admitted by accident to either side of the differential gage, the liquid contained in the safety "U" tube would instantly be forced up into one of the enlargements, thus allowing the static pressure to be applied simultaneously to both inside and outside of the pressure tube and protecting it from being destroyed.

* * *

The Isthmus of Panama was first crossed by Balboa in 1513, and as early as 1550 the question of digging a canal was first raised by the Portuguese Galvoa, who published a book to demonstrate that a canal could be dug at Nicaragua, Darien or Panama. The Spanish Government, however, which had been urged to undertake the work, was opposed to it. In 1843, the French Government advocated a canal, and the first complete surveys of both the Nicaragua and Panama routes were made in 1872 to 1875 by the United States Government. The French began the actual work on the canal in 1881 and discontinued in 1889 for lack of funds.

ANOTHER HEAVY LA FRANCE HYDRAULIC TRANSMISSION TRUCK HAUL

An illustration and brief description was published in the February number of MACHINERY of a 45-ton load, hauled by a La France hydraulic transmission truck (sold by the Hydraulic Truck Sales Co., New York City). The accompanying illustration shows another heavy load hauled March 18 in New York City, the load being part of heavy vaults made by the York Safe & Lock Co. for the bank clearing house. The frame for the door of the new vaults had to be moved through the streets. The frame was brought to New York on a lighter and delivered to Pier 11, East River. It was then loaded on a four-wheel wagon which itself, empty, weighs 16,400 pounds. The frame, which is 7 feet 6 inches wide, 9 feet long and 3 feet 6 inches thick, weighs 52,600 pounds. The La France hydraulic truck was loaded with five steel plates for the vault, which in the aggregate, weigh 12,100 pounds. The truck itself weighs 4½ tons, the total load to be moved thus being 90,100 pounds.

The shortest route to deliver the load to its destination would have been through Wall St., but permission to use Wall St. was denied because the street paving would not support the load. The truck had to proceed down Front St. to South Ferry and then up through Whitehall St. to Bowling Green and up Broadway to Cedar St. Two horses were hitched to the pole of the truck so as to control the pole and keep the trailer steered right.

La France Hydraulic Transmission Motor Truck hauling Bank Vault Parts. Total Weight hauled, 90,100 pounds

In order to show the remarkable tractive effort that can be produced by the hydraulic transmission gear, the truck was stopped with load on a 4½ per cent grade at Bowling Green and was started again with no difficulty. The draw-bar pull required to start the load and keep it moving up this hill was a little over 9000 pounds.

The speed at which the load was hauled was four miles an hour. It was estimated that at least twenty horses would have been required and that probably it would not have moved over 2½ miles an hour at the most. The probability is pointed out that the load moving at this rate damaged the street less than if it had been moving slower. The load was so heavy that after it had been delivered to the destination, the weight caused the wheels to cut deeply into the asphalt although when moving they had made little or no impression on it. The only damage done to the streets on the route was breaking a small manhole cover.

* * *

The man who tries to keep all his own trade knowledge to himself should remember that he has no right to the ideas of others, if he is too stingy with his own.

RESUSCITATION FROM ELECTRIC SHOCK

The following is a method of resuscitating victims of electric shock which has been developed by Dr. C. A. Lauffler, medical director of the Westinghouse Electric & Mfg. Co. The method may be sub-divided into four operations and one of its important features is that any man with common intelligence can apply it successfully. In addition to its application in cases of injury from electric shock, this method can also be successfully used in resuscitating victims of apparent drowning, persons who have been rendered unconscious from inhaling noxious gases, and similar accidents. The steps in the use of this method are as follows:

The Position of the Face.—The man is laid upon his stomach with his face turned to one side so that the mouth and nose do not touch the ground; his arms are then extended above his head. This causes the tongue to fall forward so that the entrance to the wind pipe is not blocked. It will be evident from the preceding that it is possible for one man to use this method in an attempt to save the life of a comrade if there is no other assistance at hand. In this connection it should be mentioned that it is of particular importance to start to revive a patient as soon as possible after the occurrence of the accident.

Position of the Operator.—The man who is working upon the patient either kneels straddling the patient's thighs or else kneels at either side of the thighs facing the patient's head. The patient's coat and shirt are then removed and the operator feels with both hands to locate the position of floating ribs. He then places one hand on either side of the patient's body so that the little fingers curl over the ends of the twelfth rib and the heel of the hand rests near the ends of the lowest ribs; the hands are placed at some distance from the spine so that a considerable leverage is obtained on the floating ribs.

Mode of Operation.—The operator's arms are held straight so that he applies his full weight from the shoulders by bringing his body and shoulders forward. This force is gradually increased until at the end of three seconds, the pressure upon the lower ribs of the patient is felt to be heavy enough to compress the lungs; the pressure is then suddenly removed, to allow the lungs to expand and draw in a fresh supply of air.

Rate of Respiration Per Minute.—The natural rate of breathing is twelve to fifteen times per minute, and the rate at which this artificial operation of respiration is conducted should not exceed this figure. It is important for the lungs to be thoroughly emptied and about three seconds of pressure is required to do this; the lungs will then be refilled in approximately two seconds. The pressure and release of pressure thus occupies a period of five seconds.

Many victims of electric shock and similar accidents have been saved by this method. The condition of such persons is apparently that of death at the time that the work of resuscitation is started, but where life can be saved there will usually be signs of returning animation in about twenty-five minutes. In any case, however, the operation should be continued for at least an hour and a half and indefinitely if there is any sign of recovery.

* * *

ENGLISH AS SHE IS SOMETIMES WRITTEN

A prominent machine tool builder recently received the following letter from a prospective customer:

"Dear Sir:—I'm glat to see your booklet—to day— Prmete me entroudonc to you my prpese. if you parmete me I tel you something. I net faar steam mill michine for my cantoroy—I want to now. Have you any steam mill michine and yous stone the hours cary of the michine you now why? My cantry never gos Fran and agan I forget I want the steam mill michine 5. hours phors. Plase answer me as soon as posebbel you can. Your varey troulay——"

The following is a "translation" of the letter above:

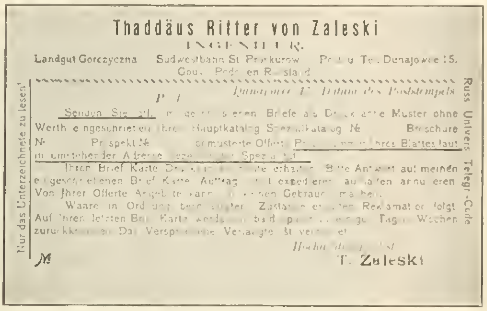
"Dear Sir:—I am glad to have received your booklet, to-day. Permit me to introduce to you my purpose. If you permit me I will tell you something. I need four flour mill machines, steam power driven, for my country. I want to know if you have any steam flour mill machines that use stones. Our people are afraid of machinery. Do you know why? Because my country never goes forward. Now, again, I forgot to say that I want the steam flour mill machines to be of five horsepower each. Please answer as soon as possible.

Yours very truly,"

LABOR-SAVING CORRESPONDENCE SCHEME!

The postcard shown in the accompanying illustration, lately received from Russia, is reproduced with the translation as an example of "efficiency" gone astray. Our German friend has ingeniously solved the problem of formulating requests, acknowledgments, etc., without writing; he simply underscores the words and sentences required to indicate his wishes.

We don't know how effective this ingenious system of correspondence is, but suggest that if correspondence is to be conducted with the sole idea of saving labor, it be abandoned altogether. Then he will save it all.



Thaddäus Ritter von Zaleski

INGENIEUR.

Landgut Gorczyczna Sudwestbahn St Proskurow

Nur das Unterzeichnete zu lesen!

Russ Univers Telegr-Code

T. Zaleski

Translation of post card from Thaddäus Ritter von Zaleski:

Read Only Portion Underlined

Dear sir:

Please send in sealed letter as printed matter marked sample without value your main catalogue special catalogue No. ... circular No. ... prospectus No. ... offer sample copy of your journal to the above address.

Your letter post card printed matter received today. Please reply to my letter post card. Immediately fill hold up cancel order. I can make no use of your offer proposition. Shipment received good damaged condition. I will send come back to letter in a few days weeks reply to your last letter post card. Promise has been kept request complied with.

Yours truly,

T. Zaleski

* * *

COOPERATIVE INSURANCE

One help in the solving of industrial problems is the creation of more friendly relations between employer and employe. The Foreman's Association of the Stetson Shoe Co., South Weymouth, Mass., has recently arranged to provide a five-hundred-dollar twenty-year endowment insurance policy for each of its twenty-five members through the insurance departments of the savings banks. The company has offered to pay one-half the cost of the premiums on these policies so long as the policy-holder remains in the employ of the company. Each year of service adds to the cash surrender value of the policy and at the end of twenty years, $500 will be paid each member of the association. This act not only protects the policy-holder and his family, but also creates a new incentive for continuing service which helps to hold valuable employes loyal to the company. In time, perhaps, this offer of cooperative life insurance will be extended to other employes. This plan probably will be adopted by others, who, in the interest of loyal service, wish to develop a business-like cooperation between employer and employe. Massachusetts Savings Bank Life Insurance, which through the cooperation of the state and the savings banks furnishes the best insurance at lowest cost, provides an unexcelled opportunity for business men to develop this cooperative insurance with their employes.

* * *

From being one of the most unhealthful and disagreeable jobs in factories the polishing of metals has been changed by the exhaust system to one of cleanliness and fairly agreeable working conditions. All grinding dust and debris is drawn away as fast as produced and discharged into the outer air, making the grinding room one of the best ventilated rooms.

LONG LINES OF MACHINE TOOLS ON

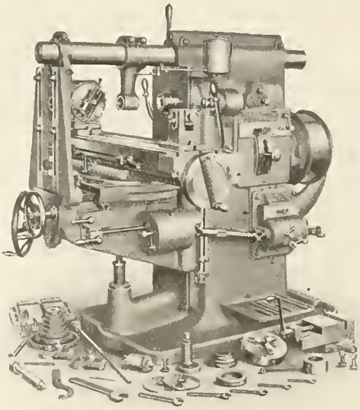
Pictures below give but a partial impression of the space devoted
1,020,900 square feet or about 23½ acres of floor space

PART OF ONE MILLING MACHINE ERECTING FLOOR

The No. 3-A Heavy Universal Milling Machine

a representative example of our extensive line of universal, plain and vertical spindle milling machines **for Heavy Service**, is shown below.

This machine is of the heavy Constant Speed Drive type that was originated at our works, and is well suited to heavy duty in Locomotive Shop Tool Rooms, or in other places where the services of a heavy universal machine are required. It has abundant power for all purposes. It is very rigid. Note the massive appearance of all parts and the stiff support for cutter arbor. Spindle speeds and table feeds are independent. Speed and feed changes are quickly and easily made. The machine can be belted directly to main line. All controlling levers and handwheels arranged for convenience of operator.



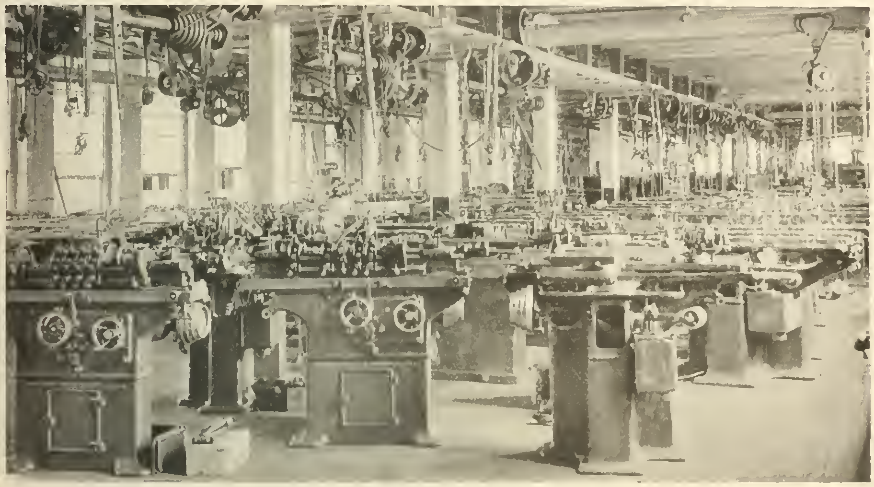
Capacity—Longitudinal feed, 30″; transverse feed, 10″; vertical feed 19″.

Write for special circular of this machine.

BROWN & SHARPE

ERECTING FLOORS IN B. & S. SHOPS

to the manufacture of machine tools. The B. & S. works contain
on a large part of which precision machine tools are built.



VIEW ON A GRINDING MACHINE ERECTING FLOOR

The No. 14 Plain Grinding Machine

shown below is one of our larger sizes, built for producing accurate work when operated under heavy cuts at fast speeds and coarse feeds. It is very rigid, and all alignments are accurately made. The wheel speeds and work feeds are independent. Universal Back Rests and the Automatic Cross Feed for wheel slide insure accurate work and enable more than one machine to be operated by one man on most work.

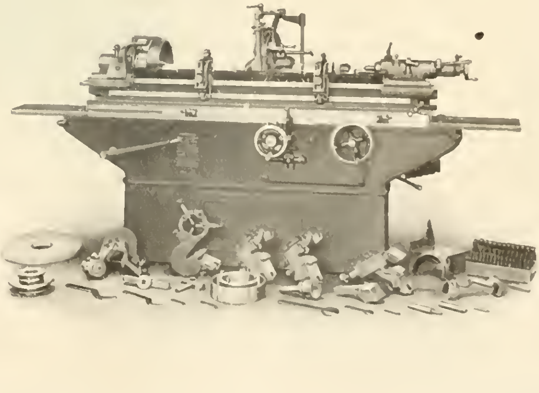
The machine takes 48″ in length and swings 10″ in diameter.

Do these points interest you?

Special circular on request.

We also manufacture Universal, Plain, Surface, Internal, Cutter and Tool Grinding Machines.

MFG. CO. Providence, R. I., U.S.A.



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PERSONALS

Edgar N. Easton has joined the railroad sales department of Joseph T. Ryerson & Son, Chicago, and will be located at New Haven, Conn.

Frank Burgess of the Boston Gear Works, Norfolk Downs, Mass., started March 8 for Jacksonville, Fla., to spend a four-weeks' vacation.

C. F. White, formerly tool designer for the Hersey Mfg. Co., South Boston, Mass., manufacturers of water meters, is now employed by the Standard Meter Co., of Brooklyn, N. Y.

F. O. Wells, president of the Wells Bros. Co., Greenfield, Mass., sailed for Europe March 8 for a two months' business and pleasure trip. The European business of the company is growing rapidly.

John H. Craigie, formerly associated with the mechanical department of the Boston & Maine R. R., has joined the railroad sales department of Joseph T. Ryerson & Son, Chicago, his headquarters being in Boston, Mass.

John Swinscoe, formerly chief engineer of the Driggs-Seabury Ordnance Corporation, Sharon, Pa., manufacturing the Vulcan truck, automobile and truck parts, pressed steel, etc., has entered the employ of the Weston-Mott Co., of Flint, Mich.

George M. Basford, assistant to the president of the American Locomotive Co., New York City, has resigned to become chief engineer of the railroad department of Joseph T. Ryerson & Son, Chicago. Mr. Basford's headquarters will be 30 Church St., New York City.

E. S. Carman, who has given several years to the design and development of various types of molding machines, has entered the employ of the Osborn Mfg. Co., Cleveland, Ohio, as chief engineer in charge of design and construction in the company's molding machine department.

George Bradshaw, general safety agent of the New York Central Lines, has resigned in order to devote his energies to speaking and writing on matters pertaining to safety, and to act in an advisory capacity as a safety engineer. Mr. Bradshaw's home address is Highland, N. Y.

* * *

COMING EVENTS

April 8.—Railroad meeting of the American Society of Mechanical Engineers at 8 P. M., to be held in the Engineering Societies Building, 29 West 39th St., New York City. The main subject for discussion will be "Steel Passenger Car Design."

April 10-12.—Triple joint convention of the National Supply & Machinery Dealers' Association, the Southern Supply & Machinery Dealers' Association and the American Supply & Machinery Manufacturers' Association at Indianapolis, Ind. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York City.

May 15-16.—Semi-annual meeting of the National Machine Tool Builders' Association at the Hotel Astor, New York City. James H. Herron, secretary, 2041 East Third St., Cleveland, Ohio.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers' Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

May 26-29.—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York City.

June 10.—Departure from New York City, of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

September 17-23.—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, Mr. J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

October 14-16.—Annual convention of the Allied Foundrymen's Associations. Hotel La Salle, headquarters, Richard Moldenke, Watchung, N. J., secretary.

SOCIETIES, SCHOOLS AND COLLEGES

Armour Institute of Technology, Chicago, Ill. Catalogue for 1912-1913.

Massachusetts Institute of Technology, Boston, Mass. Bulletin containing reports of the president and treasurer.

American Museum of Safety, 29 West 39th St., New York City. Year book and bulletin describing the general activities of the museum and the annual meeting and award of medals which took place on January 23. The museum is carrying on a vigorous work for accident prevention, hygiene and mutuality.

American Museum of Safety, 29 West 39th St., New York City. Stories Nos. 1 and 2, entitled "Hans Bright Eyes," "Fleet of Foot" and "Never Touched Me," respectively. These booklets are issued for the purpose of instructing children in the dangers of city streets and how to avoid them. They are particularly suitable for use in schools, especially those of large cities where street traffic is greatly congested.

American Society of Engineer Draftsmen, Walter M. Smyth secretary, 74 Cortlandt St., New York City, has removed its office from 116 Nassau St. to the foregoing address. The program of the regular monthly meeting, March 20, included a paper by Mr. E. S. Houghton, "The Engineer Draftsman's Part on the Erie Barge Canal," and a lecture, "The Application of Descriptive Geometry to Mechanical Drawing," by Mr. Frank Dempster Sherman.

Thaddeus Stevens Industrial School of Pennsylvania, Lancaster, Pa., will hold its first commencement exercises on Friday, March 28. A class of twenty-three students will be graduated, six of whom have taken a course in bricklaying, six in carpentry, five in machine shop practice and six in patternmaking. The instruction of this institution has been arranged to give a thorough knowledge of the theory and practice of each trade, together with instructions in the making and reading of drawings pertaining to the work, particular emphasis being placed on the practical part of the work. The trade courses in this school cover a period of three years.

NEW BOOKS AND PAMPHLETS

Costs of Producing Power in Iowa with Iowa Coals. By H. W. Wagner. 35 pages, 6 by 9 inches. Published by Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 29.

Data for Use in Designing Culverts and Short-Span Bridges. By Charles H. Moorefield. 39 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Washington, D. C., as Bulletin No. 45.

Characteristics and Limitations of the Series Transformer. By A. R. Anderson and H. R. Woodrow. 47 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 61.

Report on Incendiarism in Greater New York. By Joseph Johnson, fire commissioner, New York City. 158 pages, 6¾ by 10 inches.

This report, submitted to Mayor Gaynor, contains startling revelations of the extent to which arson has been carried by organized "fire-bugs." The importance of fire losses and insurance makes this report of national interest to property owners.

The Story of Panama. By Frank A. Gause and Charles Carl Carr. 290 pages, 5½ by 8 inches. Illustrated. Published by Silver, Burdett & Co., New York City. Price $1.50.

The near completion of the Panama Canal and the changes likely to be made in the world's commerce by its opening, make the subject of great interest to merchants, mariners, manufacturers, engineers, and, in fact, everyone in the world of trade. This work gives a brief history of the project and a description of the country and many illustrations, showing the canal and conditions of life in the Canal Zone.

Steam Turbines, Their Theory and Construction. By H. Wilda, translated from the German by Charles Sauter. 191 pages, 4½ by 7 inches. Illustrated. Published by Scott, Greenwood & Son, London, England, and D. Van Nostrand Co., New York City. Price $1.25 net.

This book, in condensed form, treats of the principles of steam turbines, the properties of steam, flow of steam, classification of steam turbines according to the arrangement of vanes, flow of steam through the steam turbine, details of steam turbines, general arrangement of various turbines in practice, condensers, utilization of exhaust steam, and practical application of steam turbines.

Essentials of Electricity. By W. H. Timbie. 271 pages, 4¾ by 7 inches. 224 illustrations. Published by John Wiley & Sons, New York City. Price $1.50.

This book is one of the Wiley Technical Series for vocational and industrial schools. The author, who is head of the department of applied science in Wentworth Institute, Boston, Mass., developed the text from notes used in a short trade course for students. It was developed with the idea that a good textbook in any applied subject is one that contains all of the more important facts and principles required by the users. The contents by chapter heads are: "Ohm's Law," "Simple Electric Circuits," "Combinations of Series and Parallel Systems," "Electric Power," "Wire and Wiring Systems," "Generators and Motors," "Locating and Correcting Trouble," "Batteries," "Wiring Diagrams."

Worm Gearing. By Hugh Kerr Thomas. 86 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York City. Price $1.50.

The applications of worm gearing are many, but its use for automobile drive has brought the subject into great prominence during the past few years. This book, which deals exhaustively with the subject, giving an analysis of the principles of worm gearing, should, therefore, be of general value and interest to machine designers and especially those connected with automobile manufacturing plants. The contents by chapter heads are: "Choice of Materials and Methods of Manufacture," "Definitions and Symbols," "Preliminary Proportions," "Pressure Angle and Form of Thread," "Strength of Worm-wheel Teeth," "Stresses in Worm Gearing," "The Width of the Worm-wheel," "The Temperature Coefficient," "Efficiency of Worm Gearing," "General Points of Design of Mounting," "Recapitulation of Formulas Used."

Engineers' Handbook on Patents. By William Macomber. 288 pages, bound in flexible leather, 4½ by 6¾ inches. Published by Little, Brown & Co., Boston, Mass. Price $2.50 net.

The author states in his introduction that the typical American inventor at one time was a clever Yankee who could sit and whittle and whistle, but asserts that the day of the clever Yankee has passed and that the important inventions of the future will be made by men trained in engineering principles. The successful inventor will also be one who understands patent law in its general aspect and who can therefore present his claims intelligently drawn—claims that cover what he wishes to cover and which omit nothing vital to the success of his invention. The contents comprise the general definition of a patent, the nature of invention, what is patentable, patentable novelties, the obtaining of patents, claim construction, infringement, patent litigation, property rights, etc. The book is well printed with large type and is illustrated. Inventors, engineers and others will find the book of interest and value if in any way concerned with invention and the protection of inventions.

Cost Reports for Executives. By Benjamin A. Franklin. 149 pages, 5½ by 8½ inches. Published by the Engineering Magazine Co., New York City. Price $5.

The author discusses the philosophy of costs and the importance of systems which truly record all the items of manufacturing cost. The work is not, however, one that professes to show executives how to construct a cost system, but one that shows him what a cost system should include. The book illustrates with actual forms filled with figures, the points that the writer wishes to make clear. The contents comprise "The Philosophy of Costs," "The Place of the Trial Balance in the Cost System," "The Cost of the Salable Article," "The Economic Consideration of Material by Costs," "Labor from the Cost Viewpoint," "The Vexing Question of Expense," "Statistics as an Aid," "Cost-System—the Basic Improvements." The book is one that should appeal to managerial officers generally, as the author has approached the subject from a new point of view. He seeks to interpret cost totals and to separate those totals into their significant parts. In other words it is the cost system for the executive—not for the cost clerk.

Gas Power. By C. F. Hirshfeld and T. C. Ulbricht. 209 pages, 4¼ by 7½ inches. 60 illustrations. Published by John Wiley & Sons, New York City. Price $1.25 net.

This textbook is intended to give the student such knowledge of the methods and facts of gas power engineering as will enable him to understand its present commercial status. The treatment is as simple and non-mathematical as possible, considering the nature of the subject. The contents by chapter heads are: "The Heat Engine Problem;" "Fuels," "Comparison of the External and Internal Combustion Principles," "Historical Development," "Four- and Two-Stroke Operations," "Methods of Cooling," "Governing and Governors," "Ignition Systems," "Carbureting and Carbureters," "Gas Producers," "Classification and Types of Modern Engines," "Modern Types of Gas and Gasoline Engines," "Modern Types of Oil Engines," "Gas Engine Auxiliaries," "American Practice in the Rating of Internal-Combustion Engines," "Methods of Testing," "Performance of American Engines," "Practical Operations." Comparatively little space is given to the automobile engine, the greater part of the work being devoted to horizontal and vertical stationary engines for power generation.

NEW CATALOGUES AND CIRCULARS

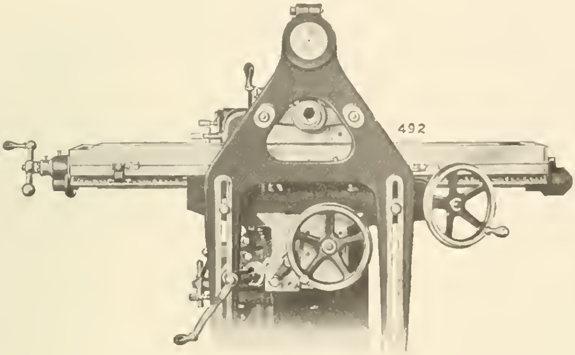
Henry G. Thompson & Son Co., New Haven, Conn. Circular of the "Carr" planer tools.

Cincinnati Planer Co., Cincinnati, Ohio. Booklet entitled "A Ragtime Essay on Speed."

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 130 on lubrication of pneumatic tools, lubricants and automatic oiling devices.

Cincinnati Rigidity

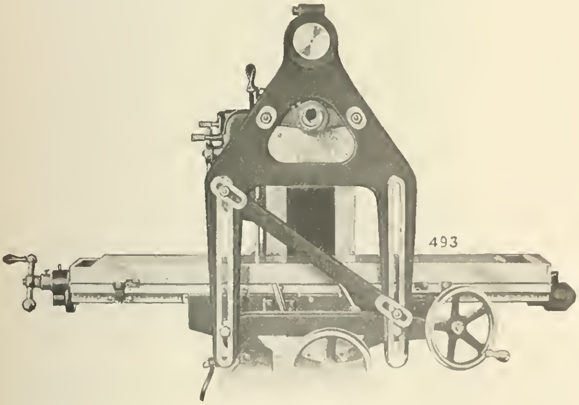
The weakest parts of any Column and Knee Type Miller are the arbor. knee and arbor supports. Their importance is emphasized by the various efforts of designers to strengthen them. The size of arbor is determined by the cutters and is therefore beyond the designer's control. For years we have been recommending the use of large arbors, because all parts of our machines are stronger than the largest arbors in use.



Usual position of Table when doing heavy cutting

The practical problem resolves itself into providing the greatest rigidity in the other members by making the strongest continuous structure of the Column, Knee, Brace and Overarm.

Thorough experiments and careful analyses have shown us that the resultant of the pressures against the outer arbor supports (the braces and overarm) on ordinary work is nearly in a horizontal plane. We designed our braces to resist such pressures, and did not forget to make them, and the arbor bearing, as handy as possible to set up and adjust.



Unusual position of Table
Braces provided with an additional truss member

We employ a single piece triangle. It is always a triangle. Its form is not changed by different positions of the table. In the lower positions the greatest rigidity is needed, and then we add another truss member, making it a double triangle.

The upper ends of the usual two-piece form of triangular braces do not cross when the table is low and they no longer form a triangle at the very time when it is needeed most. Ours, being made in *one* piece, is handy to attach or remove. It is easy to slide it, as well as the arbor supports, along our large cylindrical arm.

This contributes to that handiness in "setting up" that makes our machine more productive.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

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New Machinery and Tools....................... 637 421

George P. Clark Co., Windsor Locks, Conn. Bulletin B, illustrating and describing a line of two-wheel, barrel, keg, box and coal hand trucks, steel coal cars, etc.

Wisconsin Miller Mfg. Co., Station A, Milwaukee, Wis. Circular of the Wisconsin hand milling machine built with or without column for floor or bench use.

Bristol Co., Waterbury, Conn. Bulletins No. 138, 139 and 1200 on mechanical time recorders, electric time recorders and Class II recording thermometers, respectively.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 126, on Compression Riveters; Bulletin No. 129, on Hose, Hose Couplings and Hose Clamp Tools.

General Electric Co., Schenectady, N. Y. Bulletins No. A 4087 and A 4092 on direct-current motor-starting panels for heavy service and Thomson watt-hour meters, respectively.

Cincinnati Precision Lathe Co., Dept. D, Fosdick Bldg., Cincinnati, Ohio. Card illustrating the "Cincinnati" precision lathe, the headstock construction and the grinding attachment.

Peck-Hamre Mfg. Co., Berlin, Wis. Illustrated circular describing the "Gem" all metal machinists' tool case, which has recently been placed on the market by this company.

American Thermo-Ware Co., 16 Warren St., New York City. Circular of Autocrat" eye protectors and respirating devices to safeguard the eyes and lungs of grinders, buffers and polishers.

International Oxygen Co., 115 Broadway, New York City. Bulletins 9 and 10 on the I. O. C. system of generating oxygen and hydrogen for industrial purposes, and oxygen and hydrogen generators type 200, respectively.

Triumph Electric Co., Cincinnati, Ohio. Bulletin No. 1010 on adjustable speed motors. The bulletin contains a description of the motors and shows their application to a number of different types of machine tools.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Folder showing the construction and giving the dimensions of ball bearing hangers. The folder also calls attention to the power and lubricant savings effected.

Reade Mfg. Co., 1021-1027 Grand St., Hoboken, N. J. Folder advertising the "Incomparable" soldering fluid used for soldering metal work in general. The folder also covers tinning solutions and soldering solutions, giving prices.

Lauth-Juergens Motor Car Co., Fremont, Ohio. Catalogue of 1912 motor trucks, showing in detail some of the more important constructional features of the trucks manufactured by the company, as well as excellent halftone engravings of different types.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1031 on type DR drum controllers for direct-current motors. The bulletin contains a price list for 110 volt, 220 volt and 550 volt apparatus, giving also the horsepower ratings.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular No. 192 on the Garvin automatic oil-grooving machine which cuts straight or spiral grooves, right or left hand, in straight or taper holes, in bronze, cast iron, steel, etc.

Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa. Circular of the "Challenge" floor type or "Universal" emery wheel guard, consisting of a standard bolted to the floor and supporting a curved guard partially encircling the wheel.

Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. Catalogue of Armstrong pipe threading machines and parts, illustrating the machines and all the parts. Each piece is given a number by which it can be identified by users when ordering repair parts.

Bryant Chucking Grinder Co., Springfield, Vt. Circular of the Bryant hole and face grinder for the production of interchangeable work. The machine grinds holes up to 10 inches in diameter, 6 inches in length, and has a chuck range for work up to 12 inches in diameter.

Eugene Dietzgen Co., 218 E. 23d St., New York City. Circular of drafting-room furniture, comprising folding drawing stands, adjustable drawing tables, wooden horses, drawing boards, etc.; also circular of sectional filing cases and combination filing cabinets for drawing-rooms.

Warner & Swasey Co., Cleveland, Ohio. General catalogue No. 15 on hollow hexagon turret lathes, universal hollow turret lathes, turret screw machines, turret lathes, set-over turret lathes, forming turret lathes, miscellaneous brass working machine tools, tools and accessories, etc.

Ingersoll-Rand Co., 11 Broadway, New York City. Circular Form No. 3008 on class "PE" duplex direct-connected electrically-driven air compressors; Form No. 575, instructions for installing and operating class "PE" direct-connected electric driven air compressors with duplicate part list.

Hess-Bright Mfg. Co., 17 E. Erie Ave. Philadelphia, Pa. Data sheets on ball bearings and their correct uses, comprising thrust collar bearings, light weight series No. 1000; thrust collar bearings, medium weight series No. 1100; and ball bearing mountings for worm-driven capstan.

Monash-Younker Co., 121 W. 42nd St., New York City. Circular advertising the Monash noiseless system of vacuum heating, using exhaust steam for heating and drying purposes. The circular contains a list of plants equipped with this system of heating and describes the apparatus.

Baldwin Chain & Mfg. Co., Worcester, Mass. Catalogue of transmission chains and sprockets. The catalogue contains, in addition to tables of dimensions of chains and sprockets, formulas and directions for calculating the length of chains, and notes on the proper design of sprockets.

Thwing Instrument Co., 445 North Fifth St., Philadelphia, Pa. Bulletin V on Type A and Type C recording pyrometers. An important feature of the Thwing pyrometers is the multiple record system from which two or three records may be made from as many heat sources by one galvanometer upon one chart or section of chart.

Manning, Maxwell & Moore, 85-89 Liberty St., New York City. Catalogue F, issued by the Ashcroft Mfg. Co. (a constituent concern) on steam, pressure and vacuum gages, Edison recording gages, Tabor engine indicators, engineering specialties, pipe tools, clocks, revolution counters, test pumps, low water detectors, reducing wheels, pantographs, planimeters, etc.

General Electric Co., Schenectady, N. Y. Bulletins No. A 4070, Electrically-Operated Remote Control Switch; A 4072 Sign Lighting by Edison Mazda Sign Lamps; A 4081, Reversing Motors for Planers, Slotters, etc.; A 4083, Roller Bearing Trolley Bases; A 4085 Battery-charging Motor-Generator Sets for Railway Signalling; A 4086, Circuit Breakers for Railway Service.

Heine Safety Boiler Co., St. Louis, Mo. Pamphlet on superheating, containing a reprint of the paper from the Engineers' Society of Pennsylvania, discussing the steam and fuel economy of superheating, and a brief description of the design and operation of the Heine superheater; also abstracts from the Transactions of the A. S. M. E. on the effect of superheated steam on cast iron.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of the Canton portable floor crane and hoist, with which one man can hoist and convey to any part of the shop, a piece weighing up to 4000 pounds and deposit it on a lathe, planer, truck bed, etc. The convenience of this apparatus is illustrated by means of views showing uses in machine shops, roundhouses, foundries, etc.

Landis Machine Co., Inc., Waynesboro, Pa. 1913 catalogue, No. 21, covering 79, 6 by 9 inch pages illustrating and describing bolt, pipe and nipple threading machinery, bolt pointing and nut tapping machinery, screw cutting die-heads and special threading machines. The catalogue contains interesting information on the action of die chasers and shows in detail the construction of chaser holders, rotary die-heads, tap chucks, bolt pointer heads, reaming devices and nipple grips.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin No. 115, on Electrical Equipment for Buildings, including generators, generating sets, switchboards, wire and cable, panel boards, motors, controllers, electric hoists and fans, etc.; Catalogue No. 327, on Sprague Electric Fans, giving dimensions, weights and prices, and illustrating the different types of fans made; Bulletin No. 241, on Motor Drive for Stereotyping and Electrotyping Machinery, and Electroplating Generators.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Booklet entitled "Titanium in Steel" containing interesting statements from steel makers and scientists on the uses and benefits of ferro carbon-titanium. The claim made for this deoxidizer is that when used for scavenging purposes it not only thoroughly cleanses the metal but leaves none of its compounds in the finished product. The booklet, which contains 48 pages, 4¼ by 8½ inches, is an addition to metallurgical literature, and should be appreciated by those concerned with the use of high-grade steels.

TRADE NOTES

Windsor Machine Co., Windsor, Vt., is converting its old shop into a clubhouse for the use of its employes.

Jones & Lamson Machine Co., Springfield, Vt., is building an addition to its lower plant 110 by 400 feet. The addition is of sawtooth construction in harmony with the construction of the present plant.

Western Pump & Engineering Co., 339-343 Railway Exchange, Chicago, Ill., is bringing out a line of triplex and centrifugal pumps and air compressors in addition to its line of single and duplex steam pumps.

Hendee Mfg. Co., Springfield, Mass., has made plans to double the capacity of its plant for manufacturing motor-cycles. The production for the 1913

Supplement to

Tables for Articles in this number entitled

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DATA FOR WINDING PIANO WIRE TENSION SPRINGS—I

Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire
0.125	0.130	0.150	1	0.0098
0.187	0.192	0.212	1	0.0098
0.250	0.255	0.275	1	0.0098
0.312	0.318	0.338	1	0.0098
0.375	0.382	0.402	1	0.0098
0.125	0.130	0.151	2	0.0105
0.187	0.192	0.213	2	0.0105
0.250	0.255	0.276	2	0.0105
0.312	0.318	0.339	2	0.0105
0.375	0.382	0.403	2	0.0105
0.125	0.130	0.152	3	0.0115
0.187	0.193	0.215	3	0.0115
0.250	0.256	0.278	3	0.0115
0.312	0.320	0.342	3	0.0115
0.375	0.382	0.404	3	0.0115
0.125	0.135	0.160	4	0.0125
0.187	0.197	0.222	4	0.0125
0.250	0.260	0.285	4	0.0125
0.312	0.322	0.347	4	0.0125
0.375	0.385	0.410	4	0.0125
0.125	0.135	0.164	5	0.0145
0.187	0.198	0.227	5	0.0145
0.250	0.261	0.290	5	0.0145
0.312	0.324	0.353	5	0.0145
0.375	0.389	0.418	5	0.0145
0.125	0.135	0.165	6	0.0150
0.187	0.198	0.228	6	0.0150
0.250	0.262	0.292	6	0.0150
0.312	0.325	0.355	6	0.0150
0.375	0.390	0.420	6	0.0150
0.125	0.137	0.172	7	0.0175
0.187	0.201	0.236	7	0.0175
0.250	0.266	0.301	7	0.0175
0.312	0.330	0.365	7	0.0175
0.375	0.395	0.430	7	0.0175

Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire
0.125	0.138	0.176	8	0.0190
0.187	0.202	0.240	8	0.0190
0.250	0.266	0.304	8	0.0190
0.312	0.330	0.368	8	0.0190
0.375	0.396	0.434	8	0.0190
0.125	0.145	0.189	9	0.0220
0.187	0.209	0.253	9	0.0220
0.250	0.271	0.315	9	0.0220
0.312	0.335	0.379	9	0.0220
0.375	0.400	0.444	9	0.0220
0.187	0.209	0.258	10	0.0245
0.250	0.272	0.321	10	0.0245
0.312	0.336	0.385	10	0.0245
0.375	0.401	0.450	10	0.0245
0.437	0.465	0.514	10	0.0245
0.500	0.533	0.582	10	0.0245
0.562	0.600	0.649	10	0.0245
0.625	0.665	0.714	10	0.0245
0.187	0.212	0.266	11	0.0270
0.250	0.277	0.331	11	0.0270
0.312	0.340	0.394	11	0.0270
0.375	0.406	0.460	11	0.0270
0.437	0.470	0.524	11	0.0270
0.500	0.535	0.589	11	0.0270
0.562	0.600	0.654	11	0.0270
0.625	0.665	0.719	11	0.0270
0.187	0.212	0.269	12	0.0285
0.250	0.279	0.336	12	0.0285
0.312	0.342	0.399	12	0.0285
0.375	0.408	0.465	12	0.0285
0.437	0.472	0.529	12	0.0285
0.500	0.537	0.594	12	0.0285
0.562	0.602	0.659	12	0.0285
0.625	0.667	0.724	12	0.0285
.....	.....	.....	..	......
.....	.....	.....	..	......

No. 165, Data Sheet, MACHINERY, April, 1913

DATA FOR WINDING PIANO WIRE TENSION SPRINGS—II

Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire
0.187	0.217	0.278	13	0.0305
0.250	0.282	0.343	13	0.0305
0.312	0.346	0.407	13	0.0305
0.375	0.411	0.472	13	0.0305
0.437	0.475	0.536	13	0.0305
0.500	0.540	0.601	13	0.0305
0.562	0.604	0.665	13	0.0305
0.625	0.670	0.731	13	0.0305
0.250	0.284	0.348	14	0.0320
0.312	0.348	0.412	14	0.0320
0.375	0.414	0.478	14	0.0320
0.437	0.478	0.542	14	0.0320
0.500	0.545	0.609	14	0.0320
0.562	0.609	0.673	14	0.0320
0.625	0.677	0.741	14	0.0320
0.250	0.284	0.354	15	0.0350
0.312	0.350	0.420	15	0.0350
0.375	0.417	0.487	15	0.0350
0.437	0.480	0.550	15	0.0350
0.500	0.547	0.617	15	0.0350
0.562	0.611	0.681	15	0.0350
0.625	0.680	0.750	15	0.0350
0.250	0.290	0.362	16	0.0360
0.312	0.355	0.427	16	0.0360
0.375	0.420	0.492	16	0.0360
0.437	0.483	0.555	16	0.0360
0.500	0.550	0.622	16	0.0360
0.562	0.618	0.685	16	0.0360
0.625	0.683	0.755	16	0.0360
0.250	0.292	0.368	17	0.0380
0.312	0.358	0.434	17	0.0380
0.375	0.423	0.499	17	0.0380
0.437	0.486	0.562	17	0.0380
0.500	0.554	0.630	17	0.0380
0.562	0.615	0.691	17	0.0380
0.625	0.686	0.762	17	0.0380
.....	.....	.....	..	......
.....	.....	.....	..	......

Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire
0.250	0.294	0.374	18	0.0400
0.312	0.361	0.441	18	0.0400
0.375	0.426	0.506	18	0.0400
0.437	0.489	0.569	18	0.0400
0.500	0.557	0.637	18	0.0400
0.562	0.618	0.698	18	0.0400
0.625	0.690	0.770	18	0.0400
0.312	0.363	0.447	19	0.0420
0.375	0.427	0.511	19	0.0420
0.437	0.491	0.575	19	0.0420
0.500	0.558	0.642	19	0.0420
0.562	0.619	0.703	19	0.0420
0.625	0.691	0.775	19	0.0420
0.312	0.364	0.450	20	0.0430
0.375	0.429	0.515	20	0.0430
0.437	0.493	0.579	20	0.0430
0.500	0.560	0.646	20	0.0430
0.562	0.621	0.707	20	0.0430
0.625	0.693	0.779	20	0.0430
0.312	0.365	0.454	21	0.0445
0.375	0.431	0.520	21	0.0445
0.437	0.495	0.584	21	0.0445
0.500	0.561	0.650	21	0.0445
0.562	0.623	0.712	21	0.0445
0.625	0.695	0.784	21	0.0445
0.312	0.367	0.461	22	0.0470
0.375	0.433	0.527	22	0.0470
0.437	0.497	0.591	22	0.0470
0.500	0.563	0.657	22	0.0470
0.562	0.625	0.719	22	0.0470
0.625	0.698	0.792	22	0.0470
0.312	0.369	0.467	23	0.0490
0.375	0.436	0.534	23	0.0490
0.437	0.500	0.598	23	0.0490
0.500	0.565	0.663	23	0.0490
0.562	0.628	0.726	23	0.0490
0.625	0.700	0.798	23	0.0490

No. 165, Data Sheet, MACHINERY, April, 1913

DATA FOR WINDING PIANO WIRE TENSION SPRINGS—III

Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire	Diameter of Mandrel	Inside Diameter of Spring	Outside Diameter of Spring	Number of Piano Wire	Diameter of Piano Wire
0.312	0.371	0.477	24	0.0530	0.375	0.451	0.603	30	0.0760
0.375	0.438	0.544	24	0.0530	0.437	0.518	0.670	30	0.0760
0.437	0.504	0.610	24	0.0530	0.500	0.580	0.732	30	0.0760
0.500	0.568	0.674	24	0.0530	0.562	0.648	0.795	30	0.0760
0.562	0.630	0.736	24	0.0530	0.625	0.717	0.869	30	0.0760
0.625	0.702	0.808	24	0.0530	0.375	0.455	0.617	31	0.0810
0.312	0.374	0.486	25	0.0560	0.437	0.522	0.684	31	0.0810
0.375	0.441	0.553	25	0.0560	0.500	0.585	0.747	31	0.0810
0.437	0.508	0.620	25	0.0560	0.562	0.647	0.809	31	0.0810
0.500	0.571	0.683	25	0.0560	0.625	0.722	0.884	31	0.0810
0.562	0.634	0.746	25	0.0560	0.375	0.461	0.633	32	0.0860
0.625	0.706	0.818	25	0.0560	0.437	0.527	0.699	32	0.0860
0.312	0.375	0.495	26	0.0600	0.500	0.590	0.762	32	0.0860
0.375	0.442	0.562	26	0.0600	0.562	0.651	0.823	32	0.0860
0.437	0.511	0.631	26	0.0600	0.625	0.727	0.899	32	0.0860
0.500	0.573	0.698	26	0.0600	0.375	0.467	0.649	33	0.0910
0.562	0.635	0.755	26	0.0600	0.437	0.533	0.715	33	0.0910
0.625	0.710	0.830	26	0.0600	0.500	0.595	0.777	33	0.0910
0.375	0.445	0.573	27	0.0640	0.562	0.657	0.839	33	0.0910
0.437	0.513	0.641	27	0.0640	0.625	0.733	0.915	33	0.0910
0.500	0.575	0.703	27	0.0640	0.375	0.480	0.682	34	0.1010
0.562	0.637	0.765	27	0.0640	0.437	0.550	0.752	34	0.1010
0.625	0.713	0.841	27	0.0640	0.500	0.610	0.812	34	0.1010
0.375	0.446	0.583	28	0.0685	0.562	0.673	0.875	34	0.1010
0.437	0.514	0.651	28	0.0685	0.625	0.750	0.952	34	0.1010
0.500	0.575	0.712	28	0.0685	0.375	0.490	0.708	35	0.1090
0.562	0.638	0.775	28	0.0685	0.437	0.560	0.778	35	0.1090
0.625	0.714	0.851	28	0.0685	0.500	0.622	0.840	35	0.1090
0.375	0.448	0.591	29	0.0715	0.562	0.686	0.904	35	0.1090
0.437	0.516	0.659	29	0.0715	0.625	0.765	0.983	35	0.1090
0.500	0.577	0.720	29	0.0715	0.375	0.500	0.738	36	0.1180
0.562	0.640	0.783	29	0.0715	0.437	0.572	0.808	36	0.1180
0.625	0.714	0.857	29	0.0715	0.500	0.637	0.873	36	0.1180
.....	.....	.....	..	......	0.562	0.702	0.938	36	0.1180
.....	.....	.....	..	......	0.625	0.780	1.016	36	0.1180

No. 165, Data Sheet, MACHINERY, April, 1913

PRESSURES REQUIRED FOR PUNCHING

Pressures required to punch 0.25 Carbon Steel of 65,000 Pounds per Square Inch Tensile Strength

Circumference of Hole × Thickness of Plate (both in inches) × 50,000 = Pressure required in Pounds, approximately

Thickness of Plate, Inches	Diameter of Punch, Inches														
	1¼	1⅛	1	15/16	⅞	13/16	¾	11/16	⅝	9/16	½	7/16	⅜	5/16	¼
⅛	24600	22100	19600	18400	17200	16000	14700	13500	12300	11100	9800	8600	7400	6100	4900
3/16	36800	33100	29500	27600	25800	24000	22100	20300	18400	16600	14700	12900	11000	9200	7300
¼	49100	44200	39300	36800	34400	32000	29500	27000	24500	22100	19600	17200	14700	12300	9800
5/16	61400	55200	49100	46000	42900	39900	36800	33800	30700	27600	24500	21500	18400	15300	12300
⅜	73600	66300	58900	55200	51500	47900	44200	40500	36800	33200	29500	25800	22100	18400	14700
7/16	85900	77300	68700	64400	60100	55900	51500	47300	42900	38600	34400	30100	25800	21400	....
½	98200	88400	78500	73600	68700	63800	58900	54000	49100	44200	39300	34400	29600	....	....
9/16	110400	99400	88400	82800	77300	71800	66200	60800	55200	49700	44200	38700	....	....	....
⅝	122700	110400	98200	92000	85900	79800	73600	67500	61400	55300	49100	....	....	....	....
11/16	135000	121400	108000	101200	94500	87800	81000	74300	67500	60900	....	....	....	....	....
¾	147300	132500	117800	110400	103100	95800	88400	81000	73600	....	....	....	....	....	....
13/16	159500	143500	127600	119600	111700	103700	95700	87800	....	....	....	....	....	....	....
⅞	171800	154600	137400	128800	120300	111700	103100	....	....	....	....	....	....	....	....
15/16	184100	165600	147200	138000	128800	119700	....	....	....	....	....	....	....	....	....
1	196400	176700	157100	147200	137400	....	....	....	....	....	....	....	....	....	....
1⅛	220900	198800	176700	165600	....	....	....	....	....	....	....	....	....	....	....
1¼	245400	220900	196400	....	....	....	....	....	....	....	....	....	....	....	....

No. 165, Data Sheet, MACHINERY, April, 1913

MACHINERY

MAY, 1913

COLD-HEADING—1

PRINCIPLES OF COLD-HEADING—EARLY HISTORY—TYPES OF COLD-HEADING MACHINES, ETC.

BY CHESTER L. LUCAS* AND ERNEST W. DUSTON†

THE operation of forming the heads of rivets, wood screw blanks, machine screw blanks, and similar products, by upsetting the ends of the wire lengths while cold, is known as cold-heading. The machines to which the wire is fed from a coil, and in which it is cut off and headed, are known as cold-headers. It is the purpose of this article to describe briefly the operation of various types of heading machines, to enumerate some of the limitations and possibilities of the different cold-heading machines and to give a general idea of the way in which the tools are planned and made for this class of machinery. No attempt will be made to cover the heading of hot stock such as is followed in making hot formed bolts, as this type of machinery comes under the head of forging machinery. Fig. 1 shows some cold-headed rivets and screw blanks made on E. J. Manville cold-headers.

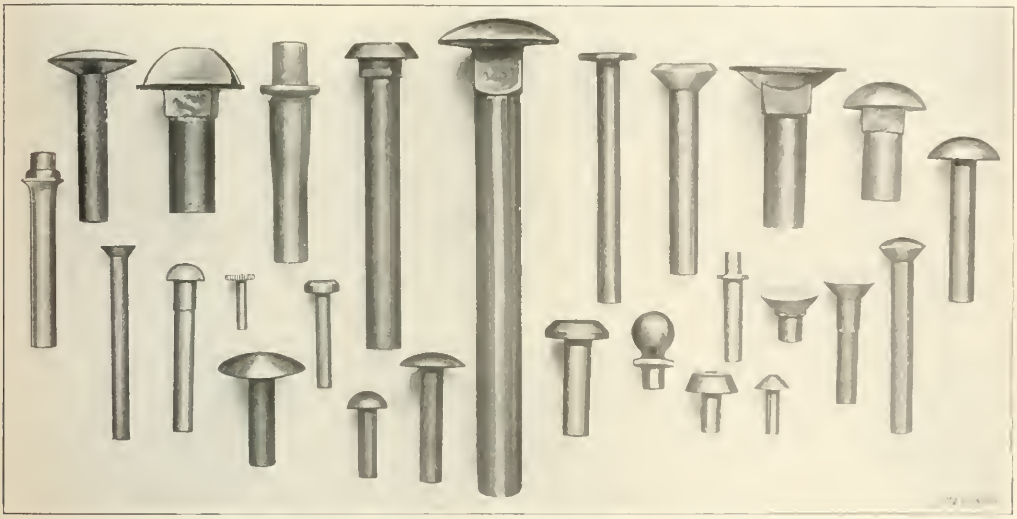
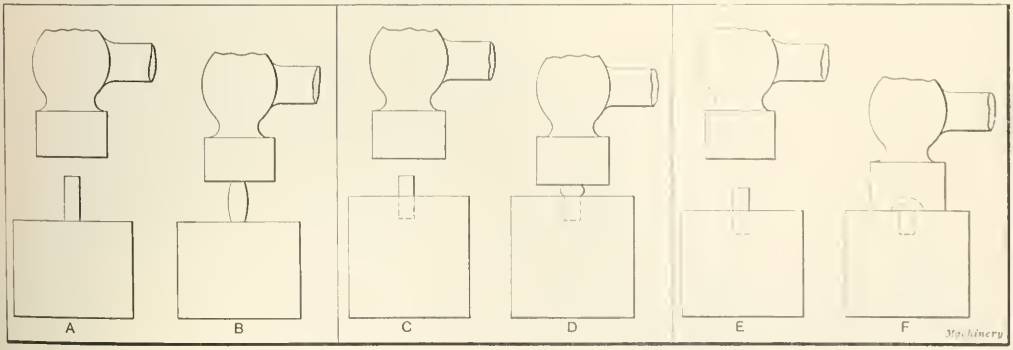


Fig. 1. Miscellaneous Samples of Cold-heading made on E. J. Manville Machines

Principles of Cold-heading

If you should cut off a piece of 3/8-inch diameter copper wire about 1 inch long, stand it on end on a hardened steel block, as shown at *A*, in Fig. 2, and strike it squarely on top with a heavy hammer, you would upset the piece as a result of the blow, causing it to bulge considerably at the center, the amount depending upon the force of the blow, leaving it with an appearance as indicated at *B*, Fig. 2. Continuing our experiments, if we take another 3/8-inch piece of copper wire, 1 inch long, as before, and drop it into a 3/8-inch hole in a hardened steel block, allowing a section 1/2 inch long to extend above the surface of the block, as at *C*, Fig. 3, and strike the end of this piece a square blow with the same hammer, the piece will assume about the appearance indicated at *D*, in Fig. 3. The projecting section will be bulged as before, but the part of the blank remaining within the block must necessarily retain its original shape, as it is confined in all directions. Continuing our experiments still further, if we



Figs. 2, 3 and 4. Illustration of Principles of Cold-heading take a new blank of the same dimensions and insert it in the same block as before, but in place of the flat ended hammer we use one with a cup-shaped depression turned in its face, as shown at *E*, Fig. 4, and strike the blank a hard blow squarely upon the projecting end, the end of the wire will necessarily take on the appearance indicated at *F*, Fig. 4. The blank *must* assume this shape because the part under the head is confined within the lower block and the head section is guided in its bulging by the cup-shaped depression in the hammer with which the blow is struck.

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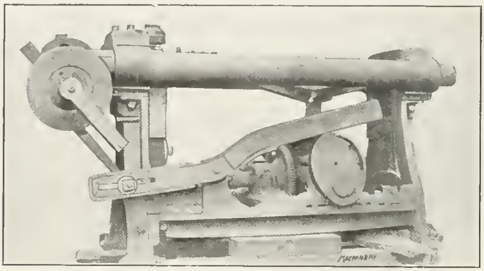

Fig. 5. An Old Type of Header

These three simple experiments outline the principles involved in cold-heading. In all cold-heading operations the blank is confined at the bottom and sides, leaving the metal which is to comprise the head projecting, so that it may be upset and shaped by the punch of the heading machine. In cold-heading, the fundamental point to be remembered is that, under pressure, the wire stock will flow in the direction of the least resistance—always.

Early History of Cold-heading Machinery

The use of hand-formed rivets dates back to the ancient Egyptians, but this article must be confined to the machines and tools used for automatically producing rivets and screw blanks. The first instance we find of cold-heading by machinery was in England, about 1760, when two brothers, John and William Wyatt, designed and built a machine for heading wood screw blanks. In America, there is no doubt that Josiah Gilbert Pierson's cold-header, patented March 23, 1794, was the first machine of its kind, although the patents were destroyed when the patent office was burned early in the last century. Pierson's factory was first on the site of the present New York Produce Exchange, but later he moved to Ramapo, N. Y. His heading machine was a massive affair, with a heavy framework anchored to the floor. A large flywheel was provided, and the machine was operated on the now familiar toggle principle. In 1838, the Eagle Screw Co., of Providence, R. I., was started by William G. Angell, and its earliest machine was what is known to-day as the old Eagle header. At the factory of the American Screw Co., Providence, R. I., this type of machine is used to-day on certain classes of work. Mr. Benjamin Thurston, superintendent of the American Screw Co., states that in the early days of cold-heading each machine was mounted upon the ends of long posts which ran through the floor down to a solid ground foundation.

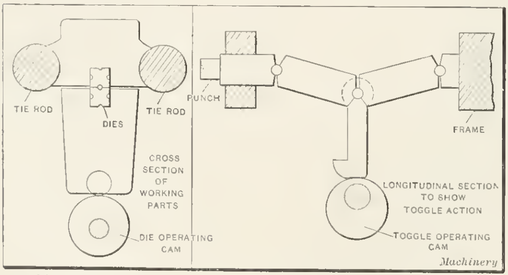

Fig. 6. Diagram illustrating Operation of Header shown in Fig. 5

An Old Type of Header

In Fig. 5, is shown one of the earliest cold-heading machines now in existence, and while it has long ago out-lived its usefulness, it is interesting to compare it with modern heading machines. This machine was designed by W. E. Ward and built by Russell, Burdsall & Ward, of Port Chester, N. Y., at some time prior to 1856. The line engraving Fig. 6 gives an idea of the general principles upon which this machine operated, from which it will be seen that the operation of the punch was effected by means of toggle mechanism actuated by a cam on the lower shaft of the machine. The vertical cross-section through the dies is indicated at the left. As the machine was of the open-die type, the lower die was actuated by another cam. Two extremely heavy rods extended the length of the sides, as shown in the engraving, Fig. 5, and in section in the illustration, Fig. 6. These served to tie the machine together, enabling it to better withstand the heading operation. The output of this machine, which was used for making stove bolts ¼ to ⅜ inch in size, was about 30,000 headed pieces per day of eleven hours.

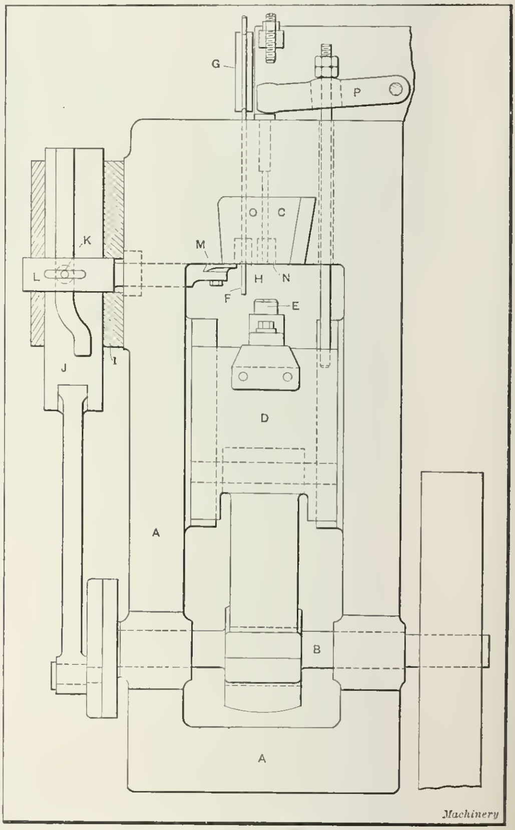

Fig. 7. Plan View of a Modern Cold-header

Operating Principle of Modern Heading Machines

Practically all modern heading machines operate upon the same general principle, although there are many modifications and features which each maker considers best. By referring to Fig. 7, which shows the plan view of a modern single-blow solid-die heading machine, it will be seen that there is a heavy framework *A*, at one end of which is located the driving shaft *B*, rotated by a driving wheel at the right-hand side; at the other end is located the die-block *C*. Between the sides of the heavy framework is a movable ram *D* which serves to actuate the heading punch *E*. The wire, which is indicated at *F*, enters the machine through feed rolls *G* and thence through the framework of the machine, passing through the cut off quill *H*. At the left-hand side of the machine is supported the bracket *I*, in which slide *J* may be reciprocated by means of a crank motion from the main driving shaft. Slide *J* contains a cam groove in which roll *K* is fitted, and as roll *K* is mounted upon the cross-slide *L*, it will be seen that a lateral motion is thus imparted to the cut-off knife *M*, located on the end of cutter bar *L*. The ratchet feed advances the wire through the cut-off quill to the feed stop, not shown, after which cut-off knife *M* is advanced in the manner just described, severing the wire, but retaining it on the cut-off blade by means of a spring finger. The advance of the cut-off knife and wire is continued until it reaches a position directly in front of the opening in die *N*. At this position it is held stationary long enough for punch *E* to begin to push it into the die, at which time the cut-off knife retreats and allows the punch *E* to continue its work by pushing the blank to the bottom of the die cavity, afterward upsetting the projecting part of the wire to form the head. The wire blank *F*, when pushed into the die, is prevented from passing too far by a backing pin *O*. After the piece has been headed, the backing pin is advanced by ejecting mechanism operated by lever *P*, which receives its motion from a crank on the right side of the machine connected to the main driving shaft. This, briefly stated, is the general principle upon which all modern heading machines of the single-blow solid-die type operate.

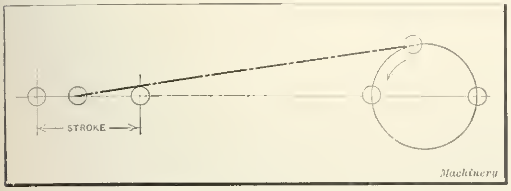

Fig. 8. Diagram to illustrate Operation of Crank Headers

Crank-operated Headers

There are two distinct principles employed for reciprocating the movable ram of a cold-header. These are the crank principle and the toggle principle. In the machine just described and illustrated in Fig. 7, motion is transmitted to the ram by means of an eccentric upon the driving shaft, the eccentric, of course, being a modification of the crank principle. By referring to the diagram Fig. 8, it will be seen that in the crank-operated header the length of the stroke is equal to the diameter of the crank-pin circle, and that one stroke is accomplished in each revolution of the driving shaft from which the crank is operated.

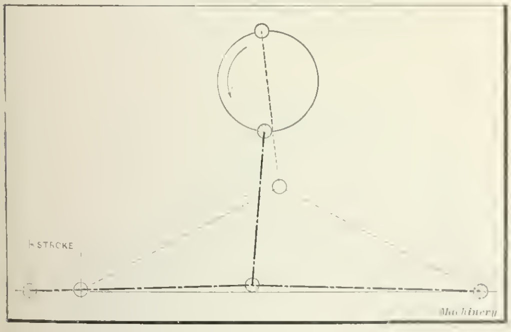

Fig. 9. Diagram to illustrate Operation of Toggle Headers of Two-cycle Type

The crank principle is employed on most single-stroke machines and by one manufacturer for double-stroke machines as well. On double-stroke cold-headers of the crank-operated type, it will be seen that the crankshaft must make two revolutions to secure the two strokes, and these two strokes will be of equal length. The blow secured by the crank-operated header is of a quick punching character rather than a gradual squeezing operation, and exponents of crank-operated headers consider this feature to be of great importance.

Toggle-operated Headers

The other principle upon which cold-headers operate is the toggle principle, of which there are several variations. The common type of toggle action is that shown in Fig. 9, in which the toggle is straightened by a crank-actuated link, which brings the arms of the toggle to a straight line once during each revolution of the crankshaft. This, of course, gives one stroke of the ram to each revolution of the crankshaft, but the blow obtained is of a gradual squeezing character, especially at the ends of the stroke where the greatest amount of work is being done. This type of toggle mechanism is known as the two-cycle type, two revolutions of the crankshaft being necessary to complete a "two-blow" rivet. Another type of toggle operating mechanism which is extensively used on the double-stroke machines is illustrated in Fig. 10, from which it will be seen that two blows are struck at each revolution of the crankshaft which operates the arms of the toggle. As this type of machine makes a two-blow rivet in one revolution, it is termed a "one-cycle" machine. The chief difference between the two-cycle type of toggle action and the one-cycle type lies in the fact that in the two-cycle mechanism the toggle is straightened when the extreme of the crank motion is reached, but in the one-cycle mechanism it is straightened midway of the extreme distance of the crank, so that in the latter machine two blows are secured during one revolution of the crankshaft. The two strokes may be of equal length; the first stroke may be the longer, or *vice versa*, by varying the distance between the crankshaft and the line of the straightened toggle. In Fig. 10, the first blow is the long blow as the toggle is pushed down to the straightening point. As the toggle is drawn further above the straightening line than it was below, the second blow will be the short one, as indicated.

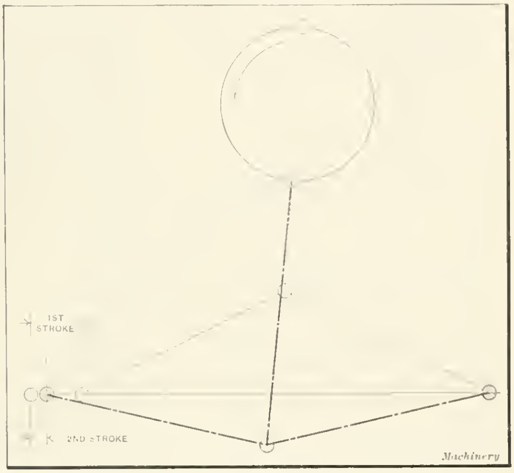

Fig. 10. Diagram to illustrate Operation of Toggle Headers of One-cycle Type

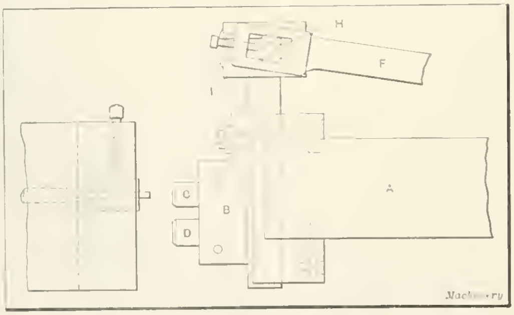

Fig. 11. Mechanism for operating Ingraham Rise-and-fall Motion

Double-stroke Cold-headers

In describing the header illustrated in Fig. 7, it was stated that this was a single-stroke machine as contrasted with a machine for striking two blows on each piece. A great many jobs of heading, however, cannot be adequately handled on a single-stroke machine, as there is too much metal to be upset in the head. When the amount of metal to be put into the head exceeds two and one half diameters of the wire in length, it is necessary to employ a double-stroke machine. The double-stroke machine operates in practically the same way as that shown in Fig. 7, except that it strikes two blows in rapid succession upon the wire blank before it is ejected. The preliminary blow is known as the coning blow; in this the wire is partly upset and prepared for the second blow which finishes the head. The two punches are "slidably" held on the ram, and the mechanism for changing the positions of the dies for the two blows is called the rise-and-fall motion. While there are several different means of securing this motion, the Ingraham rise-and-fall motion used on Blake & Johnson cold-headers is typical. By referring to the line illustration Fig. 11, which shows a side elevation of the principal parts, in connection with the halftone illustrations Figs. 12 and 13, the operation of this device can be readily followed. Upon the end of ram *A*, the die-holding slide *B* is secured. This slide is free to move vertically so that upper punch *C* or lower punch *D* may be operated in alignment with the stationary die. In Figs. 12 and 13, these dies are not shown. Pivoted upon bracket *E*, which is bolted to the left side of the frame, as shown in Figs. 12 and 13, is the lever *F* which controls the rise-and-fall movement of the punch slide. This lever is actuated by a cam upon the driving shaft of the machine, as indicated at *G*, Figs. 12 and 13. At the opposite end of lever *F*, a bearing pin *H* is adjustably mounted, being free to slide in the ways provided in section *I* of the punch-holding slide. Thus by having cam *G* of the proper shape, the rise and fall of punch-holding slide *B* may be so timed that at the time of the position of the first blow, punch *C* will be in line with the die, and at the time of the position of the second blow, punch *D* will be in line with the die. It is obvious that on double-stroke machines, the wire feeding, cut-off and ejecting mechanism must be geared to agree with every second stroke of the ram.

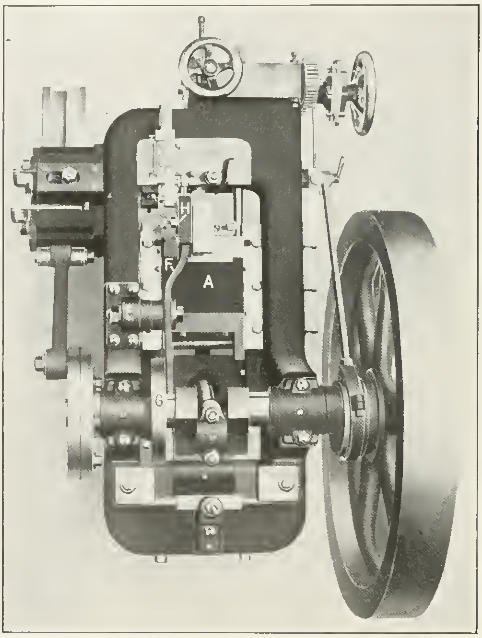

Fig. 12. Plan View of Blake & Johnson Double-stroke Solid-die Header

Triple-stroke Headers and Reheaders

In addition to single- and double-stroke machines, triple-stroke headers are sometimes used where the amount of metal to be displaced is more than can be effected with two blows. Triple-stroke headers are similar in action to other headers, except that three blows are struck. Two blows, however, will usually upset the metal of most heads to a point of crystallization so that except in special instances the use of a third blow would be of no advantage, because the blanks would require annealing before a third blow could be struck. Many heading jobs require two distinct operations to perform the work, usually on account of the shape of the pieces. For this purpose the work is carried as far as possible with an ordinary single- or double-stroke header, after which the pieces are annealed and completed in a reheader. By means of an automatic hopper feed, the partly formed pieces are placed in the heading dies and the subsequent operations performed. Reheaders are made which strike one, two or three blows.

Open-die Machines

Thus far we have only described single- and double-stroke machines of the solid-die type, but for handling work in which the length of the pieces under the head exceeds nine or ten diameters of the wire, it is necessary to employ dies which open longitudinally to make ejection of the work possible. The heading operation upsets the metal of the blank for its entire length in addition to the upsetting of the head, so that the metal of the shank is squeezed out against the sides of the die. In the case of a solid die this upsetting of the metal in the shank makes the resistance to ejection too much when the work has a long shank.

Cold-headers employing open dies require die-operating mechanism of an entirely different character from that which is used in solid-die machines. By referring to Figs. 14 and 15, the operation of the dies of a machine of this type may be followed. Referring to Fig. 14, the framework of the header is shown at *A*, the ram at *B*, and the punch at *C*. The two halves which constitute the dies are shown at *D* and *E*. The wire, which is indicated at *F*, runs through straightening rolls of the usual type through the framework of the machine

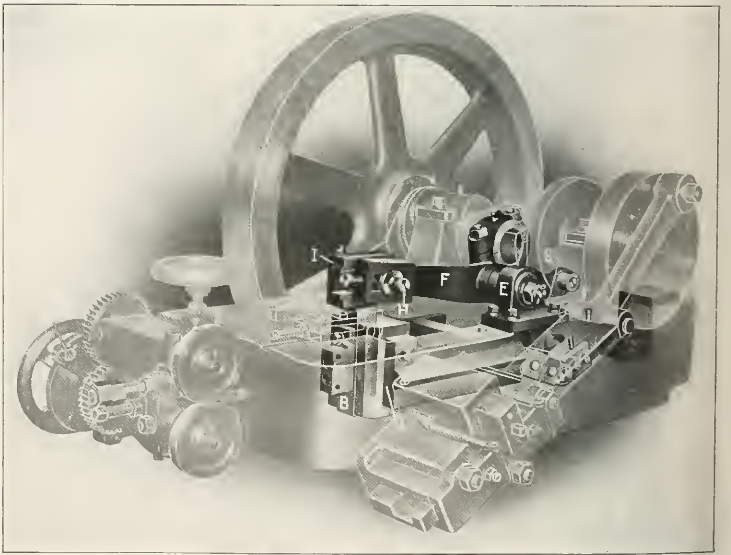

Fig. 13. Phantom View to illustrate Operation of Ingraham Rise-and-fall Motion

as well as the die-holding block, and thence through the dies themselves. In feeding, the wire is run out against a stop, not shown, and is cut off by the movement of the two halves of the die in unison toward the right, which also brings the wire blank over into line with the heading punch *C*. Different makers of cold-headers use different methods for moving the die-blocks, and one of these constructions is here illustrated. The action of this mechanism is best shown by the sectional view in Fig. 14. A flat cam *G* is reciprocated by a crank connection to the driving shaft of the machine. When this flat cam is pushed in, it raises the toggle of which arms *H* and *I* are members. This action tends to straighten another toggle composed of arms *J* and *K*, and in straightening the latter toggle, slide *L* is made to push die-halves *D* and *E* laterally, thus severing the wire and moving it into the heading position. A spring pin *M* assists in returning the toggle mechanism for another operation. By referring to the sectional illustration, it will be seen that the corners of the two halves of the die are chamfered. A wedge pin *N*, more clearly shown in the smaller illustration, Fig. 15, fits into this chamfered opening at the parting line, and by means of a flat spring which presses downward upon the wedge pin, it tends to force the dies apart whenever lateral pressure is removed. This, of course, facilitates the ejection of the headed piece, which takes place when the new length of wire comes forward. Similarly, two spring pins *O* are provided which press against a filler block *P* on the opposite side from the die-operating plunger *L*. These serve to return the dies to the cut-off position after the piece has been headed.

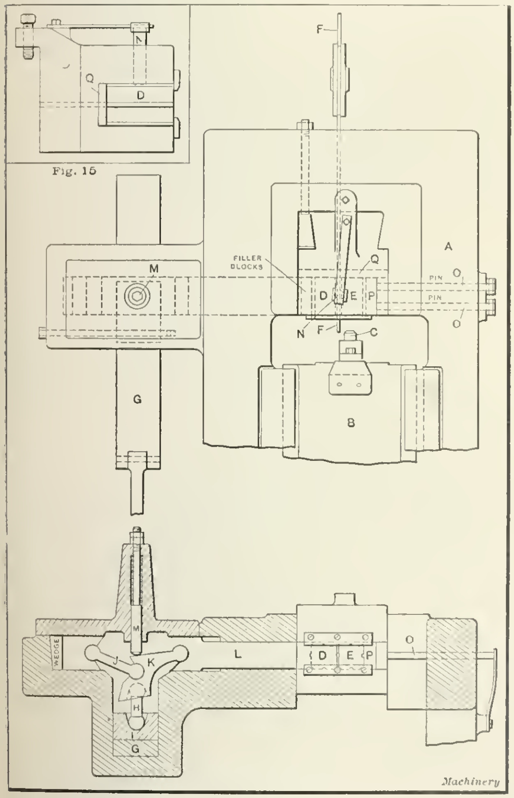

Fig. 14. Construction of Die-operating Mechanism for Open-die Headers. Fig. 15. Side Elevation of Dies and Spring Pin

In the heading position the rear end of the wire blank is backed up by backing plate *Q*, which is of hardened steel, so that the rivet or screw blank is effectively contained while being headed. From this construction it will be seen that the length of the dies must be the exact length of a headed rivet or screw blank measured under the head.

PUNCH AND DIE FOR FORMING ELECTRIC TERMINALS

BY ARTHUR L. SENESAC

The illustrations presented herewith show a useful form of punch and die for forming electric terminals of the type shown in Fig. 1. The stock from which these terminals are made consists of copper tubing which is cut into blanks of the proper length to fit into the feeding chute shown in the illustrations of the punch and die. The blanks are fed into the die by means of the handle *A*, Fig. 2. When this handle is pushed forward, it carries with it the block *T*; block *T* pushes a blank under the spring clips *W*, Fig. 3, when it moves forward. An extension on the block *T* pushes the piece finished by the preceding stroke out of the die. The handle *A* and the feeding slide are returned to their original position by the

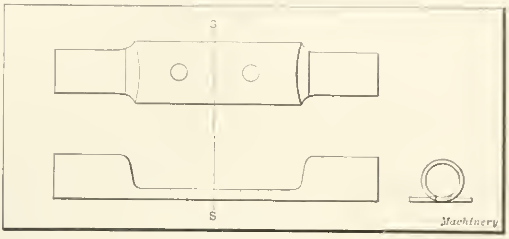

Fig. 1. Electric Terminal formed in the Punch and Die

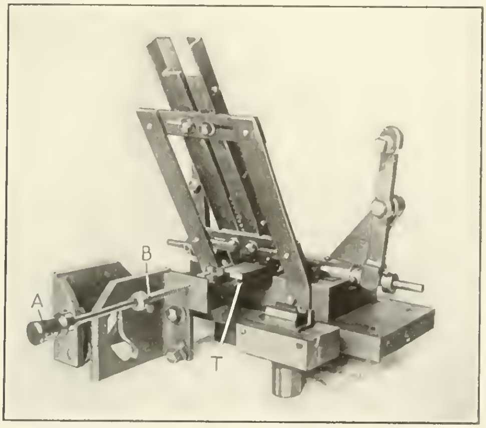

Fig. 2. Front View of Die showing Feeding Mechanism

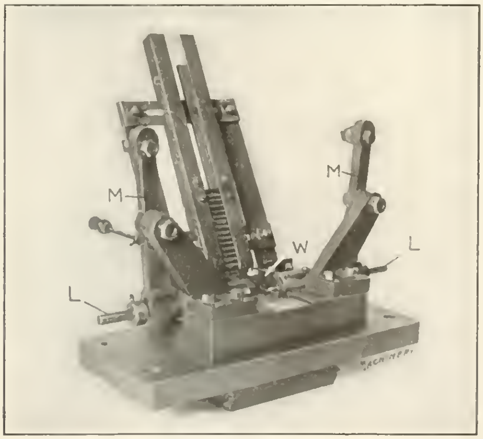

Fig. 3. Rear View of Die showing Clip for holding Blanks in Chute

tension of the spring *B*. When the press is tripped, the cam-actuated levers *M* bring the pins *L* into the ends of the blanks to prevent them from being flattened out. The punch forms the work and pierces the two holes in the flattened section in one operation. The pieces are then cut along the line *S–S* so that two terminals are produced for each stroke of the press.

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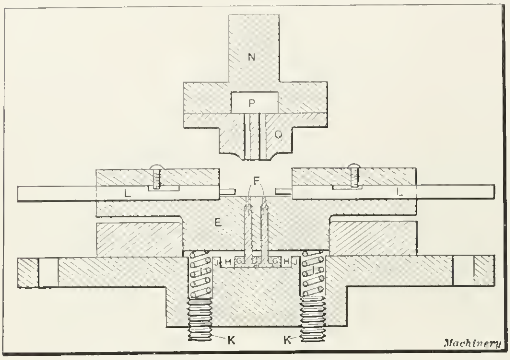

Fig. 4. Cross-sectional View showing Construction of Punch and Die

The construction of the punch and die will be understood by referring to Fig. 4. The punch-plate *E* is held up by the two springs *I* until the blank is nearly formed. Additional pressure of the punch forces the punch-plate down, and the two piercing punches *F* project sufficiently to pierce the holes in the work. When the punch rises, the pins *L* are drawn out from the ends of the work and the punch-plate *E* is then raised by the tension of the springs *I* until it engages a stop. The punch-plate thus strips the work from the punches. The two screws *K* are used to adjust the tension of the springs *I*. The punch-holder, which is shown at *N*, is dovetailed to receive the punch *O*.

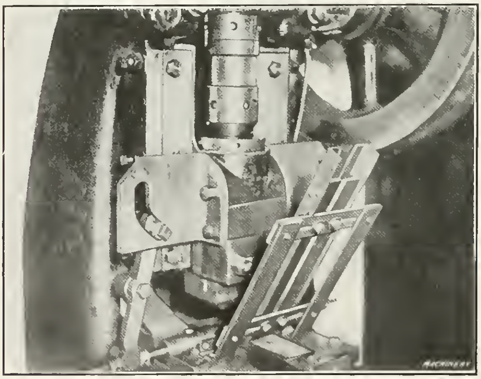

Fig. 5. The Punch and Die set up in a Press

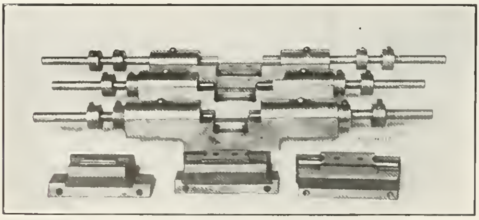

Fig. 6. Punches and Punch-plates for making Different sized Terminals

The electric terminals made in this punch and die are of several sizes, and the same equipment has been adapted to different sizes of work by simply providing different punch-plates *E* and corresponding punches *O*. When it is required to change from one size of work to another, the punch-plates are changed, the blocks *G* which carry the punches *F* being moved sufficiently to allow the punches to be entered into the new punch-plate. The new punch *O* which corresponds to the new punch-plate *E* is then mounted in the punch-holder *N*. This provision for changing the punch and punch-plate has been the means of materially reducing the cost of the equipment, as the other parts are available for the production of all sizes of terminals.

* * *

FOREIGN EXHIBITIONS

A number of foreign exhibitions of some importance will be held during the next two years. In May of this year the Ghent (Belgium) World's Fair will be opened and will remain open until late in the fall. This exhibition bids fair to exceed, both in extent and importance, all preceding exhibitions held in Belgium, including the World's Fair at Brussels in 1910. The Hall of Machinery covers an area of over 200,000 equare feet and will contain exhibitions from practically all industrial countries in the world.

At Malmö (Sweden), what is known as the Baltic Exposition will be held in 1914. The principal countries that will exhibit there will be Russia, Germany, Denmark and Sweden. The exposition will be opened May 15, 1914, and will be open until September 30. Applications for space will be received until May 31, 1913, and should be addressed to "Styrelsen for Baltiska Utställningen, Malmö, Sweden." The directors of the exhibition state that they cannot say in advance whether exhibits of manufactures other than from the four countries mentioned will be received, but they will accept applications for consideration. The exposition is to be of an industrial and general character, including all classes of machinery.

A National Exposition will be held at Berne, Switzerland, in 1914. Especial attention has been given to the machinery section, in which machinery of all classes manufactured in Switzerland will be exhibited. Prominent manufacturers of electric dynamos and turbines have reserved a large amount of space. The Machinery Hall will be the principal building of the exposition, and will contain the most complete exhibit of Swiss machinery ever made.

* * *

A large New England screw manufacturer, part of whose product is rolled thread screws, also makes bow micrometers, chiefly for use of wire drawers, sheet rollers, etc., as a small side line. These micrometers are not highly finished but are accurate, and being low-priced are well suited for the users. The screw threads of the micrometer spindles are rolled. No claim is made for superior accuracy over chased threads, but it is asserted that rolled screw threads are of very uniform pitch. Given a lot, say of one hundred rolled thread screw micrometers, they all might vary slightly from the exact pitch of forty threads to the inch, but the inaccuracy of all would be practically identical. Hence, in making up a lot of micrometers, the datum line is scribed out of parallel with the axis of the barrel the same amount for all of the one hundred micrometers. Many mechanics probably are not aware of the fact that some micrometer makers regularly adjust the datum line to the peculiarities of each instrument. If the screw is out of pitch, the datum line is set accordingly to compensate for inaccuracy of pitch one way or the other, according to whether it is long or short in the lead. The manufacturer of rolled thread screw micrometers need make only one adjustment of the machine for cutting the datum line for the whole lot that is being put through.

* * *

A marked change in the attitude of machinery manufacturers to the training of mechanics has developed within the past few years owing to the difficulty of hiring men having had general experience which fits them to do a variety of work. The great majority of men applying for employment are specialists trained to run a drilling machine, lathe, planer or other machine and having little skill for any other work. It has become practically necessary to train apprentices to work on a variety of machines and at the bench, and to pay them good wages while learning in order to have all-around workmen sufficient to fill the necessary positions.

FREE-HAND SKETCHING IN MECHANICAL WORK

VALUE OF SKETCHES—APPLICATION IN A FILING SYSTEM—FAULTS OF SKETCHES—PERSPECTIVE

BY ALBERT A. DOWD*

Free-hand sketching, as applied to the mechanical arts, is not taught in technical schools or colleges, yet it is used an incalculable number of times each day in every factory in this country. We may ask why more attention is not paid to this valuable art in our institutions of learning, and the reply comes, "It is a natural gift and something which cannot be taught to everyone, because one man has the knack of handling his pencil more cleverly than another, and has a better sense of proportion." Let us acknowledge that the latter part of this is true, as we must also admit that one man is a better mechanic than another because he seems to have the mechanical gift "born in him." There are, however, thousands of good mechanics throughout the country, not blessed with this gift, who have acquired their knowledge by good hard work, a patient application to detail and, above all, an unconquerable spirit combined with the will to succeed in whatever they may undertake. Why, then, may this not be applicable to other things, as, for instance, the free-hand sketching of mechanical things? I firmly believe, judging from my own experience, that ability may be acquired in free-hand sketching if a little time is devoted to the subject, and I hope the time may not be far distant when the technical schools of this country will realize its importance and lay more stress upon it in their curriculum.

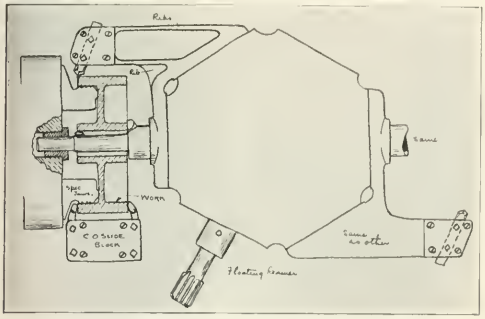

Fig. 1. Free-hand Sketch showing Tooling for a Turret Lathe Job

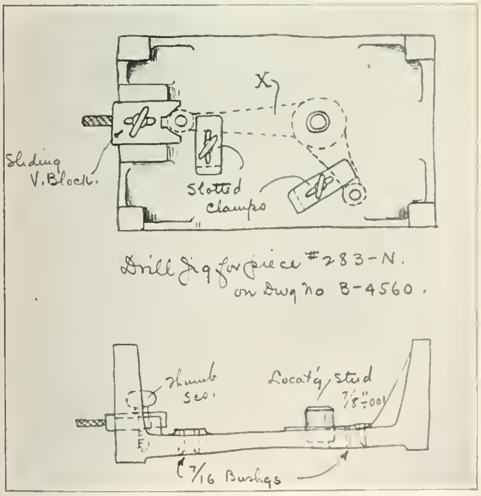

Fig. 2. Sketch of a Simple Drill Jig for a Bell-crank

I think there are very few persons who will dispute the statement that a mechanical free-hand sketch, well proportioned and clearly made, shows an object far more legibly than a mechanical drawing of the same piece. By this I simply mean to imply that it is more easily understood at a glance. There are several reasons for this. For example, in making a sketch, a person naturally exaggerates the particular points to which he wishes to draw special attention. This exaggeration may take the form of a slightly heavier outline, or it may be that the portion mentioned is more carefully delineated. At any rate we all know how easy it is to see exactly what a man is driving at when he makes a free-hand sketch before our eyes. Another reason is that a sketch contains only the particular portion which is necessary to a clearer understanding of the subject, and leaves out all other lines which tend to make a mechanical drawing more complicated and difficult to read at a glance. Note the difference in the sketches which two men make. One makes a scrawly, ill-proportioned object, which looks as if the lines might terminate anywhere and has no character whatever, being of the same neutral tint all over. The other man sketches the same subject, and his lines are clear (not perfectly straight perhaps, but having a good general sense of direction) his proportions are good, and there is a sort of "snap" to the entire sketch so that it stands out boldly on the paper. You would immediately know, without a second glance, that this man knows exactly what he wants and has shown it in the fewest possible lines.

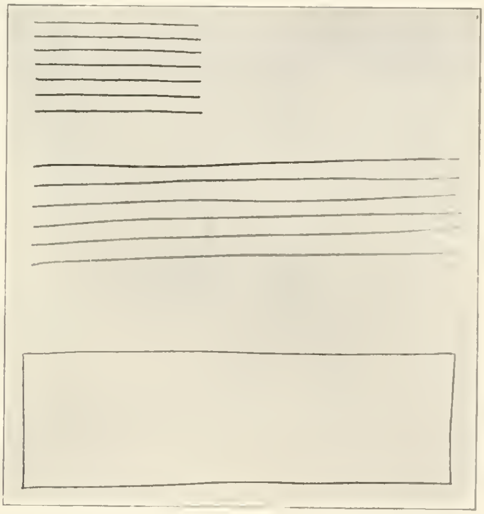
Fig. 3. Preliminary Exercises in Free-hand Sketching

The prime object of this article is to call attention to the rather neglected art of sketching as applied to mechanics, to point out the more common faults and to suggest methods of improvement which will assist one in becoming more proficient. We all know how frequently sketches are used for all sorts of purposes in the shop; they are often made hastily by the superintendent, chief draftsman, foreman or workman, and in many instances they are used as a guide in making a piece of work. Oftentimes a workman in the shop, endeavoring to explain a machining operation, will take his pencil and sketch out the object of which he is speaking on the back of a time card. This sketch is usually very crude, yet it seldom fails to explain his meaning, although he will usually apologize for it, saying, "It looks something like this but I can't make a sketch." This man is very possibly a skilled mechanic, who can produce a piece of work requiring extreme accuracy in a satisfactory manner, and yet lack of practice makes him unable to give weight to his remarks by means of a pencil sketch.

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Value of Sketches

In laying out an equipment of tools for almost any kind of work the free-hand sketch plays an important part. For example, in turret lathe tool design a sketch is almost invariably made of the holding device, whether it be a fixture or special chuck jaws. The turret is then shown with its four, five or six faces (as the case may be) and the desired cutting tools in position on their respective turret faces. The cross-slide is also shown, carrying its proper quota of tools, and several sketches are quite frequently made before the best method of handling the work is determined. An example of this kind is shown in Fig. 1. I have found a piece of cardboard layed off with ¼-inch squares of great assistance for this kind of work, where correctly proportioned sketches are essential. A piece of tracing paper may be tacked down on it and proportional sketches made quite rapidly. Sufficient information may be put on a sketch of this kind in a very short time, to enable a tool designer to lay out all the cutting tools required for the job.

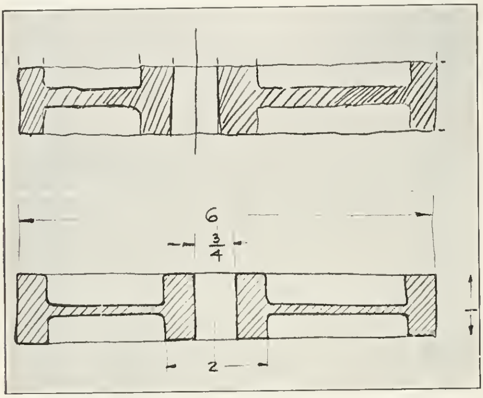

Fig. 4. Poor and Well Drawn Sketches of a Gear Blank

The jig and fixture man could hardly exist without his pencil and paper, but he would find it a great advantage to sketch in the object upon which the work is to be performed, with a red or blue pencil, before proceeding with the design, bearing the approximate proportions in mind. With this sketch as a basis, the adjacent parts of a jig or fixture can be made to adapt themselves more readily to existing conditions, and as the idea is developed, there will never be any doubt as to whether a certain line is a part of the jig or some portion of the piece on which the work is to be done. In this connection I wish to say that unless care is taken in regard to correct proportion, as previously mentioned, the draftsman who is laying out the jig will be continually in trouble, due to the "liberties of a free-hand sketch." As a matter of fact, this frequently changes the entire fixture and totally invalidates some "pet scheme" which the tool designer may have in mind, thus requiring an absolutely different handling of the work. An example of a quick jig sketch is shown in Fig. 2, which is a simple drill jig for a bell-crank. The work *X* is shown by dotted lines (for the purposes of reproduction in this article) but would, in reality, be a red or blue line in the original sketch.

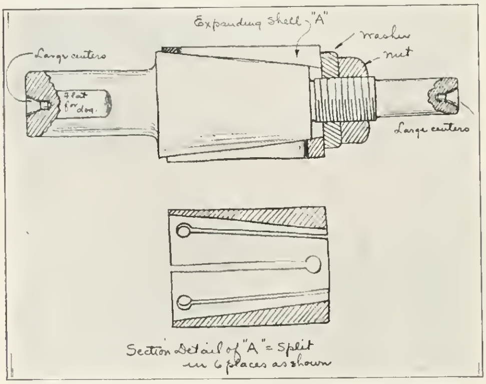

Fig. 5. Sketch of Expanding Arbor that gives Good Practice in Free-hand Drawing

Application in Filing Systems

An important field of usefulness for the free-hand sketch is found in connection with methods used in filing jigs, fixtures, cutting tools, etc. If a card system is used the back of the card may very easily contain a small sketch of the object referred to, with a couple of dimensions indicating its size. This will be found much more convenient than a reference to the original drawing, which may be filed in a way that makes it somewhat inconvenient to obtain it at a moment's notice. This method enables the jig and tool man to pick out exactly the tool he wants on a certain piece of work, although that particular job may embrace fifteen or twenty different fixtures. A record of this kind may be made more rapidly than one would think, as in filing by the card system it is necessary to have the drawing at one's elbow, so that a couple of minutes should suffice to make a rough outline which is sufficient to explain the purpose of the fixture.

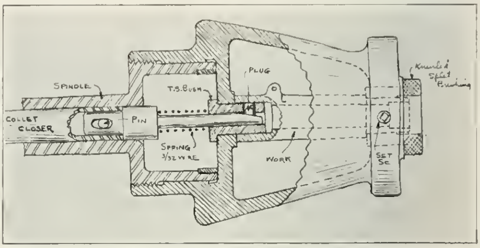

Fig. 6. Sketch showing Partial Sectional View making more than One Illustration Unnecessary

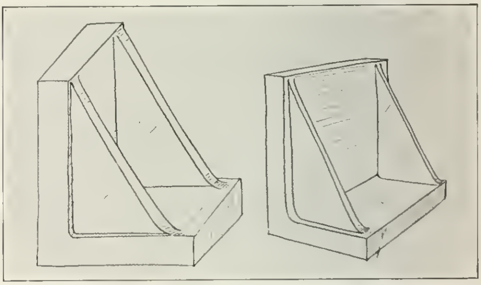

Fig. 7. Examples of Distorted and Well Drawn Perspective Sketches

Sketches Preserved for Future Reference

There is another point, of which I have made no mention, and that is the value of sketches preserved for future reference. How many mechanical men are there with experience which runs back a number of years, who have not wished they could remember the details of some special machine or method for doing a certain piece of work? I have in my possession old sketches and drawings which I have preserved for nearly fifteen years, and while these are in many cases out-of-date, something occasionally comes up where a reference to them is extremely convenient. Naturally, the sketches of more recent date are of much greater value, but the older ones are still kept, partly, perhaps, because they are "in good company." I suggest to any man engaged in mechanical pursuits, that the habit of keeping sketches for convenient reference (either in a book or loose in an envelope) will amply pay for the slight trouble which it may involve. Incidentally, I have found it a very good plan to put a date on the sketch, in addition to any data which may seem desirable. While speaking of this matter, I must mention a very successful designer and foreman of my acquaintance, who does not attempt to file or classify his sketches in any way, but simply clips a lot of them together and sticks them in a big envelope. When he wants one he hunts for it, and usually finds it in short order too, strange as it may seem, doubtless on account of his familiarity with the sketches themselves. Another man (also a successful designer) makes all his sketches in a note book containing plain paper and takes considerable pains to have the work look well. He is also particular to give all necessary information so that, as a reference, it is exceptionally valuable.

Common Faults in Free-hand Sketching

Sketches of rectangular work are seldom anywhere near rectangular. Right angles are either acute or obtuse. Curves are not symmetrical. The sketch frequently has no "character," and by that I mean that the lines are all about the same weight, no part standing out beyond another due to a heavier line or a bolder stroke of the pencil. Perhaps the greatest fault of all, and the one which is most common, is the loss of correct proportion in the object delineated.

Suggestions for Practice with a Few Helpful Hints

One of the important points which is, perhaps, the basis of the whole art, is the ability to draw an approximately straight line. Consequently the beginner should spend a little time in making parallel lines about two inches long (see Fig. 3), keeping them as nearly the same distance apart as possible. Continue this exercise until able to make lines five or six inches long which look like straight lines and not like the waves of the ocean. Having mastered this, proceed to make two parallel lines about two inches apart and six inches long, connecting the ends with two perpendiculars and thus forming a rectilinear figure as shown in the lower portion of Fig. 3.

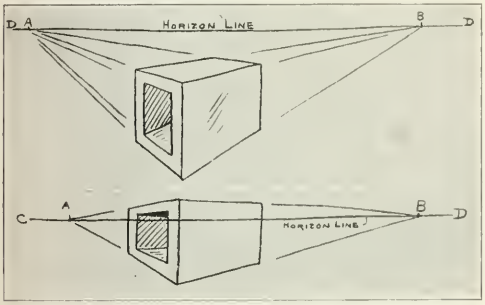

Fig. 8. Sketches made from Above and Level with the Horizon Line

After gaining confidence in the use of the pencil, proceed to make a gear blank 6 inches diameter by 1 inch face, having a ¾-inch hole through a 2-inch hub. First draw two parallel lines one inch apart and six inches long, connecting the ends by perpendiculars. Keep the correct proportions of the object constantly in mind and tick off the approximate sizes of the hub and hole with a pencil before drawing them in. Now try a scale on the sketch and see how nearly right it is. Very likely the first attempt will bear a close resemblance to the upper sketch in Fig. 4, but if drawn with more regard for the true proportions, it should more nearly approximate the result shown by the lower illustration. If the sketch is found to be badly out of scale it should be re-drawn until satisfactory; then put on the necessary dimensions, and a few light lines indicating a section. Keep these section lines about parallel and bear in mind that the outline is the principal part, the sectioning being merely to make the outline more prominent. Make your arrow heads and figures boldly and your dimension lines lightly.

After practicing on a few simple things of this nature, attempt a construction drawing of a cylindrical piece having three or more parts as, for example, the expanding arbor shown in Fig. 5. In this particular case, it might be necessary to show more than one view to make the sketch perfectly clear, as the expanding shell *A* must obviously be split in order to allow it to expand. This shell may be shown as a separate piece removed from the arbor (which is usually the better way) or somewhat less clearly in an end view. However, this end view involves drawing circles, which is by no means easy. As far as is consistent, it is well to avoid the use of circles, as they are invariably lop-sided, elliptical, or otherwise distorted, unless drawn with a compass. When absolutely unavoidable a circle may be approximated by means of a series of quarter-arcs drawn one at a time with the ends touching, using center lines crossing each other at right-angles as a guide. When making a sketch to be used as a working drawing, all *unnecessary* shading should be avoided, only enough being used to make matters perfectly clear.

Value of Sectional Drawings

Sectional drawings are of value where cylindrical objects are to be represented. If a sectional view is used it is seldom necessary to make more than one view, unless the piece shown is unsymmetrical in some way, and even then it may be so specified in the sketch. For example, the gear shown in Fig. 4 has six spokes, and a notation to that effect will cover the situation as well as if another view were shown.

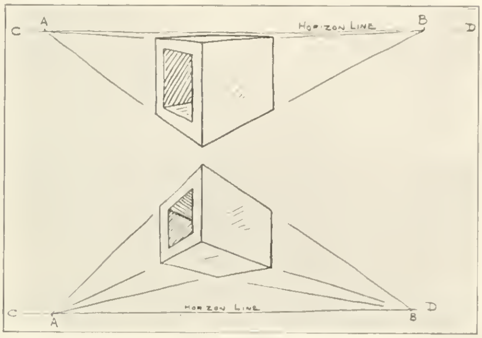

Fig. 9. Sketches made from Different Distances below the Horizon Line

In order to bring out the full value of a free-hand drawing and make it more comprehensive, a certain amount of shading is *sometimes* an advantage. For instance, one surface standing out in advance of another may be left plain, and by the addition of a few shade lines at its junction with the remainder of the fixture will throw that surface into bold relief, as shown in Fig. 2. Shading must not be carried to excess, however, and need not be used at all unless it is a distinct advantage in serving to make the drawing more readable. Cylindrical work, unless shown in section, should always have a few light shade lines to indicate its convexity.

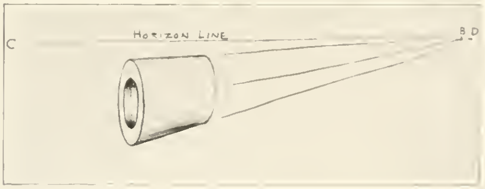

Fig. 10. Sketch of Cylindrical Piece showing Concentric Circles Drawn Free-hand

It is frequently desirable to break away some portion of a cylindrical object in order to show the interior construction more clearly and, at the same time, to give a general idea of its appearance as a whole. An example of this sort is shown in Fig. 6, and a broken section of this kind sometimes makes it unnecessary to draw in another view. The same method was followed in Fig. 5, where the ends of the arbor are broken away in order to show the prominent centers. In all cases where sections are used, considerable care should be taken to kee the portions on each side of the center line as nearly alike as possible; otherwise, when the sketch is completed, it will present a lop-sided appearance, very detrimental to the general effect.

Free-hand Perspective Drawings

After a man has become proficient he may, in certain cases, use the perspective form in sketching, but this should not be done unless he has a good eye for proportion and some knowledge of the principles involved. Where these qualifications are lacking, the result may be a frightfully distorted view, such as the one shown at the left-hand side of Fig. 7. This sketch, if drawn with more regard to the rules governing perspective, would have the appearance of the right-hand illustration in Fig. 7. Obviously, the subject of perspective is too extensive to handle thoroughly in an article of this kind and, furthermore, its field of usefulness in a mechanical way is somewhat limited, so that I shall simply give a few suggestions regarding the application of its principles.

In a perspective drawing, all vertical lines are shown vertically, but of varying heights which depend upon the ratio of distance from the eye of the observer to the lines in question. Parallel lines in any other plane except the vertical must be so drawn that all lines in such planes will meet in common points, if sufficiently prolonged, as shown at *A* or *B* in Figs. 8, 9 and 10. This point is termed the "vanishing point" and when the lines are in a horizontal plane, it invariably falls somewhere on the line *C—D*, or the "horizon line" as it is called, which is assumed to be on a level with the eye of the observer. The position of the horizon line and the location of the vanishing point determine the appearance of the object shown in the sketch. For example, compare the upper illustrations in Fig. 8 and Fig. 9. These are obviously different views of the same object, the former being seen from a point considerably above and the latter very nearly on a level with the eyes. It will be noted that the view represented in Fig. 9 appears more natural and in better proportion than the one in Fig. 8. This is due to the lower position of the horizon line and the resulting increase of the distance between the vanishing points. Bear in mind, in this connection, that the higher you place the horizon line, the closer together the vanishing points will be, and the less pleasing the resulting drawing will be to the eye. This is due to the fact that the viewpoint taken is a somewhat unnatural one, and for that reason the resulting sketch appears distorted and out of proportion. By carrying the horizon line still lower we note that the upper surfaces do not appear at all, as the edges are hidden by the projection of the two upper lines, as shown in the lower view in Fig. 8. Once more dropping the position of the horizon line, until it is entirely below the object, makes the latter appear as if suspended in the air, as shown in the lower view in Fig. 9.

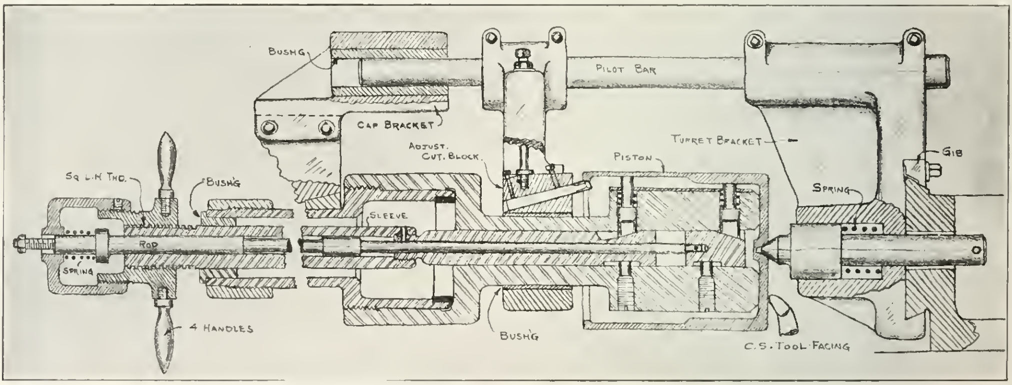

Fig. 11. Example of Proficiency which may be attained in Free-hand Sketching

I have included but one view of a cylindrical piece in Fig. 10, which is presented to show the appearance of circles when drawn in perspective. It is extremely difficult to make a drawing requiring the delineation of concentric circles, and yet not offend the eye by the representation of ellipses which cannot by any stretch of the imagination be considered as anything more than irregular curves. It will be noted that nearly all of the sketches shown are extremely simple, for it is not the writer's purpose to point out how difficult but rather how easy it is to make free-hand drawings of simple objects, after a little practice with the pencil along the lines I have mentioned.

One other example, serving to show the chance for development in sketching, is reproduced in Fig. 11. While this sketch is by no means perfect, it was drawn without the aid of any mechanical devices, straightedges or other instruments. Nothing was used to obtain the proportions except the eye, and every line in it was made absolutely free-hand. In conclusion, I will urge those sufficiently interested in the matter to try their hand at sketching, as a pastime if for no other purpose, and they may rest assured that in this case, as in all others, "practice makes perfect." In addition to this, the man who perseveres will find himself amply repaid for the effort, both at present and in his future work.

* * *

FULL WEIGHT PIPE

The National Tube Co. and other concerns manufacturing welded pipe have announced that the manufacture of the so-called "merchant" weight pipe will be abandoned, and that hereafter only full-weight pipe suitable for all purposes will be furnished. The announcement is of considerable importance to every mechanical trade, and the reason for the change, no doubt, will be of general interest.

In the past, there have been legitimate uses for "merchant" pipe, that is, pipe lighter than the standard pipe, but its use made it necessary for jobbers to keep several grades of pipe in stock, and consumers were more or less uncertain as to what grade of pipe was furnished to fill their orders. Full-weight pipe is suitable for all purposes for which the "merchant" weight pipe has been commonly used, but the opposite is not true. Serious mistakes have been made and fraudulent impositions have been practiced by the use of "merchant" weight pipe where standard pipe should have been used, and the advantage of the abandonment of its manufacture is obvious. Consumers will be furnished henceforth only with standard pipe for all purposes. The necessity of weighing or measuring to determine whether or not the standard pipe is furnished, will be obviated.

* * *

The power transmission chains made by the Whitney Mfg. Co., Hartford, Conn., are "jacked" before shipment. The "jacking" consists of running them one hour under load, the load being proportioned to the chain capacity. When the production of finished chains runs up into the hundreds per day, the matter of power consumption becomes a serious one. The company has solved the problem very simply and effectively. The same load is made to test several chains running in series. A number of ball bearing shafts and sprockets are mounted on a bed-plate with provision for adjusting them to different center distances. An electric motor drives the first chain which, in turn, drives the first spindle, and that transmits the motion to the opposite spindle and sprockets, and so on back and forth to the fan which provides the load. The load is slightly more on the first chain than on the last, of course, but the difference is only that due to the power absorbed in friction of the chain sprockets and bearings. This loss with "silent" chains and ball bearing spindles, is so low as to be negligible for the purpose of a running test.

SETTING UP AND OPERATING AUTOMATIC SCREW MACHINES*—1

APPLICATION TO THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

Given a certain piece to produce on the "Acme" automatic screw machine, the first thing to consider is the best method of applying the various tools, dividing the cuts, etc., so as to get the greatest possible production without crowding any of the tools with a heavier feed than they will stand under continued service. Another point to bear in mind is to cover the work as much as possible with the top- and side-working tools, to avoid the necessity of making elaborate or expensive gages for inspecting, where if the forming tools were properly designed, a simpler gage would serve the purpose as well. Parts which should be accurate as regards diameter should be covered with a shaving tool, and every possible advantage should be taken to produce the work accurately. Experience, of course, is of great assistance in the laying out of jobs to the best advantage on the "Acme" automatic screw machine, and a clear understanding of the possibilities of this machine is one of the first requirements. To assist those desiring this information, this series of articles will be concluded with a collection of representative examples showing commendable methods of applying the tools to the work under various conditions.

To make clear and understandable the methods followed in setting up and operating the "Acme automatic," a representative piece will be taken as an example, and the various steps to be followed in setting up and operating the machine for producing this piece will be dealt with in detail. Of course there are many points that will "crop up" in the setting up of the machine for producing various parts where actual experience in work of a similar character would in many cases eliminate the necessity of experiment. However, if the operator has a general idea of the various working mechanisms of the machine and their relation to each other, he will experience little difficulty in going through the various steps in setting up the average job.

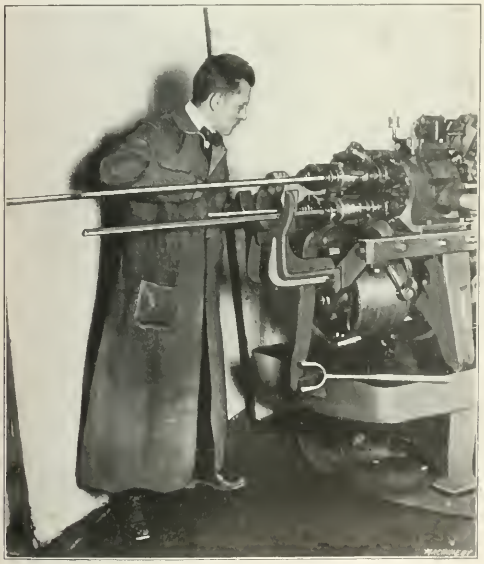

Fig. 1. Operator inserting Bars of Stock in Tool Spindles of the "Acme" Multiple-spindle Automatic Screw Machine

Preparing the Machine for a New "Set-up"

Assuming that the machine has been set up on a piece of work, the first thing that the operator does is to dismantle those parts, tools, gears, cams, etc., which have to be changed for every new job, leaving, of course, any cams or tools in position that can be used on the new piece. As a rule, the spring chucks and feed chucks are removed first and are replaced by those of the proper size and shape. Then the tools in the main tool-slide and the side- and top-working tool-slides are removed. When a straight blade cut-off tool is used in the cut-off tool-slide, it generally can be used for more than one job, so that in many cases this tool need not be removed. The cams on the main drum, and also the cams for operating the side-working tool-slides, are now removed and replaced by cams which will give the required amount of travel. The back-gears for rotating the end-working tools and the threading spindle are next removed and replaced by gears that will give the proper speeds for the work in hand.

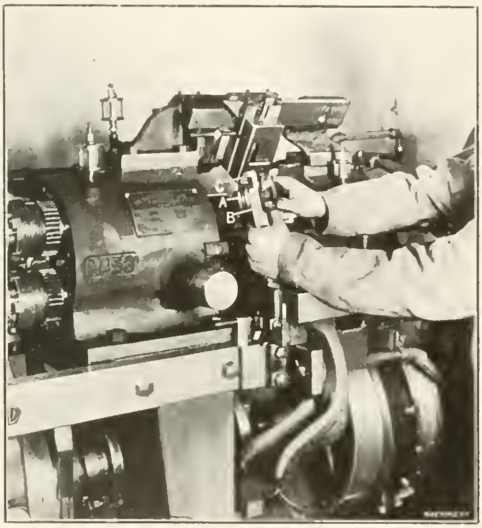

Fig. 2. Setting the Cutting Edge of the Circular Forming Tool to the Proper Height with the Tool-setting Gage

Should the job which is to be set up be laid out by the foreman of the department, the operator, of course, is given a certain piece and instructions, and it is "up to him" to produce it in the estimated time. If, on the other hand, it is necessary for the operator to set up the job without instructions, he must first decide on the best method of applying the tools before he commences to set up the machine. As this is frequently the case, it may be advisable to give in the following a short description of some of the points which have to be taken into consideration when deciding on the best method of tooling the machine for producing any certain part.

Deciding on the Method of Tooling

The four spindles of the "Acme" automatic multiple-spindle screw machine sometimes tend somewhat to confuse a new operator, and to give him the impression that a clear understanding of the method of tooling is more difficult to obtain than on a single-spindle machine. The chief reason for this is that all the tools are used at once. However, this fact frequently makes it possible to rearrange the tools considerably on repeating a set-up, and what might have been considered the best method of tooling a certain piece when it was first made may prove inferior to the new method. This possibility of improving upon the method of tooling sometimes changes the order of operations to such an extent as to entirely change the method of manufacture.

For the sake of illustration, we will assume that it is necessary to produce the cap-screw shown in Fig. 3, which is to be made from cold-rolled hexagon steel, 11/16 inch in diameter across the flats. By a close inspection of this piece it will be seen that as it is just an ordinary cap-screw, the body need not be shaved, but can be produced accurately enough for all practical purposes by dividing the cuts on the body between two box-tools, which are held in the end-working tool-slide. Referring to the diagram, Fig. 3, it will be seen that the operation at *A*, which takes place in the "first" position, is performed with a circular form tool and box-tool. Here it will be seen that the circular form tool has formed the head and necked the piece, whereas the box-tool, held in the "first" position tool spindle, has traveled up one-half the length of the body. Now in choosing the lead cam for the forward travel of the main tool-slide, a one-inch cam is sufficient, owing to the fact that the two box-tools are working on different bars at the same time. The second box-tool cutter, of course, is set one inch further out from the face of the main tool-slide than the first box-tool cutter in order to complete the turning on the body of the cap-screw.

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* For information previously published in MACHINERY on National Acme automatic screw machine equipment, see "Cross Drilling and Milling Machine Attachments," April, 1913, and articles there referred to.

†Associate Editor of MACHINERY.

Calculating the Production per Hour

As all of the end-working tools come up to the work at the same time, it follows that in most cases all four tools from the end would be at work on different bars at the same time.

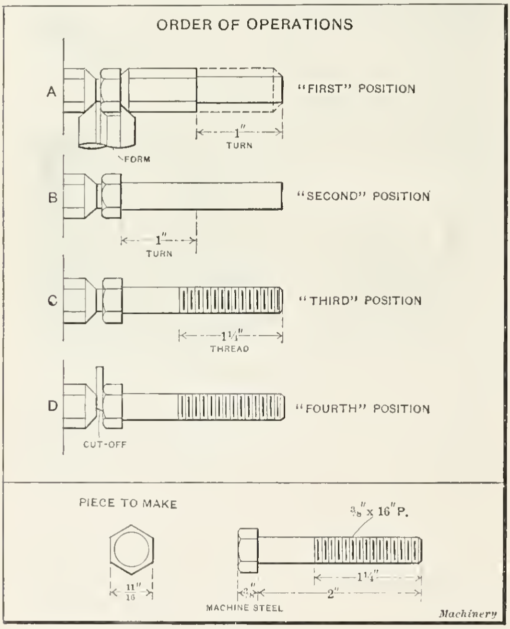

Fig. 3. Order of Operations followed in producing a Hexagon-head Cap-screw

In this case, as the screw to be made is of simple design, it only requires the use of three end-working tools—two box-tools and a die—although a pointing tool could be used if necessary to make the point on the screw after it is threaded. By considering the operations on this cap-screw, it will be found that the longest operation is that necessary to turn one-half the length of the body; then to find the production per hour, it is first necessary to determine the speed at which it is best to run the work. As a rule, ordinary cold-drawn stock can be worked at from 65 to 75 surface feet per minute for forming tools or box-tools. In this case we will select 75 surface feet as a suitable speed; then, figuring as though the bar were round and of a diameter equal to the distance across the flats, we find that a spindle speed of 420 revolutions per minute will be about right. Upon referring to the table of spindle speeds accompanying the No. 53 machine, we find that 445 is the closest obtainable. This will not increase the speed too much, so we will put the back-gears on in their positions as listed in Table VIII, which appeared in the January, 1913 issue of MACHINERY.

The next step is to find the number of revolutions of the spindle required for the box-tool to travel up one inch on the work at a certain feed per revolution. The body diameter of this cap-screw is ⅜ inch, while the diameter across the corners is 0.794 inch, giving us a depth of cut of 0.209 or approximately 7/32 inch. Deciding on a feed of 0.004 inch per revolution, and allowing 0.040 inch for the tool to approach the work, we find that it will take 260 revolutions of the spindle for the box-tool to travel the distance required.

There are several methods followed in obtaining the production of the "Acme" automatic screw machine, one method being based on the assumed output per hour, which can be obtained by the following formula:

$$P = \frac{R \times 60}{r}$$

in which P = assumed product in pieces per hour,
R = R. P. M. of work spindle,
r = revolutions of spindle required to complete the longest single operation.

Then, inserting the values previously obtained in this formula, we get:

$$P = \frac{445 \times 60}{260} = 103 \text{ (approximately).}$$

Now in assuming this product no consideration has been given the time required to feed stock, index the cylinder, etc., so instead of calculating the actual time required for these idle movements, an approximation is made. Referring to Table V, which appeared in the January, 1913 number of MACHINERY, we find that the next closest production to 103 is 98.5; then by dropping down to a product of 98.5 pieces per hour, we allow sufficient time to take of the idle movements of the machine.

Another method which will be described more fully in a future article is to calculate the time required for the longest single operation in the manner just described, and then determine definitely the actual time required to feed the stock, index the cylinder, etc. This is added to the time required for the longest single operation, the sum giving the exact time required to produce one piece. This method, while considerably longer than the other, seems to have the advantage of working on some definite basis and to be more clearly understood by those not entirely familiar with the construction and operation of this machine.

Setting up the Machine

Taking the piece shown in Fig. 3 as an example, and assuming that the machine has been dismantled, the first thing to consider is the insertion of the proper spring chucks and feed chucks for feeding and holding the bars. A point to note here, is that a round chuck should never be used for holding either square or hexagon stock, but a chuck of the same shape as the work should always be used. After the feed chuck and spring chucks have been put in place, the bars of stock, as shown in Fig. 1, are then inserted, the chucks being opened and the bars being pushed through so that they just extend far enough out of the chucks to be trimmed off with the circular cut-off tool. As a rule, it is good practice in setting up, to put the bars of stock into the pipes for guiding them before the machine is started. In putting the reel in place, when the bars are already in the spindles of the machine, it is simply slid back over the rear bracket until it passes the end of the bars, then slid forward again, the bars passing into the pipes. What probably is better practice, is to leave the reel in place and push the rods through the pipes into the spindles, then slide the reel back slightly to facilitate chucking, and replace it again in the running brackets before starting the machine. When the stock is small in diameter the ends projecting from the rear end of the machine should be guided by the pipes of the reel, as this prevents damage to both machine and operator due to a slight twist in the bars which causes them to rotate eccentrically and buckle.

Selecting and Changing the Back-gears

After the stock has been inserted in the machine, and the chucks closed on it by cranking the machine, the next step is to get the desired spindle speed. This is secured by removing the back-gears as shown in Fig. 4 and replacing them with the gears which will give the proper speed for the work in hand. For this example we have selected a spindle speed of 445 R. P. M. Referring to Table VIII, which appeared in the January, 1913 number of MACHINERY, we find that for the No. 53 machine, the gears should go on as follows: *A* — 52; *B* — 46; *C* — 26; *D* — 32. In putting on the back-gears, see that they do not mesh too closely as this will consume more power.

Selecting the Lead and Forming Cams

A feature about the "Acme" automatic screw machine which should be borne in mind is the fact that the lead cam located on the drum for governing the forward advance of the main tool-slide is not adjustable, but is bolted to the drum. Now for different jobs, these cam strips which are all of the same length, but have different rises, are put on the drum and clamped by cap-screws as shown in Fig. 6. For making the cap-screw shown in Fig. 3, it is necessary that the main tool-slide travel forward approximately one inch, so in this case a lead cam having a rise of one inch in its length is selected. To determine this, measure both the narrow and wide ends of the cam strip, and the difference between these two dimensions will be the lead of the cam.

To select the forming cam, measure the distance between the largest and smallest diameters of the work formed by it and divide the result by 2. In this case we find that the forming cam should have a rise of 7/32 inch. All forming cams are plainly marked on the end with the rise for which they were laid out. Of course it is not always possible to select a forming cam which will give the rise to within a few thousandths of an inch of that required, but this does not make much difference, as the longest single operation governs the time required to make one piece, and all the other operations are completed in that time. In this example, as is usually the case, the forming is one of the shorter operations.

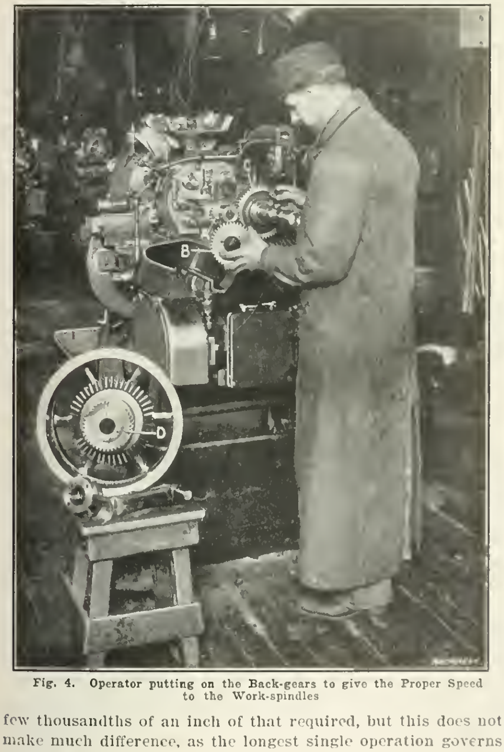

Fig. 4. Operator putting on the Back-gears to give the Proper Speed to the Work-spindles

To select the cut-off cam, measure the diameter of the piece to be cut off and at the same time make allowance for the angle on the point of the cut-off tool so that it will pass the center of the work. For cutting off the cap-screw shown in Fig. 3, a ½-inch cut-off cam, which actually has a rise on the cam of ¼ inch to cut through a bar ½ inch in diameter should be selected. The cut-off cams, it will be noticed, are all marked on the end to correspond with the diameter of the piece to be cut off.

Placing the Cams

In placing the lead cam on the drum, when the operations performed from the main tool-slide are of a heavy nature, a backing up strip should be fitted into the groove in the drum, behind the lead cam, so as to resist the thrust of the cutting tools. A starting strip should also be put on just in front of the point where the lead cam strip starts to bring the tool-slide up to the work, and a take-back cam wide enough to draw the end-working tool-slide back sufficiently to clear the work when the cylinder is indexing, should next be put in place. This starting strip is adjusted even with the starting or narrow end of the lead cam, and is used to bring the tools up quickly to the work. When the roller is working on the "fast-angle" cams, the camshaft is rotated at an increased speed, so that all the movements when the tools are not cutting are a great deal more rapid than the cutting movements. This is done, of course, to economize time and is accomplished through the medium of the Johnson clutch arrangement described in a previous article.

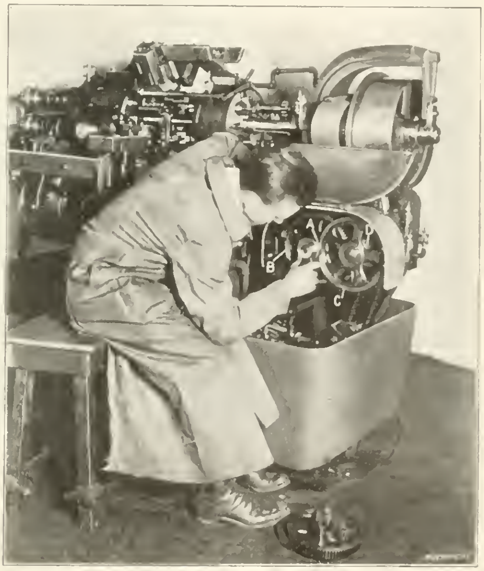

Fig. 5. Operator selecting the Proper Change-gears for rotating the Camshaft at the Required Speed

In placing the cut-off cam in position, it should be put on the disk opposite the one on which the forming cam is held, and the take-back cam is also put on the same disk and attached by screws. There are two sets of holes in the disk for the cut-off cam, and the position of this cam on the disk depends on whether the "fourth" end tool position is in use or not. The disk for the forming cam has only one set of holes, so that it is impossible to adjust it.

Setting the Circular Forming and Cut-off Tools

The circular forming tool *A*, shown in Fig. 2, is held to an oblong-shaped toolholder *B* by a stud and nut. This holder is held in the slot in the forming slide by a strap. For locating the cutting edge of the forming tool in the proper relation to the work, a tool setting gage *C* is used. This is held by the operator against the bottom face of the forming tool holder as shown, and the nut bolting the forming tool to the holder is then tightened. The holder is then placed in its proper position in the slot in the tool-slide and clamped. To bring the forming tool into its correct relation to the work, the machine is cranked until the roll is just over the starting angle on the forming cam, then the screw in the back of the slide is adjusted until the forming tool just clears the work.

The adjusting screw on the slide in which the forming tool is held should be set to stop the slide just as the cam lever clears the highest point of the cam. Usually it is good practice to put a slight tension on this lever (by adjusting the screw a little further in than necessary), so that when the extreme knife edge of the tool is removed, making the work larger in diameter, a slight outward turn of the adjusting screw will bring the work back to the required diameter.

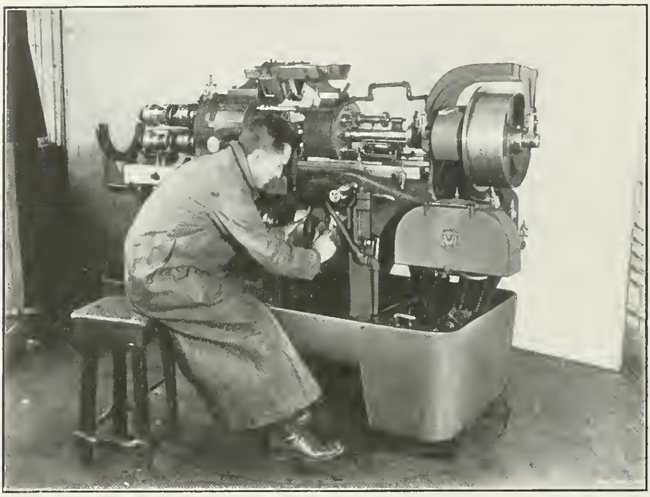

Fig. 6. Clamping the Lead Cam to the Main Drum for governing the Forward Advance of the Main Tool-slide

The next step is to set the cut-off tool. This tool, when of the blade type, is set so that its top cutting edge is on a line with the center of the work. It should also be set in a horizontal position relative to the forming tool, by adjusting the screw in the slide, which is provided for that purpose. After the form and cut-off tools have been set in approximately the correct relation to each other, the next step is to set the form tool so that it will turn the work to the required diameter. To do this, crank the machine as shown in Fig. 8, until the wedge is disengaged from the wedge fingers, then push the rod through the chuck until its end passes the outside edge of the circular form tool. Continue cranking until the rod is chucked and the roll on the lever operating the forming slide is on the starting point of the cam rise. The form tool can now be adjusted inward as previously mentioned, the machine started and a cut taken. It is good practice to get those parts of the work covered by the form tool to the required diameter before going further. Of course, it is necessary to set the cut-off tool to remove the formed ends during the adjustment of the forming tool.

After one piece has been cut off, it can easily be seen whether the cut-off tool has been set in the proper relation to the center of the stock. Care should be taken to see that the front edge of the cut-off tool passes a little beyond the center of the work, thus making sure that there are no burrs left on the end of the rod to interfere with the proper feeding of the stock against the gage stop. The adjusting screw in the bottom of the slot of the cut-off tool-slide provides a means of raising the tool so that its top edge comes in the proper relation to the center of the work.

Setting the Box-tools

Assuming that the forming and cut-off tools have been properly set, place the box-tool in the "first" position tool spindle. Then open the chuck, as previously mentioned, and feed out the stock. When the work is long or of small diameter it is good practice, in setting the box-tool, to feed the stock out only a short distance from the face of the chuck to prevent springing or bending of the bar while adjusting the tool. In setting the box-tool, release the rollers and set the front turning tool to turn from 0.005 to 0.007 inch smaller than the proper diameter, after which adjust the rollers until they come into light contact with the piece to be turned. Then by adjusting the front cutting tool upward slightly, the tool and rollers will come into the proper relation with each other. In many cases a slight additional adjustment of the box-tool cutter is necessary after the machine has been started to run on power feed.

Several methods are in common use for setting the box-tool to turn to the desired distance. One of these is to crank the machine until the roll just starts on the rise of the lead cam; then to operate the screw *A* in the tool spindle, in the manner illustrated in Fig. 7, until the box-tool cutter *B* just touches the work which, we will assume, has been fed out to the required length. After adjusting in this manner, tighten the screw holding the box-tool in position in the toolholder. After the "first" position box-tool has been set in position in proper relation to the work, the power feed may be thrown in to index the cylinder by operating the starting clutch lever *A*, see Fig. 8. This will bring the rod just operated upon into the "second" position. Now adjust the gage stop and set the feed stop on the lever operating the feeding mechanism so that the stock will be fed to the length of the piece to be made, being sure to ascertain beforehand that the feed tube is withdrawn sufficiently to insure the end of the rod coming in contact with the gage stop. When the stop has been properly set, the stock fed the proper distance and the cam roll-holders set so as to give ample clearance for all tools, crank the machine until the roll on the cam roll-holder S_2 (which appeared in Fig. 9 of the December, 1912 number of MACHINERY), is in contact with the start of the rise on the lead cam.

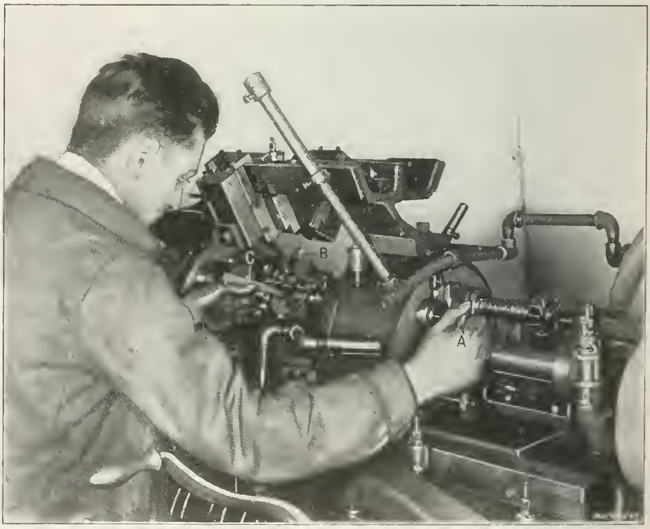

Fig. 7. Setting the "First" Position Box-tool to turn up the Required Distance on the Work

After having set the "first" position box-tool, again crank the machine until the forming tool and "first" position box-tool have completed their operations and another indexing of the cylinder is about to take place. After this indexing has proceeded about half way, place the "second" position box-tool back far enough to clear the stock during the indexing operation. Continue cranking until the cam roll is in contact with the cam as before; then adjust the "second" position box-tool so that it will pick up the cut at the position where the "first" position box-tool finished, and at the same time set the rest and front cutting tool to the diameter formed by the "first" position box-tool. To bring the box-tool out so as to turn up the correct length, an ordinary scale *C*, as shown in Fig. 7, is sometimes used. Some operators prefer the "scale method" of setting the end-working tools, instead of working from the end of the bar, as previously mentioned.

When the screw is to be pointed, a pointing tool can be held in the "first" position box-tool, or if the "fourth" position tool spindle is not used, a pointing tool can be used from this position. Assuming in this case, that we carry the pointing tool in the "first" position box-tool and that the gage stop, forming tool, box-tools, etc., have been properly set, release the set-screw holding the pointing tool which points the screw. Then crank the machine until the tool-slide travels forward the required distance, and adjust the pointing tool out until it will remove the desired amount of metal from the end of the screw.

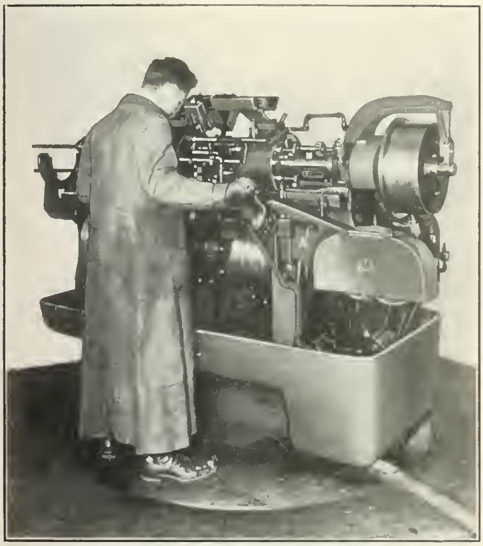

Fig. 8. Operator cranking the Machine to rotate the Cylinder and bring the Various Tools into Position when setting up

Selecting Change Gears

Assuming that all the tools previously mentioned have been set in their proper positions, several pieces are made from the bars, the machine being operated by power feed. The next step is to put on the proper change gears to give the desired product. As a rule, in setting up an "Acme" automatic screw machine, the gears which have been decided upon to give the desired production are not put on until all the tools have been properly set and the various mechanisms of the machine working in the proper relation to each other. The majority of operators set up the machine on a "slow" set of gears, and after the machine has been set correctly, put on the gears which will give the desired production. Fig. 5 shows an operator making this change. The gears which he has selected for putting on the machine are shown lying on the floor. For the piece which we have chosen as an example, we decided that a production of 98.5 pieces per hour would be suitable. Referring to Table V in the January, 1913 number of MACHINERY, we find that the first gear *B* on the shaft should have 36 teeth, the second gear *A* (immediately in front of gear *B*, but not shown) on the shaft 82 teeth, the first gear *D* (directly behind gear *C*) on the stud 74 teeth, and the second gear *C* on the stud 28 teeth. After these gears have been put in their proper positions, the next step is to set the threading spindle.

Setting the Threading Spindle

On the "Acme" multiple-spindle automatic screw machine, the work-spindle is held stationary while a right-hand thread is being cut, and the die-spindle carrying the threading tool is rotated. Then in backing off the die or tap from the work, the threading spindle is held stationary and the work-spindle rotated. The manner in which this is accomplished was explained in connection with the description of the threading mechanism in the article which appeared in the December, 1912 number of MACHINERY. In setting the tools for threading before starting the machine, see that the clearance between the ratchet and pawl extension is anywhere from 1/16 to 1/8 inch, when the pin block on the holder and the pin in the spindle are placed end to end (after the pin has been adjusted). It is very important that this precaution be taken as a "hang up" between these two points, resulting in the stripping of the teeth in the gears driving the holder, might occur, should this adjustment not be properly made. For this example, the front face of the die should be set almost in line with the cutting tool held in the box-tool in the "first" tool position, when the die-spindle is as far back as the tool-slide will let it go.

Now the lead cam does not advance the threading tool at the proper speed, but provision is made so that the die follows the lead of the thread. It is therefore unnecessary to take the lead cam into consideration at all as far as the feeding of the die-spindle is concerned. A point to look out for, however, is the length of the die pins which actuate the die-holder driving the threading die. These should be set so as to carry the die up far enough after the end of the travel of the lead cam has been reached, before allowing the die to rotate freely. In this case the lead cam only travels approximately one inch, while the travel of the die is $1\frac{1}{4}$ inch, so that it will be necessary to set out the die pins. After all the tools have been properly adjusted and are working satisfactorily, set the cam dogs which shift the clutch to direct drive to operate at the proper time in relation to the cutting tools and the indexing of the cylinder. As a general rule, the clutch should be shifted to the direct drive when the die or tap is just free from the thread and the rolls have cleared the cutting-off and forming cams. The clutch again shifts to the gear drive just before the tools begin to operate. The method of making these adjustments was described in the January, 1913 number of MACHINERY.

In the second installment of the article on "Automatic Screw Machine Equipment" published in the March number, the formula for determining the diameter of a thread roll was erroneously given as follows:

$$D = N\left(d_1 - \frac{d_2}{0.625}\right)$$

This should read:

$$D = N\ (d_1 - 0.625\ d_2)$$

* * *

THE BRITISH AERONAUTICAL EXHIBITION

The Aeronautic Show at Olympia, London, this year, was mainly devoted to the exhibition of aeroplanes of English design and manufacture, about two-thirds of the machines being British. In finish and workmanship these machines were quite comparable with the aeroplanes built in France and exhibited at the Paris Show last October. In all, there were twenty-four aeroplanes exhibited, of which six were of the hydro-aeroplane type. Fifteen were bi-planes and nine, monoplanes. One of the most interesting machines on exhibition was the Cody bi-plane which has flown over 7000 miles, reached a maximum speed of 72 miles per hour and possesses a climbing ability of 300 feet a minute. The chief novelty in construction was shown in a British built mono-hydroplane in which all the usual guys were dispensed with and the wings were braced on their under sides with strong trusses of steel tubing. The total weight of the steel tubing for trussing the wings was only thirty-five pounds. Another hydro-aeroplane of interesting construction was the so-called "flying boat" constructed by Sopwith, which is a combination of a bi-plane and a boat built of cedar, the total weight of the boat being only 180 pounds. The boat is provided with wheels so arranged that they can be raised when it is operating in water, and dropped down when it lands on the ground.

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MAY, 1913

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ANTIQUATED MACHINE TOOL EQUIPMENT

A large and well-known machinery manufacturing concern recently passed its quarterly dividend, which the directors explained as follows:

> Business conditions since the beginning of the calendar year have been of a disappointing nature. The volume of new business has decreased and prices obtainable for machinery have declined. Demand for our classes of machinery has not been equal to the present equipment of manufacturers throughout the country. *No new competition has arisen, but existing competition is, if anything, sharper than at any time in the history of the company.* (The italics are ours.)

In some of the plants of the constituent concerns of this company, the tool equipment is notoriously poor. Machine tools thirty years old are in use, which, of course, means machines of inferior design, weak power and generally low production. Some of the plants are poorly lighted and ill-arranged, the cost of labor for handling parts and material is heavy, and the unit production per man is low.

One of the competitors of the large concern which has just passed its dividend follows quite the contrary policy as regards machine tool equipment. Instead of being content to use old machine tools thirty years behind the times, its management insists on having tools that are, if anything, ahead of the times. The latest and best machinery obtainable is demanded and machinery built to order is provided, which promotes rapid and low-cost production, especially on parts made in large quantities. Machine tools that the big concern regard as being too *costly* and too special for its plant, are actually being thrown out by its smaller competitor as being too inefficient and too *expensive* to be kept in *its* service.

This example shows again that an aggregation of concerns forming a huge combination of plants has no advantage over small competitors unless it provides up-to-date machinery and methods, and employs high-grade men to manage the manufacturing as well as the selling end. The price of success is progress, and in no line of manufacture is this more evident than in the machine industry.

* * *

THE MARKING OF TOOLS

There is many a tool-room where thousands of separate tools are stored with no other marking than a card or label in front of each bin in which the tools are placed. This lack of identification makes it difficult to determine the particular operation for which each jig, arbor or special tool is intended to be used, and much time is wasted in "trying and fitting" the tools to the work to be done. In all well-organized tool-rooms, however, every individual tool is marked in some way to identify it with the operation for which it is to be used, and sometimes this marking gives almost a complete description of the purpose of the tool. No doubt this is very desirable, but it is also very expensive, because the marking of whole words on odd tools is not work that can be easily and rapidly performed. The best method is simply to give each tool a number, as a few figures can be quickly and rapidly stamped on it. Then a chart should be provided which gives the detail information required in connection with each tool. These tool numbers can be used on the drawings of the piece to be made, or on special shop operation sheets in cases where these are used. A great deal of time is saved in this way. It is much easier to keep a record of the tools that have gone out of the tool-room, and mistakes and spoiled work due to the using of wrong tools are more easily prevented. It is surprising to find that some large shops are without a proper system for marking and identifying the tools used in manufacturing.

* * *

SQUARING THE CIRCLE

A little booklet, evidently written by an amateur, on "Squaring the Circle," recently attracted our notice as an interesting example of wasted energy. Some persons with a smattering of education apparently believe that squaring the circle, that is, finding its area in terms of the square of the diameter, cannot be accomplished, simply because mathematicians have not found the number expressing the exact ratio between the diameter (or radius) and the circumference. It is true that the ratio of the diameter to the circumference of the circle is incommensurable—not capable of being exactly expressed in figures—but it has been determined with exactness to several hundred decimal places. When expressed in only four decimal places it is so nearly exact that it serves most practical requirements. The ratio to the eleventh decimal place is 3.14159265359. When calculated by the formula $A = D^2\pi \div 4$, assigning the common value 3.1416 to π, the area of a circle 100 feet in diameter is 7854 square feet. If, instead, the exact value to the eleventh place is used, the area is found to be 7853.981634 square feet, or less than 0.02 square foot difference. It is evident that any degree of accuracy ordinarily required can be obtained with the approximate value of π.

The history of the attempts made to square the circle is interesting reading, although now they are regarded as a lamentable waste of time and energy. One mathematician who devoted many years of his life to it ordered that the value of π determined by him to several hundred places be cut on his tomb. No one in this practical age need waste his time and energy on the ancient mathematical problems, of which squaring the circle is only one. They are generally regarded by able scholars as being impossible of exact determination, but even if they were solved exactly the benefits resulting would be of very little value.

THE WIDENING FIELD OF THE GYROSCOPE

The gyroscopic compass has been in service for some months in six battleships and two submarines of the Atlantic Fleet. From four of these battleships, reports have been received by the United States Naval Observatory that the performance of the new compass has been highly successful and that it is now used wholly for steering, although, as a matter of precaution, its courses are still checked by the magnetic compass.

These reports and similar ones from previous tests foreshadow, for navigation, the ultimate replacement of the magnetic needle—trustworthy when its readings are corrected with much care by the gyroscopic compass, a simple and reliable instrument of precision, which has been brought to perfection by purely engineering methods. The principles on which its action is based, are those established by the French physicist Foucault from his analysis of gyroscopic phenomena in 1851–2, *viz.*: First, that a rapidly rotating disk or wheel, which is so suspended as to be free to move about all axes, tends, in accordance with Newton's first law of motion, to maintain its axial direction in space; second, that, when the disk is so suspended that its axis is horizontal and motion about that axis is partly restrained, the directive action of the earth's rotation will cause the disk to "precess" or turn about the vertical axis so that its plane of rotation shall coincide with that of the earth and its axis shall point to the geographic north.

The probable relegation of the time-honored magnetic needle to the limbo—never of the forgotten but of the archaic, marks the growing recognition by engineers of the peculiar properties of the gyroscope. Instances of its action abound in the top spinning with an inclined axis, the child's hoop rolling in an inclined plane, the steering of the bicycle, the skidding of the automobile when rounding a curve at high speed, the similar tendency of a railroad train, the lifting or depression of the stern of a torpedo boat when turning rapidly, and many others.

Owing doubtless to the complex nature of gyroscopic action, its applications in practice have been relatively few. Admiral Fleuriais used it to give an artificial horizon for observations at sea, when the real horizon was obscured. Beginning with the mechanism of the Austrian inventor Obrey, it has since been employed almost universally in forcing the submarine torpedo to keep to the course on which it is aimed. Brennan applied it with but partial success in his mono-rail system for railroads. Schlick has used it successfully in damping the rolling of ships. Sperry, the inventor of the gyrocompass, has gone a step farther than Schlick, not only in preventing such rolling but in reversing the process and inducing rolling for freeing a ship in ice-bound waters. Finally, Russell Thayer proposed its use as a virtual keel for the dirigible balloon.

While progress has been slow, there seems little doubt that the gyroscope will yet come into its own in the field of engineering, through the full appreciation by inventors of its two unique properties: the capacity to provide a fulcrum in space and also to induce revolution, at a predetermined velocity, in an axis at right angles to its own, thus transferring its power "around the corner."

* * *

The hobbing process of gear making has been severely criticized because of alleged inferiority of product. Inaccurate tooth forms were commonly produced and the gears were regarded as being fit only for second-class work and slow speeds. The high production speed possible by hobbing has concentrated the attention of machine builders and tool makers on eliminating the defects. The realization grew that the chief source of inaccuracy in modern machines is the hob. A solid hob made in the common way is a very uncertain product. No two hobs are exactly alike and no two are exactly accurate within the requirements of present-day gear-cutting practice. Limits of one-ten-thousandth inch in accuracy of tooth forms are essential for high-speed gears. The cure for hob troubles, obviously, is grinding the teeth all over and that is now an accomplished fact. Hob makers in America as well as abroad are furnishing ground hobs true to correct shape and commercially perfect.

NOTES AND COMMENT

The tonnage of vessels constructed in all countries in 1912 was the largest on record for any one year. The United Kingdom led with a total tonnage of 1,930,000 tons. Germany came second with 478,000 tons and the United States third, with 349,000 tons. The total tonnage constructed in all countries was 3,436,000 tons.

Alloy steel is being used with satisfaction for lathe, grinder and milling machine mandrels. When properly heat-treated, it is stronger and tougher than carbon steel and not so likely to spring or break under stress. Being free from internal stresses, it is also not so likely to spring out of shape which is a very important consideration where close limits are fixed for turning, grinding and gear cutting.

The missionary work of some large city churches includes the collection of discarded papers, magazines and books for distribution in the Far West, Canada and English-speaking colonies. The demand for some classes of second-hand literature is greater than the supply, especially technical journals. The order of demand is first, technical and mechanical publications; second women's magazines and fashion papers; and third, general fiction.

The tremendous growth of the automobile industry is well illustrated by the fact that the Ford Motor Co. is now building about 1000 cars a day. One day in January, in fact, 1326 cars were completed. The factories employ about 13,000 men working on three 8-hour shifts. An average production of 1000 cars per day would indicate that an automobile can be completed in slightly more than 100 working hours—a most remarkable achievement.

The time interval between the initial operation on steel tools and the hardening and testing is so long in some plants that thousands of parts may be in various stages of manufacture before defects in steel are discovered. The result may be heavy losses. The remedy is either to test every lot of steel carefully before starting to manufacture, or to so arrange the process of work through the plant that all departments are working close on the heels of the others.

The great majority of taps spoiled in use are broken. The breakages in nut making are very largely caused by the nuts being punched too small. An investigation made by the Wells Bros. Co. of the conditions in nut tapping concerns showed that fifty per cent of the nut sizes tapped by half the makers were punched too small. The folly of such practice is evident. Taps must not only tap but ream small holes to thread root diameters. The extra torsional stress causes much unnecessary breakage.

The Hamburg-American steamship *Imperator*, which for the time being is largest in the world, having a length of 919 feet, breadth 98 feet, depth 62 feet and 50,000 tonnage, will sail from Hamburg for New York, May 28. The vessel is of a new type as regards cellular construction, water-tight bulkheads and other safety provisions. It carries three captains, one with the rank of commodore, and one captain will always be on the bridge. Two wireless operators, day and night, will be on duty. The lesson of the *Titanic* apparently was not lost.

Gas engine poppet valves are difficult to keep in tight condition because of pitting, warping and carbon deposits, incident to the high temperature in which they work. Frequent grindings are necessary to prevent leakage and waste of gas. The peculiar characteristic of tungsten steel known as "red hardness," that is, the retention of initial hardness up to a temperature of 1700 degrees F., has been taken advantage of by one manufacturer to make an engine poppet valve that is unaffected by the heat. Tungsten steel valves are hardened and are claimed to retain a mirror-like finish on the seats indefinitely, regrinding rarely being required.

A still exhibit at a convention, exposition or other place where people congregate is of little force as compared with one that is alive and moving. Even things that in themselves are always passive, like hand tools, acquire much greater attractiveness in a show window when mounted in a revolving case. Tool manufacturers have found that machinists' tools mounted in revolving cabinets attract much greater attention than the same tools mounted in the same manner, but standing still.

It is difficult to get a satisfactory wood floor on the ground—almost impossible. After five years' use, the Aberthaw Construction Co., of Boston, has taken up a floor laid with plank driven into tar, with hardwood above this, and the plank came out as powder. It is obvious that fermentation will set up wherever air is kept from timber that has any sap in it. The wood top is very nearly airproof. The tar is absolutely so. The result is that disintegration of the plank will occur, as might be expected. For ground floors use either cement, asphalt, or tar concrete if possible.

One of the cheapest advertisements that a concern can use especially if in sight of a railroad is a large tasteful sign. This seems so obvious that it is a matter of considerable surprise to find well-known concerns that have no large signs and even no small signs over their doorways to identify the plant. This practice seems unbusinesslike and one to be deprecated. If the reason is modesty we think that it is a case where modesty is carried to the breaking point. Surely concerns doing business with the public owe to the public the duty of making easy the finding of their plants. The time lost when means of identification are not provided may often be a serious matter.

One of the means proposed for making kerosene available in motors designed for gasoline fuel is preheating the air supply as it is admitted to the carbureter, by an electrical device. If the air supply can be drawn through the carbureter at a comparatively high temperature the kerosene will be gasified without difficulty. The device for heating the air is an electric coil energized by a storage battery or the dynamo now provided for lighting, engine starting, etc., on high-grade cars. An advantage of this system is that, if properly designed, the engine can be made to start on kerosene. A few moments' application of current to the coil in the air supply pipe serves to heat it to the required temperature.

Designing and building special machinery is interesting work especially to men of considerable inventive ability, but it is likely to prove unprofitable if conducted at the usual rates of compensation. Under these conditions there is little of profit or honor. The alleged inventors claim all the credit if the machines are successful, but are often quick to blame the designer if his work does not prove as successful as they have fondly hoped. The designer and builder of special machinery who has to assume responsibility for its success should, as a rule, demand better pay than he receives. The fact that the work is unprofitable as now done is shown by the fact that special machinery building concerns are going into manufacture wherever they can find a profitable line to engage in.

In northern latitudes where the snowfall is heavy, much trouble is caused by snow melting on the roofs of shops and the water damming up at the eaves. When built in the usual manner, the roof cornices projecting beyond the walls of the shop are unheated and consequently the snow on them does not melt in cold weather. The melting snow on the main part of the roof runs down to the cold cornices, freezes and forms a dam behind which the water is held. Leaks result, which are difficult to stop. The roof of the plant of the Fellows Gear Shaper Co., Springfield, Vt., is built with hollow cornices so constructed that the heated air of the shop circulates through them and keeps the eaves warm. This, effectually prevents damming up and incident troubles from leakage.

The Blanchard Machine Co., Cambridge, Boston, Mass., uses a simple and effective means of fixing face grinding wheels in the iron retaining ring. Instead of employing a contracting clutch to grasp the wheel, a cast-iron ring is turned, bored 1/4 inch larger in diameter than the wheel and internally grooved. The wheel is set in the ring centrally, thus leaving an annular space 1/8 inch wide around it. Into this space is tamped a fluid mixture of Portland cement and sand. The cement hardens in forty-eight hours and holds the wheel firmly. The advantages of this method are simplicity, low cost and absence of compressive strains. The wheel is held by a bond which unites it to the iron ring firmly and permanently.

Experiments have been undertaken in Germany with a view to determining whether wire ropes made of alloy steels of very high tensile strength can be safely bent over pulleys to the same extent as winding ropes made from ordinary wire used for this purpose. A fear had been expressed that ropes made of very strong material would not be able to stand up as well when frequently bent over sheaves or drums. The tests indicate, however, that the number of safe bendings of a rope increases with the increase of tensile strength of the wire, and that it is not necessary to use larger pulleys for ropes made of stronger material. Of course the number of safe bendings increases rapidly with an increase in the radius of the pulley or drum.

A simple method of segregating work for machines is employed in the shop of the Wells Bros. Co., Greenfield, Mass. Where a large variety of work of the same general class is waiting for a machine operation, it is helpful to let the operators as well as the foreman see just what is on hand. This is accomplished simply by laying off with paint lines a series of rectangles on the shop floor within which the trays of taps to be machined are set. These rectangles are marked to indicate the size and pitch of the taps to be placed therein. The foreman can tell at a glance just how the work is running, what machines are fully supplied with work, and what machines are running out of work. The practice, of course, is to keep a machine on one class of work so far as possible, and thus avoid unnecessary changes of set up.

Since high-speed steel has come into general use the discovery has been made that carbon steel tools can be run much faster than commonly supposed. A user of high-speed drills ran out of stock of drills and being in a great hurry to finish a job gave the men carbon steel drills with instructions to use them with the same feeds and speeds. To the surprise of every one concerned the drills stood up to the work as well as or even better than the high-speed steel drills. There are several reasons for the improvement in capacity. Drilling machines and other machine tools have been greatly strengthened in every part since the advent of high-speed steel, and consequently are much stiffer and more powerful. Another factor that makes for higher speed is flood lubrication on the cutting points, and still another is that the maximum capacity of carbon steel tools was rarely reached in the past even with the weak machine tools then in use.

One important advantage of individual motor drive for machine tools is the elimination of overhead countershafts and belts that obscure the light. Separate motors for small machines, however, are of questionable economy. The initial cost of installing motors and controllers on each small machine is a high percentage of the total machine installation cost. The overhead transmission defect can be overcome by arranging machines in rows and driving them from jackshafts on or near the floor at the back or directly beneath the bed of the machine in the case of lathes. Manual training schools use the F. E. Wells & Son Co.'s speed lathes largely. These machines are built with the countershaft mounted on the legs of the machine. An Oldham coupling is provided at each end of the shaft to engage the shaft of the next lathe and thus convey power to it. The arrangement is neat and effective. The cone pulley and belt beneath the bed are guarded so that the boys cannot come in contact with it.

A DIFFICULT GEAR-CUTTING PROPOSITION

When quantities of gears must be cut from blanks having relatively small bores by which they must be held for the gear cutting, it is usually difficult to decide upon the best way to handle the work; for if the gear is to run smoothly when in use, the teeth must be cut truly concentric with the bore. It is obvious that an ordinary arbor of small diameter constitutes a delicate support when cutting coarse pitch gear teeth that are at a considerable distance from the point of support.

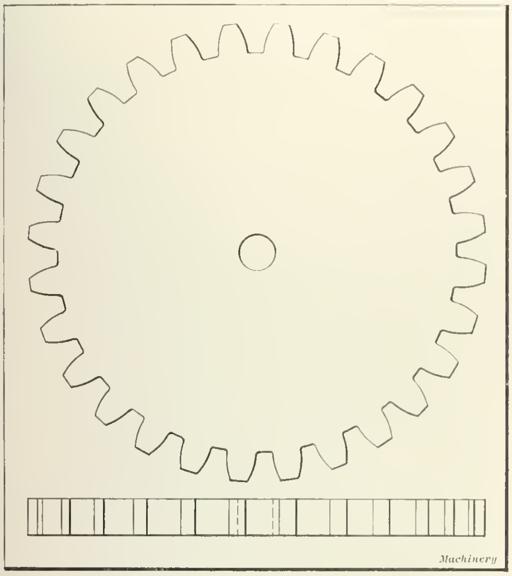

Fig. 1. The Gear to be cut—Actual Size

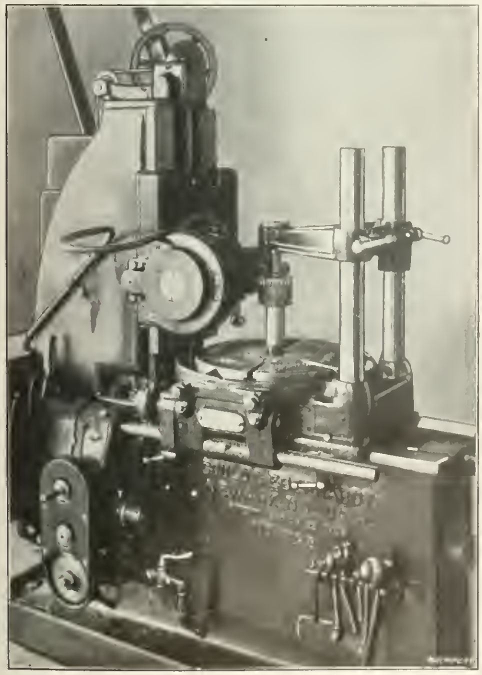

Fig. 2. Hobbing the Gears on a Gould & Eberhardt Gear Hobber

The Jones Speedometer Co., at its Bush Terminal factory, Brooklyn, N. Y., is making quantities of steel gears which must be cut with 28 teeth of 9 pitch. A representation of a completed gear of this character is shown in Fig. 1. It will be noticed that the central hole is but ¼ inch diameter and as the blank is ¼ inch thick and 3 inches diameter it is a difficult proposition to support these gears for cutting on a commercial basis. The work is performed on a Gould & Eberhardt gear hobbing machine as shown in Fig. 2, using an equipment devised by the machine makers. The gears are supported upon an arbor ten at a time and cut in the usual way. From the halftone illustration it is impossible to see just how the gears are held, but by referring to the line illustration Fig. 3, it will be seen that the hobbing machine arbor *A* is fitted with an auxiliary arbor *B*, which is ¼ inch in diameter. This auxiliary arbor is made of chrome-nickel steel, hardened and ground and is fitted into the hobbing machine arbor with a standard taper and held in place by a key *C*. Ten gear blanks *D* are placed upon this arbor and then a hardened and ground bushing *E* is slipped over the arbor, extending upward for about 1½ inch. Above this a double length nut *F*, also hardened, serves to clamp the bushing and gear blanks to the arbor. Next, the usual arbor support *G* of the gear hobbing machine, which slides upon two standards in front of the table, is lowered until its ring bearing *H* slips over the hardened and ground bushing for a sufficient distance to support it while the gears are being cut. Only enough play is allowed between the bushing on the arbor and the ring bearing in the arbor support to allow it to turn during the hobbing operation.

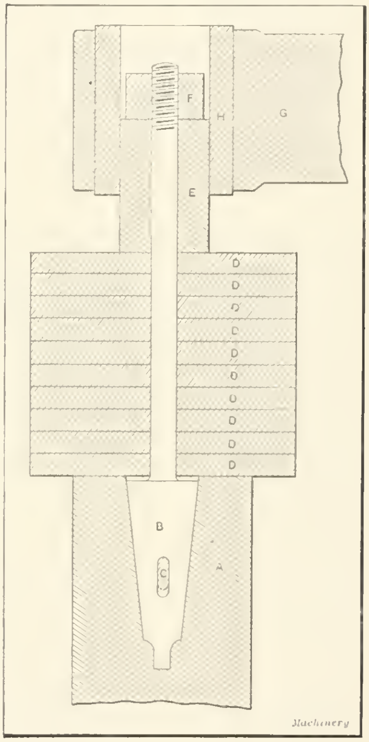

Fig. 3. Details of Method of supporting Blanks on Special Arbor

Of course there is a good deal of strain on the small arbor, but by using the best steel and hardening methods, the arbors last for a considerable length of time. The ends of the teeth as well as the sides and bottoms are finished by the hob. The cutter revolves at the rate of 120 R. P. M., and the hob feeds downward at the rate of 1/32 inch per revolution of the table. The speed at which the gears are cut is remarkable, ten gears being finished in twenty-five minutes.

C. L. L.

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The Wells Bros. Co., Greenfield, Mass., has established a circulating library for its employes to give them the use of technical books, magazines and catalogues. The idea of circulating catalogues is particularly good. Most concerns receive large numbers of catalogues which are scrupulously indexed and filed away where few ever see them. With the circulating method they are seen by the men who often get valuable ideas from them. The plan is one that could be advantageously followed generally.

MODERN PRACTICE IN MANUFACTURING PLANT APPRAISAL

ON THE DETERMINATION OF VALUES OF THE ELEMENTS OF A GOING CONCERN

BY CHARLES W. MC KAY*

The constantly increasing demand for the scientific valuation of manufacturing plants has created a new field for the mechanical engineer. While appraisals have been made for many years by appraisers who base their estimates entirely upon individual judgment, it is only within a comparatively short time that work of this nature has been placed on a scientific basis, and a study made of the underlying theories of depreciation. The outcome has tended to standardize results and to reduce to a minimum the discrepancies due to individual judgment.

Several books have been written on the appraisal of public utility properties, but in taking up the study of the appraisal of manufacturing plants some time ago it was found that a comparatively small amount of information was available in published form.

The appraisal of the equipment of a plant engaged in the manufacture of electric motors and generators offers several interesting problems, and it is the purpose of this article to outline some of those encountered in the recent appraisal of a plant of this nature.

The method pursued in appraisal work is somewhat dependent upon the purpose of the appraisal even when the appraisal is based on scientific methods. No matter how proficient an engineer may be, there are times when it is impossible for him to determine absolutely the value of a machine. He may know that his value is correct within a reasonable range, but he cannot deny that a value varying a few dollars one way or the other would be equally justifiable under certain conditions. If he is making an appraisal for the prospective buyer of a plant he will naturally take the lower range of values in cases of this kind, knowing full well that the expert retained by the owners will take the upper range, and *vice versa*. If the appraisal is made for the owners for purposes of taxation, accounting and insurance it is well to take average values.

The plant under consideration was equipped for the manufacture of electric fans, motors ranging from one-seventh to fifty horsepower, and generators of corresponding kilowattage. The appraisal was for the purpose of determining present and replacement values of the plant for insurance and accounting purposes.

There seems to be a discrepancy in the definition and application of terms used in appraisal work and a brief explanation of terms and underlying theories may serve to make the following discussion clearer:

Unit Plant.—A unit portion of the equipment of the entire plant.

Replacement Value.—Actual cost of replacing a unit of plant with plant of the same type at prevalent market prices at time of appraisal. Replacement value is, then, the market price of the machine in question plus freight plus cost of installation. In the case of large machine tools, the freight and installation items are large enough to be well worth considering, especially when expensive foundations are necessary. In the appraisal under consideration an allowance of five per cent of the market price of the machine was made to cover freight and ten per cent to cover installation. In evaluating small parts of machinery and small tools these items are practically negligible when considering individual tools. Of course in appraising the contents of a tool-room where large quantities of tools have been purchased in bulk some allowance should be made for freight.

First Cost Installed.—The original cost of unit plant at market prices prevalent at the time of purchase of the plant under consideration plus freight and installation. The first cost installed can often be obtained directly from the books of the company.

Scrap Value.—The actual cash return brought by the sale of materials (iron, copper, etc.) used in the construction of a machine or tool at current market prices less cost of junking. The cost of junking will be high in the case of large and unwieldy machines, and in some cases will offset the return from sale of scrap, making the net scrap value zero or even a negative quantity.

Depreciation.—The lessening in value of unit plant due to (*a*) wear and tear (*b*) age and deterioration, (*c*) inadequacy and obsolescence.

Depreciable or Wearing Value.—The replacement value of plant less the scrap value.

Depreciated or Present Value.—Value of unit plant at the time of the appraisal. Present value equals the replacement value less the accrued depreciation at the time of the appraisal.

The determination of the replacement value is simply a matter of applying unit prices to the machine or tool in question with proper additions for freight and installation. A careful check of unit prices is of course necessary to ascertain their accuracy at the time of the appraisal. The increased costs of material and labor have caused a marked rise in the prices of certain of the larger machine tools within the past decade. This fact was very evident in the appraisal in question in comparing present market prices with original costs as shown on the company's books. In the case of the smaller machine tools, prices in many instances have decreased within the past few years. Inasmuch as these tools are largely produced by labor-saving machinery this fact can be attributed to the introduction and perfection of automatic and semi-automatic machinery, and to increased efficiency in shop methods.

The computation of the theoretical present value can be most easily effected by applying an annual rate of depreciation directly to the wearing value and subtracting the result from the replacement value. The wearing value equals the replacement value less the scrap value. The scrap value has a definite ratio to the replacement value for each type of plant. The information as to life of machine tools, small tools, etc., was compiled from averages obtained from actual practice. The reciprocal of the life of a machine or tool gives the rate per cent which when applied to the wearing value and multiplied by the age in years gives the accrued depreciation. This latter subtracted from the replacement value gives the present value.

The present value can be obtained directly by applying the following formula:

$$\text{Present value} = \frac{a(l - f + fr)}{l}$$

where

a = replacement value,
b = scrap value,
f = age of machine,
l = life of machine,
r = ratio of b to a

The following list of average lives of various types of plants includes all three of the items given in the definition of depreciation, *i. e.* (*a*) Wear and tear; (*b*) age and deterioration from natural causes; (*c*) inadequacy and obsolescence. If item (*c*) were not considered, the averages would be considerably higher.

Large Machine Tools.—(Boring mills, planers, engine lathes, etc.) Estimated life twenty-five years.

Small Machine Tools.—(Lathes, small drill presses, shapers, bench tools, etc.) Estimated life twenty years.

Small Parts. (Jigs, chucks, fixtures, etc.) Estimated life fifteen years.

Small Tools.—(Reamers, boring bars, drills, etc.) Estimated life ten years.

Miscellaneous.—(Closets, tool-stands, shop furniture, etc.) Estimated life fifteen years.

Motors and Electrical Equipment.—Estimated life twenty years.

Shafting.—Estimated life fifteen years.

Belting.—Estimated life ten years.

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After the present value has been obtained by either of the methods outlined above, allowance should be made for the actual condition of the machine or tool in question as ascertained by the careful personal inspection of the appraiser. For example, two drill presses of the same make and size, recently installed, are operating side by side. One is found to be in excellent condition while the other has a table badly mutilated by careless operators. Obviously the accrued depreciation on the second should be greater and the present value less than on the first. It is in cases of this kind that the appraiser's judgment comes into play.

The actual appraisal of a large plant may prove an expensive operation unless the work is carefully planned beforehand. The method adopted in the appraisal under discussion is outlined here. The plant was divided into twenty-five or more departments, each with a foreman, for performing different stages in the process of manufacture and assembly of the various types of motors and generators. A set of floor plans was available giving approximate locations of machine tools, benches, etc., and with the aid of these it was a comparatively simple matter to locate and identify the machinery.

Each department was appraised as a unit. It was found advantageous to explain briefly to the foreman in charge the object of the appraisal and obtain from him any information he had at hand as to obsolete tools and contemplated changes in machinery. The foreman then instructed the operators to arrange all tools so that they would be readily accessible for inspection by the appraiser, except those drawn from the toolroom. The appraiser then carefully inspected each machine with its equipment, making note of condition, tool numbers, etc. In this way the inspection was accomplished without confusion and with a minimum of interference.

The next step was the identification and inspection of the miscellaneous equipment, *i. e.*, benches, tool cabinets, shop furniture, etc. The appraisal of the belting and shafting and the contents of the tool-room was made separately on Sundays and holidays when the plant was not running.

The tabulation of the mass of data obtained in an appraisal of this nature in a manner suitable for insurance purposes, and without confusion, is a problem requiring thought and care. In the present case, each class of plant equipment, *i. e.*, machine tools, motors, small tools, etc., was tabulated separately for each department with totals for groups and for departments. The following illustration of the tabulation under the caption small tools will give a clearer idea of the plan adopted:

Tool No.	Used on Machine No.	Description	R. Val.	P. Val.
....	....	....	....	....

A summary of the totals tabulated in the following form made it possible to see at a glance the results of the entire appraisal:

SUMMARY OF SHOP EQUIPMENT

Department	Machine Tools		Elec. Equip		Etc.	Total	
	R. Val.	P. Val.	R. Val	P. Val.	R. and P. V.	R. Val.	P. Val.
Dpt. 1 bldg. 4..	......	......	......	......	......	......	......
Dpt. 2 bldg. 4..	......	......	......	......	......	......	......
Etc., etc........	......	......	......	......	......	......	......
Totals......	......	......	......	......	......	......	......

The proper method of appraising patterns and drawings is a subject regarding which there is considerable difference of opinion among appraisers. A detailed inspection of patterns is not feasible unless the manufacturer is willing to have the superintendent or some official equally well informed go over the stock with the appraiser and furnish information as to obsolete and obsolescent patterns. It often happens that a company's sales contracts require them to furnish duplicate parts on demand. This necessitates the preservation of patterns for machines superseded by those of more recent design in order to fill occasional orders. Obviously, the only way the appraiser can know of these cases is by the personal assistance of a representative of the company.

In the plant under discussion a satisfactory compromise was effected by going over the pattern books with the superintendent and obtaining the original cost and date of manufacture together with information as to obsolete and obsolescent patterns. It was found that approximately ninety per cent of the patterns made during the first eight years of the plant's operation were obsolete, fifty per cent of those for the next four years were obsolete, and ten per cent for the five years preceding the appraisal.

The appraisal of the drawings was based on the assumption that each drawing is a necessary accessory of the pattern built from it. The value of the drawings therefore bore a definite ratio to the value of the corresponding patterns with the exception of drawings relating to obsolete patterns. While from time to time it may be necessary to destroy obsolete patterns in order to avoid congestion in the pattern store room, it is rarely advisable to destroy the corresponding drawing. The drawing requires little space and can easily be preserved to provide for the construction of a new pattern if occasion demands. The valuation of the office equipment completed the appraisal here described. In conclusion it may be said that the appraisal of a modern manufacturing plant requires as careful analysis and presents as many original problems as any other line of consulting engineering.

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VARIATIONS IN TOOL STEEL

Variations in tool steel are puzzling to users, and they are prone to charge the steel makers with carelessness when bad results are obtained with the same methods of hardening and tempering that have been used with success ordinarily. Steel makers are keenly alive to the need of uniformity and constantly strive to improve their product, but are likely to overlook the limitations of equipment possessed by the average user. Take, for example, a steel that has excellent characteristics when hardened within a comparatively wide range of temperatures—say between 1400 and 1500 degrees F. The maker uses a formula for his mixture that has been determined by many experiments. The average user finds it satisfactory as he can hold hardening heats to the limits which insure success. But now suppose the ambitious steel maker finds that a modification of his formula, in some particulars, materially improves the steel but narrows the limits between which it should be hardened. He is likely to put the new formula into use, forgetting that the average user cannot or will not treat the steel as he does. The result will be that some users find the steel very satisfactory indeed while many others suddenly discover that their standard steel has "gone back on them," and a howl is raised that the steel is no longer good.

* * *

In an article in the *Railway Age Gazette*, Mr. Henry W. Jacobs relates some of his impressions of European railway practice. It is interesting to note that so far as regards railway development and machinery, the time-honored European conservatism does not seem to have retarded progress. To quote from Mr. Jacobs' article:

"I had often heard of the ultra-conservatism of Europeans in adopting changes, but I must confess that my personal observations inclined me rather to the opposite view. I found European engineers and shop officials only too ready to accept changes in existing practice that could be shown to be an improvement. For instance, their new shop layouts are well designed and the most modern machinery is installed, some of it, as stated, coming from America. Roundhouses are modern in construction, such details as power driven turntables (even with the smaller locomotives used abroad), efficient ventilation, etc., being given attention. In modern improvements in locomotive design, we must give Europe credit for making the fullest practical use of superheaters, compound and multicompound engines, tank engines for all classes of service except the heaviest long-distance through express and freight trains; and we should not ignore the practical conservation resulting from the general use of briquetted fuel."

A "THREE POINT" MICROMETER AND ITS USE

In the production of perfect and smooth running automobile motors, it is necessary for the crankshaft and connecting-rod bearings to be correctly fitted to the crankshaft and crankpins, and the latter must also be properly hardened and ground. A running balance of all the moving parts or internal members of the motor is also essential. Many motor manufacturers are content to measure the diameters only of their crankpins, and to hold these dimensions to within 0.0002 inch. The Continental Motor Mfg. Co., with plants in Muskegon and Detroit, Mich., has found that a crankpin which appears to be accurate, when measured with an ordinary micrometer, does not necessarily give a perfect fit in a correctly reamed bearing. The reason for this is that it has been ground "three cornered."

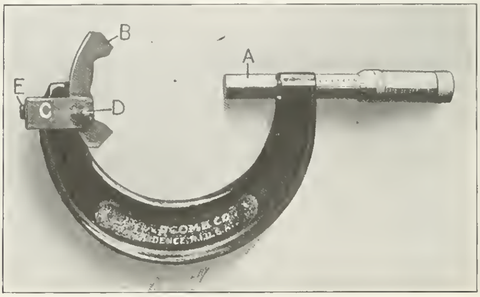

Fig. 1. Three-point Micrometer used for detecting Low Spots on Crankpins

The three-cornered shape of the crankpin is not noticeable with an ordinary micrometer, which only enables the diameters of the pin to be determined at different points; this will be seen by referring to *A* in Fig. 2, where the points of the micrometer are shown bearing on a high and a low spot at the same time, thus giving practically the same reading all around the pin, when it is really out of round. If this crankpin, which has been ground three-cornered, is placed in a perfectly round bearing, it will be found that it bears heavily in spots, and yet the ordinary micrometer fails to show any error in diameter. The reason for this, as was previously mentioned, is that when the spindle of the micrometer is on the low spot, the anvil is on the corresponding high point, and *vice versa*. Generally when the crankpin bears heavily in spots, the bearing is scraped in an attempt to correct the bearing surface; this is not effective, however, if the pin is out of round.

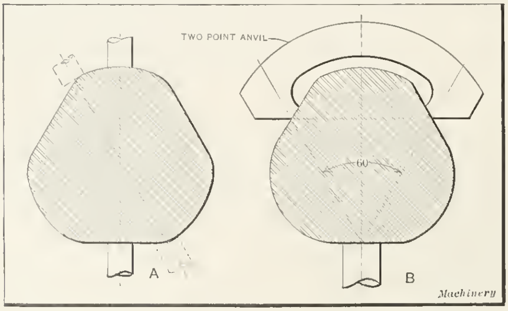

Fig. 2. "Three-cornered" Shape of Crankpin greatly exaggerated

Considerable trouble was experienced by the Continental Motor Mfg. Co. in obtaining a correct bearing between the crankpins and connecting-rod bearings, and several methods were tried in an endeavor to overcome the difficulty. The various methods that were tried proved unsuccessful until a means was found for measuring the crankpins accurately. To do this a "three-point" micrometer was made, which is simply an ordinary micrometer provided with two anvils instead of one. As shown at *B* in Fig. 2, the two anvil bearings form the two upper corners of an isosceles triangle, the spindle of the micrometer forming the lower corner, when the micrometer is set to the correct diameter. Now by referring to *B* in Fig. 2, it will be seen that no matter at what position the micrometer is placed on the work, it is impossible to get an inaccurate measurement over a high and a low spot; consequently the low spots of a three-cornered crankpin can always be located. With this three-point micrometer low spots, with an error as great as 0.002 inch on a crankpin 1⅞ inch in diameter, were located, which an ordinary micrometer could not detect.

There are several reasons given in an endeavor to explain why a crankpin is ground three-cornered. One is that soft spots tend to reduce its diameter more at some points than at others during the grinding operation. This reason does not, however, prove that it should be ground three-cornered. Another reason, more plausible, is that as the bearings of the grinder wear loose, the crankpin springs away and makes a high spot, when the heaviest part of the crankshaft turns away from the grinding wheel; the opposite effect takes place when the center of gravity of the crankshaft changes its position in relation to the wheel. The design of the crankshaft may have something to do with the shape to which the crankpins are ground, but does not prevent the grinding of low and high spots. By properly balancing the work and keeping the bushings in the grinder in good condition, the three-cornered effect can be obviated. The Continental Motor Mfg. Co. constantly uses the three-point micrometer to ascertain, as soon as possible, when any error is creeping in.

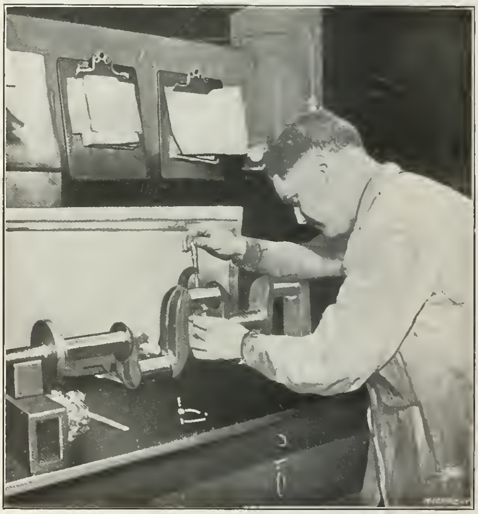
Fig. 3. Inspector using the "Three-point" Micrometer for detecting Low Spots on Crankpins

To convert an ordinary micrometer into one having three contact points, a sleeve *A* is made to fit the spindle, as shown in Fig. 1. The reason for using this sleeve is that the regular spindle of the micrometer would soon become worn in one point on the front edge, owing to the constant friction on the crankpin. This sleeve is made so that it can be removed when worn on the edge, and a new one put in its place. The two-point anvil *B* is made from a flat piece of tool steel about 5/16 inch thick, and is provided with a hole for the anvil. This block *B* is hardened and lapped on the contact surfaces, and is held to a machined seat on the micrometer frame by a yoke *C*, pin *D* and the headless screw *E*.

This micrometer is not used for taking direct measurements, but is intended for determining whether the crankpin has been ground out of round. As shown in Fig. 3, the crankshaft to be measured is supported in vee-blocks located on machined blocks on the work-bench. After the inspector has measured the crankpins with an ordinary micrometer to see that they are of the correct diameter, he applies the three-point micrometer in the manner illustrated. Crankshafts are not allowed to pass the inspector if the pins are out of round more than 0.0002 inch.

D. T. H.

THE HISTORY OF THE SEWING MACHINE

The following historical notes on the history of the development of the sewing machine have been compiled by Mr. J. J. Darby, principal examiner, United States patent office: The earliest attempt at sewing by machinery of which there is any authentic record was in 1755, in which year a machine was patented in England by Charles F. Weisenthal. In this machine the stitch was formed by a needle, having two points with an eye at mid-length, which passed completely through the goods in imitation of hand sewing. This was followed by an English patent dated July 17, 1790, granted to Thomas Saint, for a machine that embodied several features which are employed in the modern sewing machine, namely, an overhanging arm, a horizontal cloth plate, a vertically reciprocating needle, and a feeding device. The needle, notched at its lower end, pushed a loop of thread through a hole previously made by an awl. The loop thus formed was held beneath the goods and the next loop was passed through it, thus making what is known as the chain stitch. In 1804 an Englishman named Duncan made a chain-stitch machine that employed two hooked needles, and in 1830 a Frenchman named Barthelemy Thimonnier invented a machine which embodied the Saint principles with the exception that the loop of thread was pulled instead of pushed through the fabric.

First American Patent

The first American patent for a sewing machine was issued to a man named Lye in 1836. A fire which occurred that same year destroyed all the patent office records, so the construction of this machine is not known. In the years 1832 to 1834 Walter Hunt, of New York City, built what was probably the first lock-stitch machine. This was provided with a curved needle (with an eye near the point) mounted on a vibrating arm. A loop was formed beneath the cloth by this thread-carrying needle, and a shuttle carrying an additional thread was passed through the loop thus formed, making a lock stitch. Hunt, however, did not apply for a patent until after the granting of the Howe patent in 1846, and his application was refused.

On February 21, 1842, patent No. 2466 was granted to John Greenough. This was the first United States patent for a sewing machine of which there is any existing record. This machine employed two needles, which were pulled entirely through the cloth by pincers, and the stitch was formed with two threads. The machine was used principally on leather work.

On March 4, 1843, patent No. 2982 was granted to B. W. Bean; on December 27, 1843, patent No. 3389 was issued to G. H. Corliss; and on July 22, 1844, patent No. 3672 was granted to J. Rodgers. In all of these machines a thread-carrying needle was pulled entirely through the cloth by pincers or clamps, forming what is known as a basting or running stitch.

The Howe and Other Patents

The great epoch of the sewing machine began with Elias Howe and the machine patented by him September 10, 1846, patent No. 4750. In this machine a curved, eye-pointed needle was carried at the end of a pendant, vibrating lever which had a motion simulating that of a pickax in the hands of a laborer. The needle took its thread from a spool above the lever, and the tension on the thread was produced by a spring brake whose semicircular end bore upon the spool, the pressure being regulated by a vertical thumbscrew. The work was held by a row of pins projecting from the edge of a thin metal "baster plate" to which an intermittent motion was given by the teeth of a pinion. Above and to one side of the baster plate was the shuttle race, through which the shuttle carrying the second thread was driven by two strikers, which were operated by two arms and cams on the horizontal main shaft. Although this machine bears little resemblance to the present-day domestic or household sewing machine, it embodied several elements which appear in a modified form in practically all modern lock-stitch machines, *viz.*, a needle with an eye at the point, a shuttle adapted to pass through the needle loop, and an automatic feed.

The next patent of importance in the development of the sewing machine was No. 6439, granted to Bachelder May 8, 1849, in which a spiked, endless belt passed horizontally around two pulleys and constituted the first practical continuous feed.

Other inventions which contributed much to sewing-machine progress are: Singer patent No. 8294, August 12, 1851, in which a horizontal cloth plate was employed in connection with an overhanging arm carrying a vertically reciprocating eye-pointed needle and a spring presser foot, a horizontally reciprocating shuttle, and an intermittently rotating feed wheel operating through the cloth plate; the patent to A. B. Wilson, No. 9041, June 15, 1852, in which a rotating hook carried the needle loop entirely around a stationary bobbin; and the Wilson patent, No. 12,116, December 19, 1854, in which appeared a feed device comprising a horizontal bar furnished with a serrated surface, which bar was given an up-and-down motion in addition to a forward-and-back motion to feed the goods. This feed, known as the four-motion feed, is present in practically all modern domestic machines.

An average of 500 to 600 applications for patents relating to the sewing machine are filed each year in the United States patent office, of which possibly 400 are granted. They deal chiefly with improvements to existing machines, and especially to "factory" or special machines; probably not more than a dozen are for improvements to domestic or household machines, and these are usually for some small attachment. It is said that the development of the "factory" machine has been at the expense of the demand for household machines, one instance being that cited by a man prominent in the sewing-machine industry, who stated that the rapid advance of the "women's wear" trade has resulted in annually increasing purchases of ready-to-wear apparel where formerly the garments were made in the homes on the domestic machine.

With a capital investment of $33,000,000 and a yearly output of more than $28,000,000, the sewing-machine industry now occupies an important place in the United States. These are the figures of the census of manufactures for 1909.

* * *

THE OXY-ACETYLENE PROCESS IN THE RAILWAY SHOP

From an article by a practical railroad man in the *Railway Age Gazette*, based on personal observation of European practice, it appears that the oxy-acetylene welding and cutting process is used in railroad work to a greater extent in Europe than here. One of the reasons for this appears to be that serious mistakes were made in first introducing the system by salesmen who were not familiar with the requirements in railroad work and the needs of railroad shops, and who made too many claims for it. The result was that the apparatus was often left in unskilled hands and the claims made for it were not realized, mainly because the necessity for systematically instructing the men in the use of the apparatus had not been fully appreciated. The process as used at the Topeka Shops of the Atchison, Topeka & Santa Fe Railroad is said to have given extremely satisfactory results when proper training has been given to the employes. Hence, it is likely that the use of the apparatus will be still further extended in railroad shops when it becomes more fully understood and its limitations are appreciated as well. In some instances, the process, as a whole, has been discredited, simply because the users have not understood its limitations or been able to judge of the class of work for which it was best fitted.

* * *

Careful experiments have been made to determine the amount of change in the height dimensions of the Eiffel Tower, in Paris, due to changes in temperature. Figures for exact temperature changes are not available, but it appears that in a height of about 380 feet the tower increased in length slightly more than ⅜ inch in the course of a summer day. The structure of the Eiffel Tower, which rises to a height of about 1000 feet, is very slender. Reduced to a scale of one to 1000, the model would have a height of 12 inches and would weigh one-fourth ounce (?). Thus the iron is quickly heated or cooled, and the experiments made indicate that it is so quickly affected by temperature changes that it responds to the sudden outburst of the sun's rays through a cloudy sky, or to the cooling effect of a shower on a warm day.

MICROSCOPIC REVELATIONS OF STEEL STRUCTURES[*]

A STUDY OF STRUCTURAL CHANGES DUE TO HEAT-TREATMENT

BY E. F. LAKE[†]

It is only about twenty years ago that the examination of metals under the microscope began. Many different formations of the structure of the crystals were observed, which gave promise of opening up an extensive field for investigation. Several years were required for the examination, study and analysis of these structures. As fast as the results were tabulated and compared a bigger field was opened up, as each formation that the microscope revealed seemed to have a practical application. During the last decade, therefore, the microscope has been brought into practical use in many of the industries engaged in the mechanical working or heat-treatment of the ferrous and non-ferrous metals and alloys.

The steels, in particular, show many changes of structure due to the mechanical and thermal treatment which they receive, so that the microscope has become a very valuable instrument with which to inspect steels. To one who understands what the different formations of crystalline structure denote, the magnified surface reveals the temperature at which the steel was hardened, or at which it was drawn, and the depth to which the hardness penetrated. It also shows whether the steel was annealed or casehardened, as well as the depth to which the carbon penetrated. The carbon content can be closely judged, when the steel is annealed, and also how much of it is in the graphitic state in the high carbon steels. The quantity of special elements that is added to steel, such as nickel, chromium, tungsten, etc., can also be estimated, when the alloy to be examined has been put through its prescribed heat-treatment. Likewise, the impurities that may be present are clearly seen, regardless of whether they are solid or gaseous substances. As the various constituents of the steel, either common or special, are seen under the microscope in the combinations which they form, and as the structure reveals the real anatomy of the steel, these proximate analyses can be made of more practical value than the ultimate analyses made by the chemist, even though the latter be more accurate as to quantities. Chemistry has become invaluable in the metal industries, yet it must stop with quantitative analyses and the combinations the elements will form. Microscopy goes further by making it possible to see the various formations in metals submitted to different kinds of treatment to alter their physical properties, so that it has been made possible to foretell what the same chemical combination will do when treated in different ways. Microscopical examination also reveals the mechanical working that the steel has received. That is, it shows whether the metal was cast, hot-rolled, cold-rolled, or whether it was hammer-forged, drop-forged, or slowly pressed into shape as in the hydraulic forging press. It also shows when any of the elements have segregated, as well as any flaws or other imperfections that may exist in the metal. Thus it is covering a wider and wider field every year. As photo-micrographs can easily be made of the surface which is being examined under the microscope, much valuable data is now available in a form in which it can be conveniently preserved.

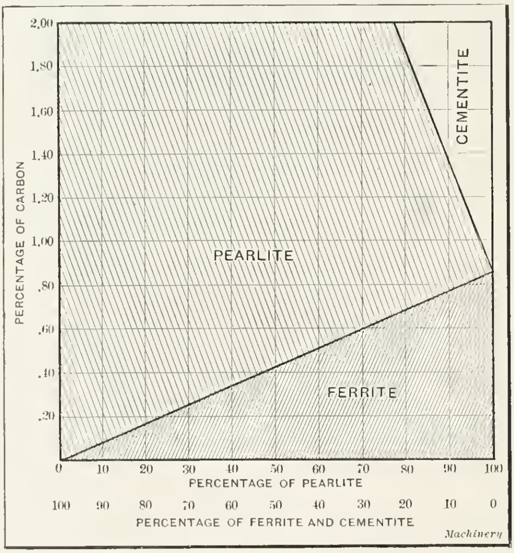

Fig. 1. Chart used to obtain Percentage of Carbon in Steel from Appearance of Micrograph

The majority of metallurgists call this new science metallography, although many call it crystallography. Probably this is because no bigger words could be found. The word metallography is of Greek origin, the first part meaning metal, as it says, and the second part meaning to write; so that literally the word means an account or description of metals. Not all who study metals with the microscope either write about or describe them; hence the word is rather misleading. The science of metals is a broader meaning given the word. While the study of metals with the microscope can well be termed a science, so also can the reduction of ores and their conversion into usable metals. Their mechanical working and heat-treatment can also be classed with the sciences to-day. Thus, even with this broader meaning, the word is unsatisfactory, although constant use may give it the desired meaning. Crystallography is altogether too broad a word, as metals are but a small part of the things in Nature that have a crystalline formation. An easier word, such as micrometal, would fit the case more definitely. The prefix "micro" is of Greek origin and indicates something that is too small to be recognized without the aid of a microscope. It is easily adapted to micrometaly, micrometalist, micrometallurgy or any other affix.

In the annealed steel, the constituents that are visible under the microscope are ferrite, pearlite and cementite. Ferrite is pure iron, and when carbon is added to it, each atom of carbon absorbs three atoms of iron, or combines with it. This carbide of iron is called cementite. Pearlite is an intimate mixture of cementite and ferrite, in the definite proportions of 32 parts ferrite to 5 of cementite. Thus it contains 0.90 per cent of carbon. Therefore, when the carbon content of steel reaches 0.90 per cent, a microscopical examination will reveal only pearlite. Below this percentage the surface will show pearlite and ferrite, with the pearlite constantly decreasing until the carbon content becomes nil, and then the surface will be entirely ferritic. Above a content of 0.90 per cent of carbon, the polished surface of the steel will show both pearlite and cementite, until a carbon content of 6.6 per cent is reached, when only cementite will be seen. By using the chart shown in Fig. 1, the carbon content of steel can be calculated from the view obtained with the microscope. As an example, if 70 per cent of the area seen in the microscope shows ferrite and 30 per cent shows pearlite, the vertical line indicating 30 per cent of pearlite is followed upward until it intersects the diagonal line that separates the ferrite from the pearlite. The horizontal line through this point of intersection is then followed to the left to find the percentage of carbon in the steel. In this example it will be 0.270 per cent of carbon.

Figs. 2 to 7, inclusive, are from photographs of the magnified steel surfaces seen under the microscope. In these the pearlite shows black and the ferrite white. But 6 per cent of the area in Fig. 2 is covered with pearlite, which signifies that this steel contains 0.054 per cent of carbon. The black patches are the pearlite and the fine black lines are divisional lines between the different crystals, the steel being composed of tiny crystals that are held together by cohesive force. In Fig. 3 the pearlite covers 12 per cent of the total area, which means that it is a 0.108 per cent carbon steel. Fig. 4 has 17 per cent of its area pearlitic and hence the steel has a car-

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[*] For further information on the metallurgy of steel, see "Natural Alloy Steel," August, 1912, and articles there referred to.

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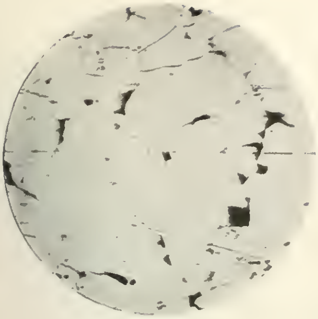

Fig. 2. Ferrite and Pearlite; Carbon, 0.054 Per Cent

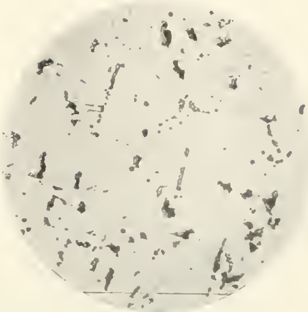

Fig. 3. Ferrite with Pearlite Islands; Carbon 0.108 Per Cent

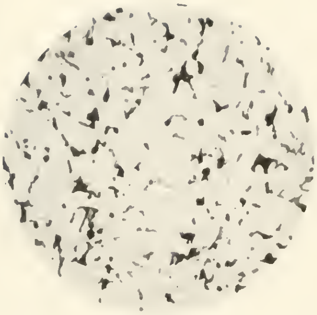

Fig. 4. Ferrite and Pearlite; Carbon, 0.162 Per Cent

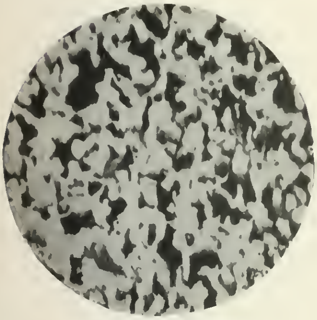

Fig. 5. Pearlite, 28 Per Cent; Carbon, 0.252 Per Cent

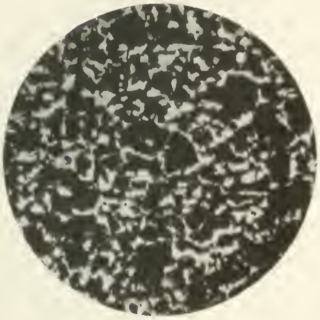

Fig. 6. Pearlite, 60 Per Cent; Carbon, 0.54 Per Cent

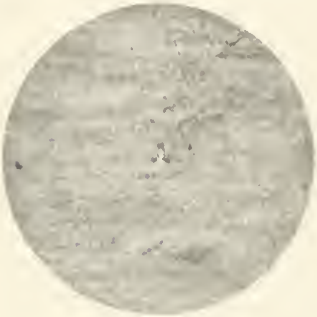

Fig. 7. Pearlite Area predominating; Carbon, 0.80 Per Cent

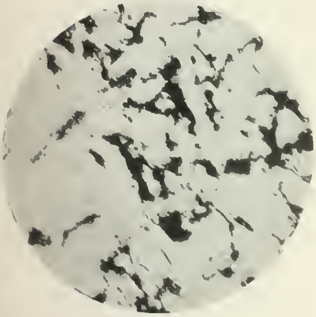

Fig. 8. Photo-micrograph of Cast Steel

Fig. 9. Steel in Fig. 8 after being Hot-rolled

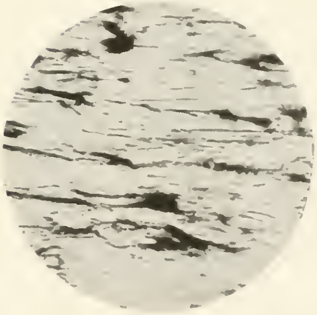

Fig. 10. Steel in Fig. 9 after being Cold-drawn

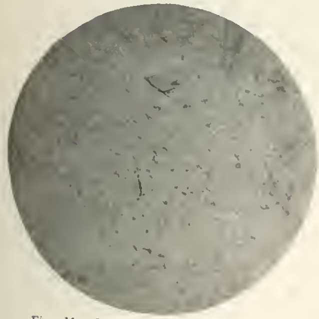

Fig. 11. Steel quenched at Transformation Point

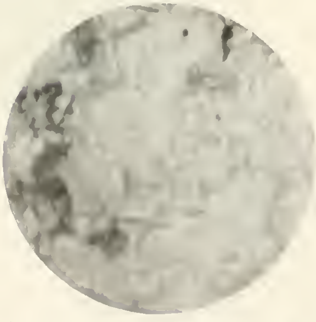

Fig. 12. Steel quenched at 50 Degrees C. (90 Degrees F.) above Transformation Point

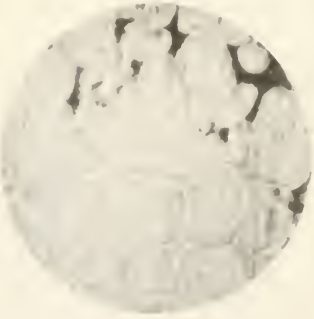

Fig. 13. Steel quenched at 100 Degrees C. (180 Degrees F.) above Transformation Point

bon content of 0.162 per cent. Fig. 5 contains 28 per cent of pearlite and the carbon content of the steel is 0.252 per cent. In Fig 6 the pearlitic area is 60 per cent of the total, and thus the carbon content proves to be 0.54 per cent. In the above the percentages of pearlitic area are multiplied by 0.90 to get the carbon content. Fig. 7 shows the pearlite predominating, as in the 0.90 per cent carbon steels. This specimen was treated with a different etching material from the others and hence the pearlite shows gray instead of black. Under the microscope it has the appearance of mother of pearl, from which its name is derived. When 0.90 per cent of carbon is reached the ferrite has disappeared and each increase, above that point, increases the volume of cementite. Then the carbon content is figured from the percentages of pearlite and cementite.

The use of the microscope for judging the mechanical working received by a steel is shown in the photo-micrographs reproduced in Figs. 8 to 10. Fig. 8 shows a 0.10 per cent carbon steel as it was cast. The pearlite is in irregular patches resembling islands. Fig. 9 shows the same steel after it was hot-rolled. Here the pearlite was pressed out into layers, with the ferrite. Fig. 10 is the same steel after it was cold-drawn. As will be noted, the pearlite islands were still further squeezed out of shape and distorted into thinner and more irregular layers.

In preparing specimens for microscopical examination, they are ground and polished until all scratches are removed and the surface is highly specular. This is done by using abrasives of four or five different degrees of fineness. The different constituents cannot then be clearly seen, if at all, and various methods of etching are resorted to for developing them. This treatment cuts away certain constituents and makes others stand out in relief. These raised portions resemble hills and plateaus, in miniature, which show white from the reflected light in the microscope; while the portions cut away are valleys that receive no light and are thus black. In some cases, constituents are colored by various etching materials and are thus distinguished by their color. The three most commonly used etching materials are picric acid, nitric acid and tincture of iodine. When using, 5 grains of picric acid are dissolved in 95 cubic centimeters of absolute alcohol, and the specimen to be etched is immersed in it 30 seconds; or 10 parts of nitric acid are mixed with 90 parts of alcohol, and the specimen immersed from 10 to 15 seconds; or 1 drop of tincture of iodine is put on each square centimeter of surface to be etched and allowed to stand until the specimen is discolored. Any of these methods will give the steel the appearance shown in Figs. 2 to 10.

Polishing in bas relief will make the pearlite show white and the ferrite black. Thus the white portions in Figs. 2 to 10 would be black and the black areas, or pearlite, would be white. Relief polishing is done with a piece of parchment stretched over a smooth pine block. Rouge is rubbed very hard into the parchment and then rinsed off with running water, until only the rouge is left that was forced into the pores. By rubbing the specimen on this yielding surface, the softer ferrite is ground out below the level of the pearlite. Therefore the reflected light makes the pearlite show bright and the ferrite dark.

The polish attack, which is a combination of etching and polishing, also has the same effect. The same wooden block covered with parchment is used, but in place of the rouge, the parchment is wet with a solution composed of 2 parts of the crystallized nitrate of ammonium to 98 parts of distilled water. The specimen is then rubbed on this until it has been properly etched.

Cementite is a carbide of iron that is not as easily attacked as other constituents, and hence different etching materials have to be used. Immersion for 30 minutes in a 2 per cent solution of oxalate of ammonium will give the cementite a red color. A picrate of soda solution will color cementite brown. When it comes to the higher carbon, cementite steels, it is difficult to distinguish between the cementite and pearlite, pearlite with a slight excess of cementite, and pearlite with a slight excess of ferrite. Thus this special method of etching is necessary.

All of the above methods are good for developing either the ferrite, pearlite or cementite, which are the constituents of the annealed or normal steels only. When we come to the heat-treated steels, these constituents disappear to be replaced by others, and it is in the heat-treated steels that the microscope has been of the greatest practical benefit. Many different constituents are formed as a result of the various degrees of temperature to which steels are submitted for annealing, hardening, tempering and carbonizing, and other etching materials have been found to develop them better. The way in which the metal is affected by each change in temperature has thus been revealed, and the microscope has placed this branch of the industry among the sciences.

To give the steel the correct temper, it is first necessary to obtain the greatest hardness that the metal is inherently capable of attaining, without a coarsening of the grain. As this leaves the steel quite brittle, it is afterward drawn enough to bring back the desired amount of toughness and ductility. When steel is being heated, it reaches a point where it loses its magnetism. If the heat is measured with a pyrometer, the pointer that indicates the temperature will halt in its upward travel when this point is reached. This is due to a transformation that is taking place in the steel. In other words a new grain structure is being born and the temperature of the metal ceases to rise until the transformation is completed and each crystal has absorbed the required amount of heat to effect this change. In most steels this change of structure occurs below 810° C. (1490° F.), and if the steel is instantly reduced to atmospheric temperature this new grain structure will be preserved. It is the finest grain structure that can be produced in the metal and the steel is as hard as it can be made without coarsening the grain.

If steel is heated above the transformation point and suddenly quenched, as in ice water, a constituent called austenite is developed. The grain is also coarsened, and the higher the temperature, the coarser will be the grain. In Fig. 11 is shown a steel that was quenched at the transformation point. Fig. 12 shows the same steel suddenly cooled from 50° C. (90° F.) above the transformation point; Fig. 13 from 100° C. (180° F.) above, and Fig. 14 from 200° C. (360° F.) above. In the last three illustrations, the austenite structure is revealed. It will be seen that the line of demarcation between the crystals becomes more and more pronounced as the temperature rises, and this indicates a weakening of the metal, as the substance of which these lines are composed is very hard and brittle. In fact, when the temperature is increased very much beyond the transformation point, the internal strains cause microscopic cracks to appear, and these develop into distinct cleavages between the crystals. Thus, to quench steels from above the transformation point has a weakening effect, which is due to the separation of the crystals as shown in the preceding illustrations. Austenite is very unstable and is rapidly changed into other constituents as the steel cools down. Martensite is the constituent that takes its place when the transformation point is reached. When the hardening temperature is too high both austenite and martensite are developed. When the temperature is the correct one, however, only the martensite is seen in the polished surface of the steel. This is shown in Figs. 15 and 16, Fig. 15 being taken from a fine steel and Fig. 16 from a coarse one. The martensite formation resembles a mass of needles that intersect one another in the direction of the sides of an equilateral triangle. All steels that contain more than 0.16 per cent of carbon and have been hardened, will develop the martensitic structure. It is easily retained by any of the hardening and quenching methods; and is the hardest of all the constituents formed in the steel and very brittle. The microscope thus reveals the condition of steels that are martensitic, as the more martensite that is present, the greater will be the degree of hardness of the metal.

One might think that austenite would be harder than martensite, owing to the higher temperatures at which it is developed, but a steel needle will scratch austenite and leave the martensite untouched, when drawn across a steel surface that contains both constituents. In the low carbon steels free ferrite develops with the martensite, and the lower the carbon content, the more ferrite will be present. In large steel pieces, the center is not affected by the heat-treatment as much as the outer portions, and another constituent called troostite is usually intermingled with the martensite. The martensitic structure of hardened steel is changed into troostite by drawing out a part of the hardness; this is done by reheating it to temperatures below 400° C. (752° F.). The troostitic structure is shown in Fig. 17. As the drawing temperature rises from nothing up to 400° C. (752° F.) the martensite gradually disappears and troostite takes its place. Troostite is almost amorphous and generally appears in irregular areas that are dark colored. It is sometimes slightly granular. The white

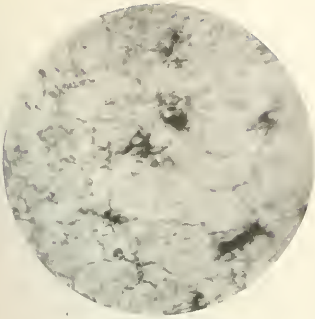
Fig. 14. Steel quenched at 200 Degrees C. (360 Degrees F.) above Transformation Point

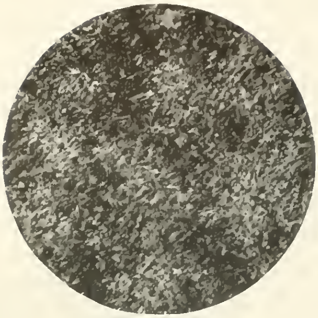
Fig. 15. Martensite Structure in a Fine Grained Steel

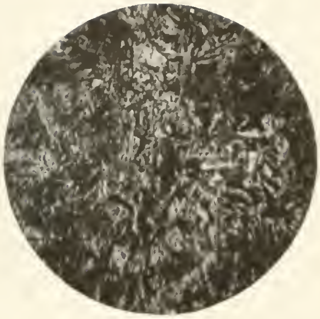
Fig. 16. Martensite Structure in a Coarse Grained Steel

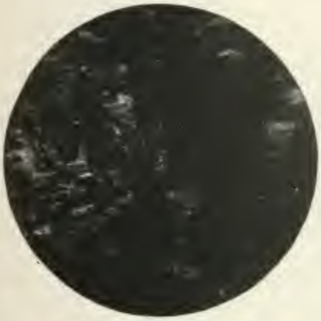
Fig. 17. Troostite Structure; Steel drawn at 250 Degrees C. (482 Degrees F.)

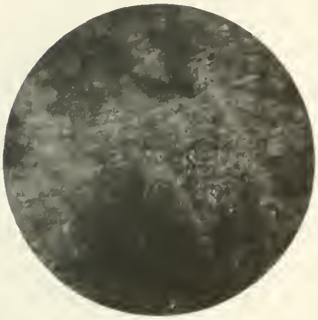
Fig. 18. Temper drawn at 400 Degrees C. (752 Degrees F.); Osmondite Structure

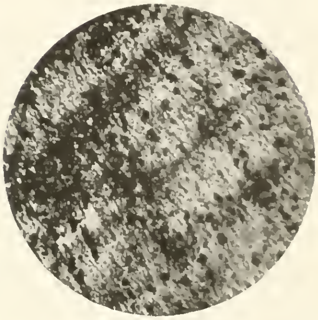
Fig. 19. Temper drawn at 550 Degrees C. (1022 Degrees F.); Sorbite Structure

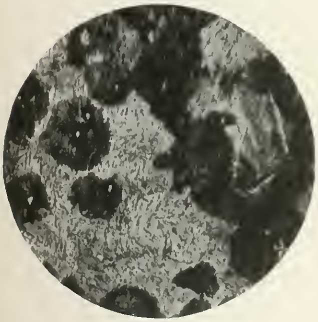
Fig. 20. Quenching Oil too Hot; Troostite and Martensite Structure

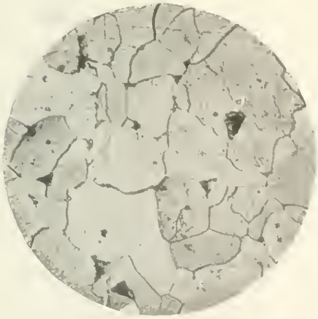
Fig. 21. Crystalline Structure of Overheated Steel

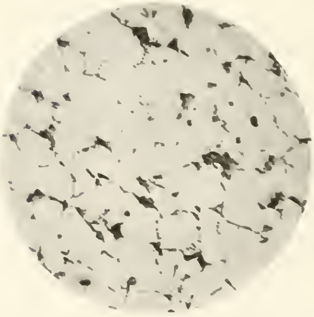
Fig. 22. Steel of Fig. 21 restored by Correct Heat-treatment

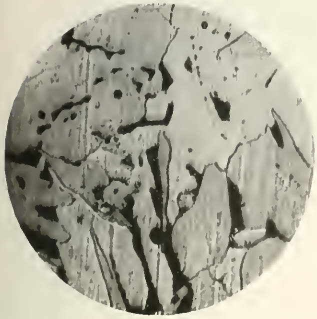
Fig. 23. Burnt Steel showing Cracks between Crystals

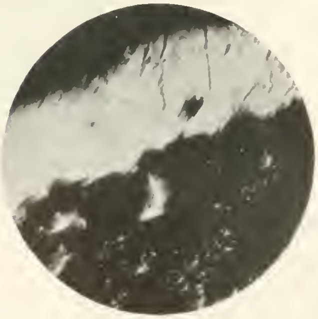
Fig. 24. Casehardened Steel showing Unequal Carbonization

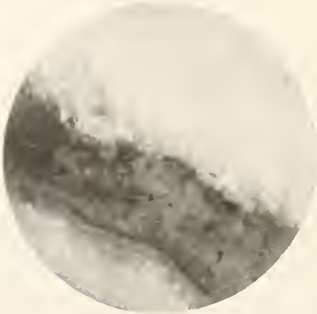
Fig. 25. Crack between Carbonized Shell and Core

places in Fig. 17 are needles of martensite, which remained in the steel because the drawing temperature was not high enough to convert it all into troostite. Thus it is called a troosto-martensitic steel. The temperature at which the metal was drawn can be judged from the amount of each constituent that is present. When a drawing temperature of about 400° C. (752° F.) is reached the martensite has all disappeared and the steel surface has the appearance shown in Fig. 18. This has been named osmondite, but as it is the boundary line between troostite and the next constituent which is developed by higher drawing temperatures, it is a question as to there being any definite constituent that can always be located and named. In this illustration, the lighter areas very much resemble the birth, or beginning, of the sorbitic structure which follows the troostitic.

When the drawing temperature is approximately between 400° and 800° C. (752 and 1472° F.) the constituent called sorbite is developed, which reaches its maximum at 600° C. (1112° F.), and the polished surface will then be entirely sorbitic. The sorbitic structure is shown by Fig. 19. Hardened steels that have been reheated for tempering, to between 400° and 600° C. (752 and 1112° F.) will show both troostite and sorbite, and these are called troosto-sorbitic steels. The amount of each constituent that is present will show the temperature at which the steel was drawn. With the drawing temperature from 600° to 800° C. (1112 to 1472° F.) both sorbite and pearlite can be seen, while above 800° C. only the pearlite, ferrite and cementite, of the thoroughly annealed steels, are visible.

The chart shown in Fig. 26 illustrates how the various constituents overlap each other and how the use of the microscope enables one to judge the drawing temperature from the amount of each constituent that is present. Sorbite is softer and tougher than troostite and troostite is softer and tougher than martensite. Pearlite is softer than any of the others, while austenite is more brittle. Thus, as these various constituents intertwine with one another like the branches of trees in a forest, they impart to the steel the hardness, toughness, ductility, strength, or other properties in the exact proportion to the amount of each constituent that is present.

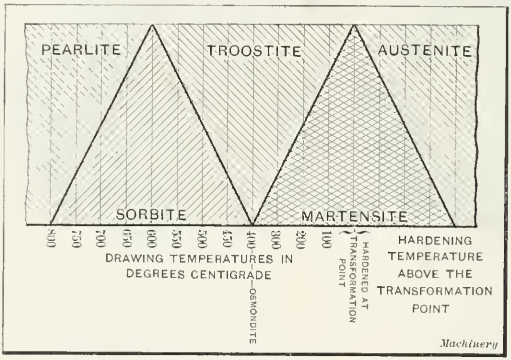

Fig. 26. Constituents seen in Microscope and their Relation to Hardening and Drawing Temperatures

In etching specimens to develop the constituents of hardened and tempered steels, very good results are obtained with sulphurous acid that is composed of 4 parts sulphur dioxide to 96 parts of distilled water. The specimens are immersed in this, face upward, and removed as soon as the polished surface is frosted. This takes from 7 seconds to 1 minute. They are then rinsed with water, as usual, and dried with alcohol. Very thin layers of iron sulphide are deposited on the different constituents in different thicknesses, and this gives them different colors. Austenite remains a pale brown; martensite is given a pale blue and deep blue and brown color; troostite is made very dark; sorbite is uncolored; cementite exhibits a brilliant white; and ferrite is made dark brown. In ferrite and pearlite steels, the ferrite is instantly pitted without developing the crystalline junction and hence is hard to distinguish from finely divided pearlite. Austenite can also be made white by 10 per cent of hydrochloric acid in solution. Martensite can be brought out by the picric, nitric or hydrochloric acid solutions or by the polish attack. Troostite can be made white with tincture of iodine and black with the picric acid solution or the polish attack. Osmondite is etched the most deeply with hydrochloric or sulphuric acid solutions. Sorbite shows white when etched with picric acid.

A few of the imperfections found in steels are illustrated by Figs. 20 to 25. Fig. 20 shows a steel that was quenched at the correct temperature, but the oil in which it was quenched was too hot and, hence, it was not cooled down suddenly enough. The light areas are martensite and the black ones are troostite. This means that the steel is not uniform in hardness, as the troostite produces spots that are softer than the martensite areas. This condition can only be cured by a reheating and hardening. In Fig. 21 is shown a steel that was overheated. The grain was thus coarsened, and the heavy lines of demarcation between the crystals are a hard and brittle substance that weakens the cohesive force which binds them into a solid mass. This condition can be corrected by re-heat-treating the steel, and Fig. 22 shows this same steel after it has been correctly heat-treated. The cohesive force has been restored to its former power and the grain has been refined. A steel is shown in Fig. 23 that was heated to a considerably higher temperature than that in Fig. 21 and the internal strains, due to expansion and contraction, caused distinct cracks to appear between the crystals. These are shown by the black areas. Such a condition can only be cured by a remelting and working. This shows what is called "crystallization" by some and "burnt steel" by others. It is difficult, however, to draw a line between overheated steel that can be restored by heat-treatment and burnt steel that must be remelted. The microscope enables us to reach a much more definite conclusion on this point than any other known method of examination or testing.

In Figs. 24 and 25 are shown steels that were carbonized. In Fig. 24, the white streak and spots are almost pure iron, or ferrite, while the black areas are saturated with carbon. This means that the carbon did not have a uniform penetration, and either the carbonizing material was of a very poor quality or the steel was not heated to the proper temperature during the carbonizing operation. In Fig. 25 the black streak represents a crack that developed between the carbonized outer shell and the core. In the heat-treatment after carbonizing, cracks like this can be caused by heating the steel too rapidly and then quenching it before the heat has penetrated to the center of the piece. They can also be caused by the use of incorrect temperatures during the carbonizing operations, or of carbonaceous materials that are not rich in carbon. Either of these conditions might cause a decided demarcation line to exist between the outer shell and the core, and this would mean that the high percentage of carbon in the outer shell came to an abrupt end at this line. Whereas, in properly carbonized steel, the carbon percentage is highest at the outer surface and gradually tapers down to the percentage contained in the core. Then no sharp dividing line exists between the carbonized shell and the core, and the expansion and contraction strains are equally distributed throughout the piece.

There are many other things that the microscope reveals about steels and it is also quite extensively used on steel castings, cast iron, sintering materials, non-ferrous metals and other products. It is really remarkable how much knowledge has been gained about a science that is so new, and how this knowledge has been applied to practical everyday work in such a short time. With all that has been done, however, there is still room for more development along this line, the principal need at present being standardization that will bring order out of the chaos previously existing. For instance, several hundred different magnifications are used in the examinations, but if certain standard sizes were adopted this number could be reduced to about twelve, and specimens or micro-photographs could be compared with much profit to both the worker and the student. With but few exceptions, the meaning of the names of constituents have been well defined by different societies during the past year, and the confusion that previously existed on this score has been overcome. A few new words were also coined to better express certain things in this connection and we can be thankful that the coiners made them simple and easy to pronounce.

* * *

A patent has been granted to Mr. C. F. Marston of Great Neck, N. Y., for a signal device which is so connected with the brake mechanism of an automobile that the signal is operated whenever the brakes are manipulated. The object of the device is to warn an automobile approaching another from the rear, of the fact that the automobile in the front is applying its brakes to reduce its speed or stop, and, in this way, to prevent rear-end collisions.

EFFICIENT PRODUCTION DEPENDENT ON UP-TO-DATE EQUIPMENT

BY A. A. PEEBLES*

In these days of keen competition it is essential to the success of any engineering establishment that its equipment should be of a nature to permit of rapid and efficient production. In order that this desideratum may be realized the machinery employed must be of the most modern type, and of a character adapted to the requirements of the particular line of manufacture which is to be undertaken.

Although the importance of these factors must be evident to all engineers, it is relatively seldom that the required conditions are realized in practice. Any engineer who is in close touch with modern machine tool developments, and whose business gives him the *entree* to a large number of different machine shops, cannot help but realize how very few there are in which the equipment does not permit of considerable criticism. Sometimes it will be found that the tools employed are out-of-date on account of false economy on the part of the management, which grudges the capital expenditure involved in replacing obsolete machines by those of improved design. Sometimes it may be observed that, while the plant is quite modern, it is not of the type best suited to the conditions prevailing in the particular factory in which it is installed. Sometimes it is the general lay-out which permits of improvement. And it is the rare exception that a machine shop is found which realizes the ideal that the expert knows to be within the bounds of practical possibility.

The reason for this is fairly obvious, and is, in itself, productive of speculation. This is an age of specialization, and before a man can occupy a managerial position in a shop manufacturing steam engines, or gas engines, or agricultural machinery, he has to have many years of experience solely in that particular line. And, having attained such a position, the exigencies of his business usually demand the whole of his time. He is frequently a good engineer, with a fair general knowledge of his profession and an exhaustive knowledge of his own particular groove. But, while his knowledge of machine tools is frequently considerable, it is rarely anywhere nearly complete.

To-day the tendency is toward standardization, and standardization means the increasing introduction of repetition work. The day of the general engineering shop is passing, and giving place to factories which make only one class of articles. The result of this is that the old-style shop equipment, consisting of engine lathes, planing machines, slotting machines, drills and shapers, has also given place to the more specialized machine tool, and every day, figuratively speaking, some enterprising machine tool manufacturer puts on the market a new design especially adapted to some particular process. To-day, instead of the general machine used for many purposes, we have the special machine which will perform a special operation with a maximum of efficiency, and in order to keep track of all such tools which are annually placed on the market it is necessary for a man to devote his whole attention to a study of the subject.

This is impossible for the manager of a large engineering works, and it is equally impossible for any of his staff, who all have other duties which demand their attention. It therefore follows that when a new plant is being installed, the machines selected, though usually adequate, are frequently not the very best which could be had for the purpose. The manager usually has the last word in selecting new tools, and not being in intimate touch with the latest practices in machine design, the chances are against his getting the equipment suited in the best possible way to his requirements, while sometimes exceedingly poor judgment is discernible in the choice of tools.

A number of instances of the latter have come to the writer's notice, some of which were very marked. One was in a large automobile shop in London, England, which carried out a very big repair business, but did little manufacturing. Included in the machine shop equipment was an expensive fully-automatic bevel planing machine, for cutting the teeth on crown, differential and other bevel gearing used in automobiles. The tool was eminently adapted for the production of a large number of wheels of one pattern, and would have been excellent for a large producing factory working on the standardization principle. But for the odd jobs of a repair shop it was quite unsuitable on account of the time occupied in setting it up. There are semi-automatic machines which, though slower in operation, are much more easily prepared for cutting any given wheel, and are, therefore, far more suitable for the requirements of a shop doing the kind of work undertaken by the one in question.

In this same works there was a large high-speed sliding, surfacing, and screw-cutting lathe capable of swinging twenty-four inches over the bed, and big enough to handle work three times the size of anything connected with an automobile. It was useless as a lathe, so the slide-rest had been dismantled and a vise arrangement fixed up for holding heavy bar steel, while the mandrel had been equipped with a circular saw for cutting the latter. It was the case of a $1200 machine doing the work which a $500 one would have done more efficiently.

Another case was that of a London firm which had a world-wide reputation as makers of high-class steam fittings, and which enjoyed a large share of the patronage of the British Admiralty. Two years ago this firm went into liquidation, the cause being directly traceable to poor equipment. The shops in this case contained some 300 machines, and produced valves and steam fittings of standard designs in large quantities. It was a case in which machines suitable for repetition work were absolutely essential for efficient production, and yet out of the 300 tools only six were adapted for such work: four small wire-feed automatic capstan lathes, and two larger machines fitted with chasing saddles.

Even in the biggest concerns one finds a similar state of things. One of the largest Tyneside shipyards, possessing a plant valued at over $5,000,000 and employing 4000 hands, has gone for several years without paying any dividend, and while this may be due in part to other causes, it is certainly largely attributable to the fact that the equipment employed is not up-to-date, and it cannot therefore compete with other more modern plants. In the shops in question there are a number of excellent and modern tools, but there are also far more old ones, which should have been scrapped as soon as developments of tool steel rendered heavy cutting practicable.

These are just a few instances. They could be multiplied indefinitely by any engineer who has had the opportunity of studying the subject. And the conditions outlined are not confined to the British Islands. They are found in even more marked preponderance in Canada, and although the United States exhibits generally a more progressive and judicious spirit, it is by no means free from similar cases.

There are two factors causative to the existence of such conditions. The first is lack of progressive policy, and the second lack of expert knowledge in machine tool developments. The former is the cause of nearly all glaringly inefficient equipments, while the latter results in an *ensemble* which, though often fairly effectual, permits of improvement. The first can be remedied only by scrapping every tool as soon as a new one of marked superiority is brought out. The latter can be mitigated by a careful study, on the part of the management, of technical journals dealing with machine improvements, and by examining the new catalogues of the leading machine tool manufacturers.

There are thirty-two firms known to the writer which specialize to a greater or less extent in the manufacture of turret and capstan lathes. All are firms of standing, and produce work of the highest class, and each makes a number of different designs of tools. In addition, there are numerous smaller firms doing similar work, and the total number of different types of this one class of machine at present on the market is enormous. Each type and each make differs in some particular from all the rest. Some are preeminent for one class of work, some for other classes. And whatever class of work is required, there is probably one machine which will do it just a little better than any other machine. But it takes a man who has had wide experience in the machine tool business to put his finger on that particular one. The same thing applies to milling machines, to boring and facing machines, and to every class of tool found in the modern workshop, while in addition there are scores of special machines designed solely for one particular operation and class of work, such as crankshaft lathes, railway axle lathes, turbine boring machines, and many others.

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* Address: 221 Edmonton St., Winnipeg, Manitoba, Canada.

Among the latter is one particular tool which has been on the market now for some two years. It is designed for boring automobile cylinders, and where repetition work is required, it is perhaps the best tool for the purpose. It consists of a central column carrying three working spindles, each of which is provided with automatic feed. A circular table revolves about this column, and the cylinders are held to the table by jigs, accommodation being provided for the mounting of four cylinders at one time. Cylinder No. 1 is then brought under spindle No. 1, where it is rough-bored. It is then swung round to spindle No. 2, where it is rough-reamed, the same movement bringing cylinder No. 2 under spindle No. 1, where it is bored while the first one is being reamed. The next movement of the table brings cylinder No. 1 beneath spindle No. 3, where it is finish-reamed, cylinders Nos. 2 and 3 being simultaneously rough-reamed and bored, respectively. At the following movement cylinder No. 1 can be removed, and replaced by a fresh one, while cylinders Nos. 2, 3 and 4 are undergoing their various operations in the cycle. But although this machine is within the reach of all, one still finds manufacturers doing the work on single- and double-spindle boring machines of the old type, and sacrificing time and profits in the process, simply because they are not versed in modern machine tool practice.

The whole trend of development in modern machine shop methods tends to the evolution of the machine tool expert: The man who has a practical knowledge of latter-day improvements, and who has made a study of the machinery market. Such a man, after due study of the requirements of a particular case, would be in a position to insure an equipment of a nature suited to the need of that case, and the errors of judgment which are the cause of such serious losses would be abolished. But, apart from this, a good deal could be done to mitigate existing conditions by a more careful study, on the part of those in control of engineering establishments, of the technical press, and by paying more attention to the catalogues of the machine tool trade.

* * *

UNIT MACHINE CONSTRUCTION

The unit system of machine construction is becoming more and more common especially with machine tools. It has several advantages. In the first place the separate units can be made and assembled in separate departments, each department being arranged to suit the condition of work, whether light or heavy, etc. In the second place the units can be independently tested, and if defects develop they are corrected without seriously blocking the output of finished machines. If a complete machine is tested and found faulty it is held until a minor defect, perhaps, is found and repaired. The same defect found in a separate unit would have been corrected before reaching the assembly floor and thus no delay at this stage of output would have occurred. The third advantage is that unit construction encourages interchangeable manufacture—in fact makes it necessary to a certain extent. The units can be withdrawn from the machine by the user to be repaired in his own plant or shipped to the home shop. Another feature of unit construction of importance to makers of special machinery having the same general characteristics is that unit gear boxes, headstocks, etc., may be used in special machines. Thus the cost of special machinery can be reduced because of the possibility of manufacturing some of the parts.

* * *

One of the very best types of floor, incidentally rather an expensive floor, is the creosote or hardwood block laid end grain. The Aberthaw Construction Co. of Boston in a recent investigation found that several paper mills have used these with considerable success. The floor has the advantage of resisting water conditions, of standing up under the hardest trucking, of being a resilient, noiseless floor and one which can be kept very clean. For practical use in this country the creosoted block is almost the only one used. Where these are laid on a concrete floor, the best practice is to dip them in tar and stick them down to the floor, then grout between the blocks with cement. A three-inch block has sufficient depth.

COMPOSITION OF NON-FERROUS ALLOYS[*][†]

The Bureau of Steam Engineering of the U. S. Navy Department issued specifications in 1910 for materials to be supplied to the navy. As the compositions of these materials are based on the most approved practice and on thorough experience with metals of this kind, they should be of value to every one who has to deal with metal alloys. The most important points of the specifications published have, therefore, been collected and are published in the accompanying Data Sheet Supplement. The essential properties required of metals of this kind by the Navy Department are given in the following.

Properties Required of Non-ferrous Casting Materials

The properties required in the most important of the non-ferrous casting materials are as follows:

Gun bronze: The minimum tensile strength must be 30,000 pounds per square inch; the minimum yield-point, 15,000 pounds per square inch; and the elongation in 2 inches, 15 per cent.

Manganese bronze: The minimum tensile strength must be 60,000 pounds per square inch; the yield-point, 30,000 pounds per square inch; and the elongation in 2 inches, 20 per cent.

Monel metal: The minimum tensile strength must be 65,000 pounds per square inch; the yield-point, 32,500 pounds per square inch; and the elongation in 2 inches, 25 per cent.

Phosphor-bronze: The minimum tensile strength must be 40,000 pounds per square inch; the yield-point 20,000 pounds per square inch; and the elongation in 2 inches, 20 per cent.

Specifications for Rolled Plates, Sheets, Shapes, etc.

The principal requirements of the more important non-ferrous materials used for rolled plates, sheets, shapes, etc., are as follows:

Copper: Ultimate tensile strength, 30,000 pounds per square inch; elongation in 2 inches, 25 per cent.

Muntz metal: Tensile strength, 40,000 pounds per square inch; elongation in 2 inches, 25 per cent.

Phosphor-bronze: Tensile strength, 50,000 pounds per square inch; elongation in 2 inches, 25 per cent.

Naval brass, 1 inch and below: Tensile strength, 62,000 pounds per square inch; elongation in 2 inches, 25 per cent. Above 1 inch: Tensile strength, 60,000 pounds per square inch; elongation in 2 inches, 28 per cent.

Manganese bronze, 1 inch and below: Tensile strength, 72,000 pounds per square inch; elongation in 2 inches, 28 per cent. Above 1 inch: Tensile strength, 70,000 pounds per square inch; elongation in 2 inches, 30 per cent.

Monel metal, 1 inch and below: Tensile strength, 84,000 pounds per square inch; yield-point, 47,000 pounds per square inch; elongation in 2 inches, 25 per cent. Above 1 inch: Tensile strength, 80,000 pounds per square inch; yield-point, 45,000 pounds per square inch; elongation in 2 inches, 28 per cent.

In the case of Muntz metal, phosphor-bronze, naval brass, and manganese bronze, the yield-point should be one-half of the ultimate tensile strength specified.

The Tensile Strength of Piping

The tensile strength of piping should be as follows: Brass piping, 7000 pounds per square inch; copper piping, 6000 pounds per square inch; Benedict nickel piping, 14,000 pounds per square inch; and Monel metal piping, 20,000 pounds per square inch. Brass and copper pipe should not be tested, however, beyond 1000 pounds per square inch, and Benedict and Monel metal pipes should not be tested beyond 2000 pounds per square inch.

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The greatest problem of today is not how to increase efficiency, but how to distribute equitably the products of the increased efficiency.

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[*] With Data Sheet Supplement.

[†] The following articles on this and kindred subjects have previously been published in Machinery, April 1911, engineering edition, "Aluminum Alloys"; February, 1911, engineering edition, "Common Defects in Metal Alloys"; August, 1909, engineering edition, "Bearing Metals"; May, 1909, engineering edition, "Anti-friction Alloys for Bearings"; October, 1903, engineering edition, "The Study of Alloys Suitable for Bearing Purposes." See also Machinery's Reference Series No. 11, "Bearings."

GRAPHICAL METHOD OF DETERMINING MOMENTS OF INERTIA

MOHR'S METHOD OF GRAPHICAL DETERMINATION SIMPLY EXPLAINED

BY R. KRAUS[*]

In all problems of mechanical design, the question of stresses occurs. If the material is subject to bending or torsional stresses, the determination of the amount of such stresses makes it necessary to first determine the moment of inertia of the section under consideration. For some of the simpler forms of sections, analytical methods solve the problem readily, but many of us know how long it takes to arrive at the result, where complicated sections are involved, and how many chances there are for errors to be made in the calculations. Various graphical methods have been developed for the solution of this problem. The writer is using Mohr's method which, in his opinion, is the simplest of all. This method is not original with him but has not, to his knowledge, been published in English, and it is given here with the hope that its advantages may be made of more general value.

Many readers will welcome a complete derivation of the method, and all the fundamental principles will be given instead of assuming that each reader will review them in some text on mechanics. In Fig. 1, let us assume a force P_1 in pounds and a pole O in the same plane and at a distance p_1 in inches. The moment M_1 is given by the following equation:

$$M_1 = P_1 p_1 \text{ inch-pounds.} \tag{1}$$

Now the product $P_1 p_1$ can be represented by the area of a rectangle, assuming P_1 as the base and p_1 as the height. Another force P_2 has a moment relative to the pole O of

$$M_2 = P_2 p_2 \text{ inch-pounds.} \tag{2}$$

To compare these two moments, we shall express them by a length only. For this purpose, we treat the rectangles representing the moments in a purely geometrical sense, changing both rectangles to a common base H, keeping the areas the same, and letting the heights of the rectangles be p_3 and p_4, Fig. 2. Then,

$$Hp_3 = P_1 p_1 = M_1 \tag{3}$$
$$Hp_4 = P_2 p_2 = M_2 \tag{4}$$

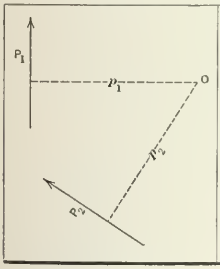

Fig. 1. Diagram of Moments about Pole O

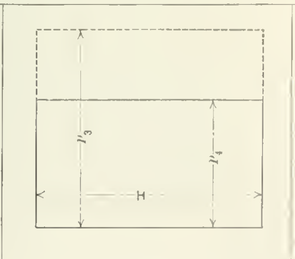

Fig. 2. Diagram explaining "Base of Moments"

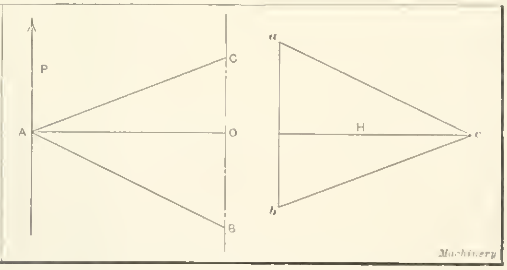

Fig. 3. Diagram showing Method of determining Moment of Force P about Pole O

Thus by using H as the base unit, we can compare the moments by simply comparing the lengths p_3 and p_4. During the remainder of the article we shall call H the "base of the moments." We shall make an application of this principle to determine the moment of the force P relative to the pole O in Fig. 3. Choose any point A in the line of action of the force P and draw a line through O parallel to P. Draw any other line, such as ab, parallel to the last line drawn, and lay out a length ab on it to represent the force P to some convenient scale. Choose also some point c as a pole, at a distance H from ab. Join ca and cb. Now from A, draw lines AB and AC parallel to ac and bc, respectively. Compare the triangles abc and ABC; since the sides are parallel, the triangles are similar and we have:

$$ab : H = CB : AO$$
$$ab \times AO = H \times CB$$

But $ab \times AO$ represents the moment of the force P about the pole O. Thus, if we consider H as the base of the moment, the length CB will also represent that moment to some scale. Thus we see that the distance between two points of intersection of the two sides of the polygon, on a line parallel to the line of action of the force, represents the moment of the force about any point in this line to some scale. This theorem will be used in what follows.

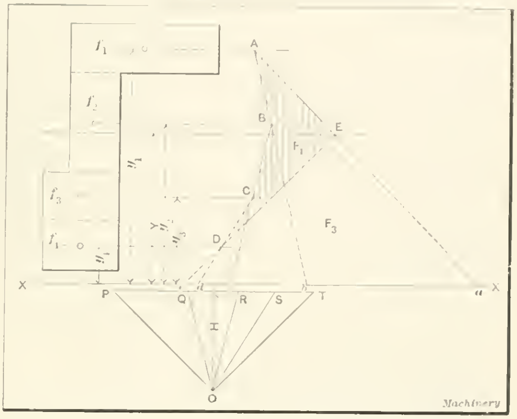

Fig. 4. Derivation of Mohr's Method for Graphical Determination of Moment of Inertia

We can now undertake the construction for finding the moment of inertia. To find the moment of inertia of an area relative to the axis $X—X$, Fig. 4, divide the area under consideration into a number of small strips whose areas are f_1, f_2, f_3 etc. Find the area and center of gravity of each strip and consider the area of each strip as a weight. Imagine these weights suspended about a line through their centers of gravity and parallel to the axis $X—X$. We shall now draw the polygon of forces. For that purpose, draw any line PT parallel to the axis $X—X$ and lay out on it to some convenient scale, the areas $f_1 = PQ$, $f_2 = QR$, etc. Then choose a pole O at a distance H from the line PT and connect O with P, Q, R, S and T. Then construct the polygon A, B, C, D, E in the usual manner. As previously shown, the length between the intersection of two sides of this polygon with the axis, such as $X—X$, represents the moment of the force about that axis. Thus, the moment of f_1 about $X—X$ is equal to $a\,b\,H$ to the proper scale. Then, letting M_1, M_2, etc., be the moments of f_1, f_2, etc., about $X—X$ we have:

$$M_1 = ab\,H \tag{5}$$
$$M_2 = bc\,H \tag{6}$$

Now let y_1, y_2, etc., be the distances of the centers of gravity of the respective areas f_1, f_2, etc., from the axis $X—X$. Their moments can also be expressed as the product of the weights of the strips and the distances of their centers of gravity from the axis. Thus:

$$M_1 = f_1 y_1 \tag{7}$$
$$M_2 = f_2 y_2 \tag{8}$$

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[*] Address: Care of Engineering Works of Canada, Ltd., Montreal, Canada.

But from Equations (5) and (6)

$$M_1 = ab\,H = f_1\,y_1 \qquad (9)$$

$$M_2 = bc\,H = f_2\,y_2 \qquad (10)$$

Suppose that F is the total area of the section $= f_1 + f_2 + f_3$, etc., and that Y is the distance of its center of gravity from the axis $X—X$, and let M be the total moment. Then:

$$M = f_1\,y_1 + f_2\,y_2 + f_3\,y_3 + \text{etc.} = \Sigma\,f\,y \qquad (11)$$

$$M = ab\,H + bc\,H + \text{etc.} = ae\,H \qquad (12)$$

Now consider the triangles POT and eaE. Since the sides are parallel by construction

$$ae : Y = TP : H$$

or

$$ae\,H = TPY = Y\Sigma f = YF.$$

Hence, we have from Equation (12)

$$M = Y\,F \qquad (13)$$

Thus Y is the distance of the center of gravity of the section from the axis $X—X$, or a line through E parallel to $X—X$ passes through the center of gravity of the section.

The moment of inertia of the area relative to the axis $X—X$ is expressed by the quantity Σfy^2. Calling the moment of inertia I, we have:

$$I = \Sigma fy^2 = \Sigma(fy)\,\Sigma y = H\,ae\,\Sigma y \qquad (14)$$

by substitution from (11) and (12).

Now consider the triangle Aba. Here ab is the base and y_1 is the height; thus $aby_1 =$ twice the area. Similarly for bcy_2, etc. Call F_2 the area of the polygon $ABCDea$. Then:

$$ab\,y_1 + bc\,y_2 + \text{etc.} = 2F_2.$$

or

$$ae\Sigma y = 2F_2. \qquad (15)$$

Substituting this value in Equation (14):

$$I = 2H\,F_2. \qquad (16)$$

Let I_0 be the moment of inertia of this area about a line through its center of gravity, Y being the distance of its center of gravity from the axis $X—X$. Then:

$$I_0 = I - FY^2. \qquad (17)$$

and

$$FY^2 = (FY)\,(Y) = \Sigma(fy)Y = H\,ae\,Y \qquad (18)$$

Consider the triangle eaE. Let its area be F_3.

$$ae\,Y = 2F_2. \qquad (19)$$

Thus from (18) and (19)

$$FY^2 = 2HF_3. \qquad (20)$$

$$\text{Then } I_0 = I - FY^2 \qquad (17)$$

$$= 2HF_2 - 2HF_3 \text{ [from (16) and (20)]}$$

$$= 2H\,(F_2 - F_3)$$

$$= 2HF_4 \qquad (21)$$

$F_4 = F_2 - F_3$; and from an inspection of the figure we see that F_4 is the area of the polygon $ABCDE$. This equation can now be expressed as follows: "The moment of inertia of an area about an axis through its center of gravity is represented by the product of the area of the polygon of forces and twice the base of the moment." This gives us a key to the following simple construction for finding the moment of inertia. Make H equal to half the length PT which represents the area of the section under consideration to some convenient scale. Then the moment of inertia is represented by the product of the area F and the area F_4 of the polygon of forces. An inspection of the derivation shows that the result obtained from the construction is dependent only on the scale to which the area of the section has been drawn. The scale which we choose in laying out the polygon is immaterial, since if the area of the section is shown full size, the area of the polygon of forces is also shown full size. If, however, the area is not drawn full size, the actual moment of inertia is obtained by multiplying the moment of inertia derived from the drawing by X^4, where X is the scale used.

Example: Suppose Fig. 5 represents (reduced size) a section whose moment of inertia we wish to obtain about its neutral axis. The section is divided into seven small areas whose centers of gravity are readily found. The areas of these are set off along the line PW to a scale of ½ inch = 1 square inch. The point O is chosen at a distance from this line of $\frac{F}{2}$ to the same scale, and joined with the points $P\ Q\ R\ S\ T\ U\ V\ W$. Then the polygon of forces $F\ G\ H\ I\ J\ K\ L\ M$ is constructed. The area of this polygon is determined either mathematically or with a planimeter, and is found to be 12 square inches. The sum of the small areas of the section F is 17.41 square inches. Thus the moment of inertia is 17.41 × 12 = 208.92. Also the neutral axis of the section passes through the point M, from which we find its ordinates $e_1 = 5.8$ and $e_2 = 5.2$.

* * *

The bill introduced into the House of Representatives asking for an appropriation for the preliminary work of building a dam or jetty some two hundred miles long, reaching out into the Atlantic from the coast of New Foundland, is not especially creditable to its advocate. As is well known, the modest purpose of the congressman who introduced the bill is to divert the Gulf Stream so as to bring about great climatic changes to the advantage of the United States and Greenland; incidentally these advantages would be accompanied by a "slight" change in climatic conditions in northwestern Europe, making the British Islands and the Scandinavian countries uninhabitable. The *Scientific American*, in commenting upon the scheme, expresses the hope that the gift of imagination will be so mercifully tempered by the saving grace of humor, that the measure will be given an early burial with such obsequies as are becoming to its dignity and importance.

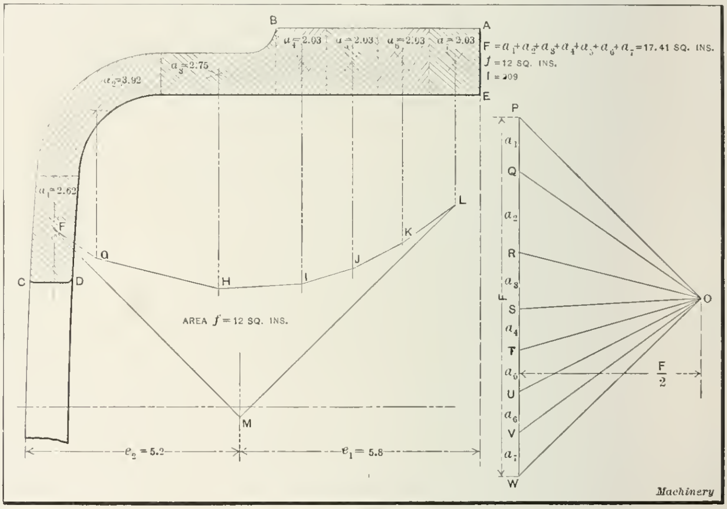

Fig. 5. Application of Mohr's Method in determining Moment of Inertia of the Section ABCDE

* * *

In tests made by French engineers to determine the most favorable conditions under which belting should be run, it was found that the greatest efficiency of transmission was obtained when oak tanned belts ran at a speed of from 65 to 80 feet per second. What is termed "chromium-treated" leather belts ran most favorably at about 100 feet per second. The most satisfactory working tension was from 575 to 850 pounds per square inch of section. The tests indicated that the thickness of the belt should be from 1/20 to 1/30 of the radius of the pulley. When chromium-treated belts are used, which are more elastic, a thickness of about 1/15 of the radius is permissible. In fact, a chromium-treated leather belt, 0.4 inch thick, gave good results on a pulley 9⅜ inches in diameter.

* * *

A suspension bridge of much greater extension than any yet erected has been proposed to span the Mersey at Liverpool, England. The main span will be 2700 feet long with towers 500 feet high. The height of the center of the bridge from high water mark will be 200 feet.

THE ENGINEERING WORKSHOPS OF THE UNIVERSITY OF SHEFFIELD[*]

NOTES ON THE MECHANICAL EQUIPMENT AND METHODS OF INSTRUCTION

BY GEORGE W. BURLEY[†]

The University of Sheffield is one of several higher educational institutions which have sprung into existence during the past ten or fifteen years in England. These universities aim at giving instruction and offering opportunities for research work in the arts and sciences, but chiefly in technology or applied science, each university especially developing those applied sciences which are likely to be of benefit to the industries and trades carried on in its own particular district. In the applied science department of Sheffield University, the three chief subjects taught are engineering (mechanical, electrical and civil), metallurgy, and mining, these being the three chief industries of the district in which the university is situated. It is not, however, a purely local institution, and aims to be of service to the engineering and metallurgical industries of the whole country.

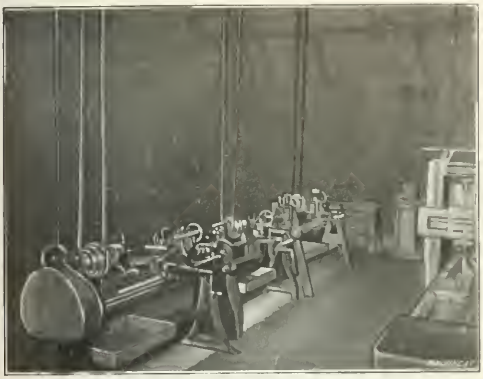

Fig. 1. Machine Shop, First and Second Year Shop

This university is the outcome of the development of three local teaching institutions, of which the old Sheffield Technical School was one, the latter, on the creation of the university, being converted into the applied science department of the university. The old technical school dates from the year 1886, from which year instruction in engineering and mechanical science has been given continuously, engineering-workshop practice also being included in this course. The history of the workshops is practically the history of the whole institution, since the curriculum in engineering includes for each student a certain number of hours per week in actual workshop practice. The ordinary course (whether degree, associateship or non-associateship) in engineering is of three years' duration, and all students in mechanical and electrical engineering during those three years have to work from three to eight hours per week in two shops, the first of which is reserved for first and second year students only, and the second for third year and advanced students. The work in the latter shop is, naturally, of a higher order than that which is done in the other. The number of students who pass through the shops each year varies from 100 to 120.

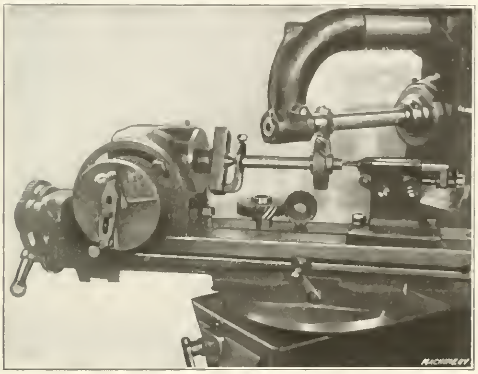

Fig. 3. Milling Spiral Gears

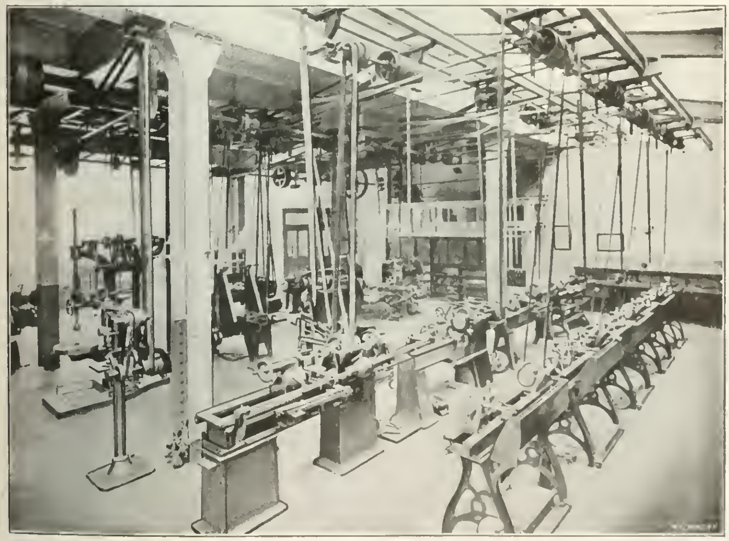

Fig. 2. Tool-room, Third Year Shop

In the first shop there is an equipment of modern machine tools, including a large number of engine lathes (of English and American manufacture) ranging from eight-inch swing to twenty-two-inch swing, universal and plain horizontal-spindle milling machines, planing machines, sensitive and upright or pillar drilling machines, power hacksaws, cylindrical grinders and wet tool grinders. A general view of this shop is shown in Fig. 1.

In the second shop, which is virtually a large tool-room, the machine tool equipment comprises engine lathes, relieving or backing-off lathe, universal milling machines, universal cutter grinding machines, planing machine, shaping machine, Gisholt universal tool grinder, wet tool grinder, sensitive, upright and high-speed drilling machines, power hacksaw, and turret lathe. In this shop is also situated the experimental high-speed tool steel testing plant, which consists of an electrically-driven thirty-six-inch swing lathe provided with an independent electric motor. A general view of this shop is shown in Fig. 2.

In common with the principles which operate in other educational institutions of this type, the prime object of sending students through the shops is not necessarily to convert these students into expert mechanics (for the time which is devoted to work in the shops is not by any means sufficient for this purpose), but to enable the students to get an insight into the actual working of machine tools, their possibilities, their weaknesses and their efficiency, and to learn how the various machine tool operations are performed, so that they can compare the different methods of doing the same kind of work. The work which is given to the students is graduated and carefully selected, so that the students who enter the shops in their first year are given the simplest work to do and the simplest machine tool operations to perform, the grade of the work from this being gradually yet surely improved. The whole range of the work enables the students with alert minds to grasp readily the principles which underlie the working of every machine tool in the shops, while in addition to this practical acquaintance with machine tools, weekly lectures on the theory and practice of machine tools are given to assist the students in their work and to add to their store of knowledge in connection with machine tools and their operation in their latest phases.

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[*] For articles on trade schools and engineering shops, see "State Trade School of Bridgeport," October, 1912; "Features of Apprenticeship System at the G. E. Lynn Works," April, 1912; "Training of Machinists in the Trade School," July, 1911, and the articles there referred to.

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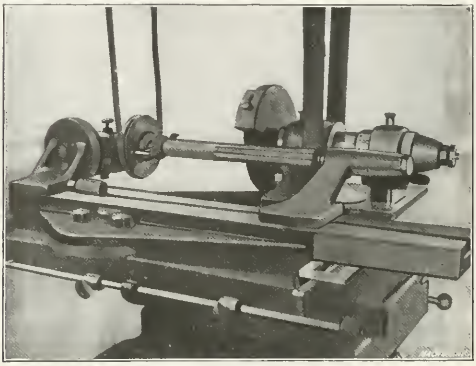


Fig. 4. Grinding Hand Reamers

The work in the first and second year shop begins with hand bench operations, such as chipping and filing up square blocks, making simple surface gages or scribing blocks, angle gages and similar tools. This is followed by machine tool work, plain turning, taper turning, surfacing, boring and screw-cutting operations on the lathe, being performed in a progressive manner. The drilling machine, planing machine, shaping machine and slotting machine are all, in turn, worked on by every student. Second year students who make exceptionally good progress, are put on to the making of simple steam, gas and petrol engines, all the operations connected with this kind of work being done by the students themselves under the tuition of expert instructors.

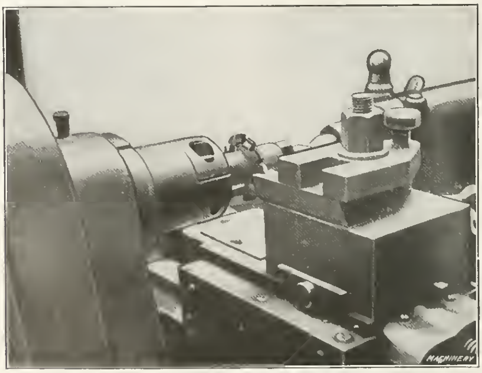


Fig. 5. Backing off Formed Milling Cutters

The work which is done in the third year shop is of a tool-room character. It includes the making of limit gages, standard ring and plug gages, stepped gages, fluted and formed milling cutters, reamers, twist drills and similar tools, the cutting of spur, spiral, bevel and worm gears, and the making of jigs, templets, laps, etc. All the operations are of the precision type, and the students are taught the use of the precision tools such as the micrometer gages, outside and inside, the limit gage, the thread gage, the standard gage (internal and external), the test indicator, and the gear-tooth depth gage. Furthermore, all the machine tools have their feed-screws and elevating and horizontal adjusting screws provided with micrometrically graduated dials, and these the students are taught to use. Comparisons between different methods of doing the same kind of work or effecting the same object are made, as well as tests of the accuracy of machine tools and work turned out on them. The principle of this shop is the combination of accuracy or exactitude with economy of production as far as such a combination can be effected.

In Fig. 3 is represented the cutting of spiral gears on a universal milling machine, this being an exercise that is done by every student. In Fig. 4 is shown the grinding of a hand reamer after hardening. This operation is performed on a Cincinnati universal cutter grinder, the precise operation represented being the circular grinding of the whole reamer prior to grinding the clearance or relief on the teeth.

A feature of this tool-room is that it can accommodate practically every machine tool required for tool-room operations, usual and unusual. One machine tool, not found in every tool-room, is the backing-off or relieving lathe. An example is, however, installed in this shop, this being a Loewe machine. On this machine are formed and backed-off twist drill fluting cutters, reamer fluting cutters, work hobs and gear-cutters, all of these being made from first principles, as it were, including the initial laying out of the shape, the making of templets and the forming of the forming tools. In Fig. 5 is shown the last operation before hardening and grinding, *viz*, the relieving or backing-off of a cutter such as any of the above, in the Loewe lathe. This lathe has a differential mechanism for use in connection with the forming and relieving of worm hobs to get the exact number of reciprocations of the forming tool per revolution of the hob, and the students are taught how to use this and how to perform the calculations required to obtain the setting of the mechanism.

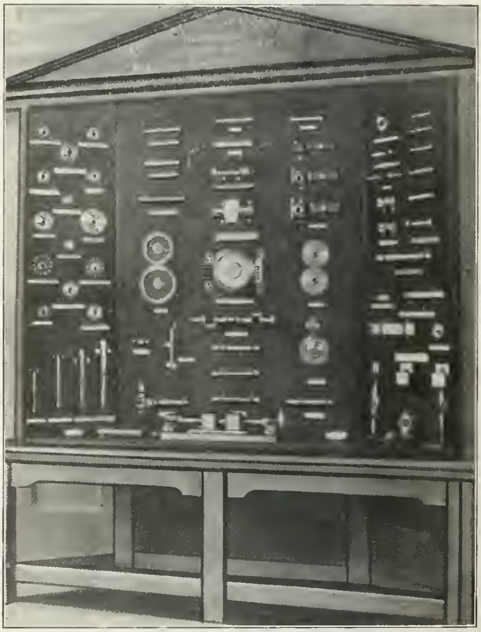


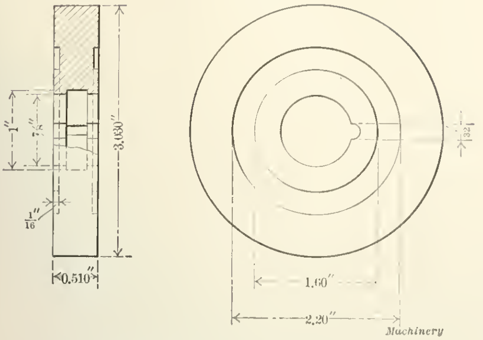
Fig. 6. Exhibition Case of Students' Work

A view of a case of students' work (chiefly tool-room work), which was exhibited at the Franco-British Exhibition in London, England, in 1908, is shown in Fig. 6.

A sample operation or exercise sheet with accompanying drawings is shown herewith, the students being given the material required, its dimensions, and the sequence of the operations to be performed on the material, together with instructions as to how best to set about the work:

EXERCISE NO. 12

SLOTTING CUTTER



Make a ½-inch slotting cutter (for milling keyways in shafts, etc.). Material: 3⅛-inch diameter cutter blank, ⅝-inch thick. Annealed cast steel. Method: (1) Fix the blank in the lathe chuck and face the side. Rechuck, and face the other side to 1/32 inch above size. Drill a 55/64-inch hole in the blank, and bore out to ⅞ inch, using the limit gage to get this dimension. (2) Place the blank on a mandrel, turn to the required size, then turn and recess faces as shown in drawing. (3) Remove the blank from mandrel, drive a ⅞-inch turned plug in hole till it is level on each side, then drill keyway out to required size. (4) Replace the blank on the mandrel, mount it between the centers of the heads of the universal milling machines, and set the indexing head for 26 divisions. (5) Place a 65-degree single-angle fluting cutter on the milling machine spindle, and adjust the position of the blank until the cutter is set central with respect to the blank. (6) Adjust the micrometer dial on the elevating screw handle to zero and then with the cutter not immediately above the blank, raise the knee 0.1300 inch for the first cut; the 26 teeth can now be rough-cut. (7) Raise the knee another 0.0115 inch, and then run around the blank with a finishing cut. (This depth of cut is based upon a land-width ratio of 0.020.) (8) Remove the blank from the mandrel and mount it on the tapered mandrel which fits in the spindle of the dividing head. (9) Set the dividing-head spindle at an angle of 86 degrees 13 minutes with the horizontal. (10) Remove the 65-degree cutter and substitute a 75-degree cutter for it. (11) Obtain the position of initial setting for a right-hand cutter, raise the blank 0.0850 inch and rough-cut one side of the blank. (12) Raise the blank another 0.0109 inch and finish-cut the teeth on that side. (These dimensions are based upon a land-width ratio of 0.020 as above). (13) Substitute a 75-degree fluting cutter of the left-hand type for the above and repeat the operations. (14) Remove the cutter from the mandrel, and stamp its dimensions on before it is hardened. (15) Heat in salt bath to a temperature of from 790 to 800 degrees C. and plunge it into the quenching bath in a vertical position, afterward moving it about horizontally to and fro beneath the surface until it is the same temperature as the bath, that is, about 25 degrees C. (16) Temper the cutter down, using a temperature of about 230 degrees C. (17) Fix up a universal grinding machine: first, to grind out the hole to standard size, using the limit gage to test the size; second, to grind five degrees clearance on the axial teeth, treating each tooth separately; third, to grind five degrees clearance of the radial teeth on one side; and fourth, to treat the other side in the same manner, making the width of the cutter 0.500 inch and the two sides alike.

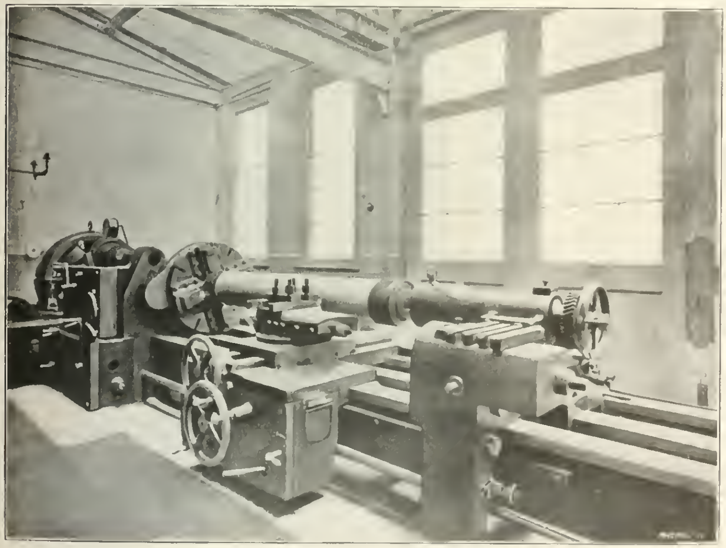


Fig. 7. High-speed Experimental Lathe

In Fig. 7 is shown a high-speed steel testing lathe which has been installed in the tool-room. It is a thirty-six-inch swing lathe and will take test bars up to ten feet in length. It is provided with two electric motors, one being the driving motor of forty horsepower and the other a feed motor of five horsepower. The latter is so arranged that it can be either connected or disconnected to the feed-rod. In the latter case, the power feed of the slide-rest is obtained direct from the main driving spindle of the headstock of the lathe. The headstock of the lathe is designed so that the driving spindle can be connected direct or through gearing to the armature shaft of the driving motor. There are three sets of gearing of different ratios from four to one to forty to one; hence, with two field-circuit rheostats for the motor in series and 253 different rheostat contact combinations available, upward of 1000 different spindle and test bar speeds are possible for one voltage. Any feed of the slide-rest up to 200 inches per minute is also available, so that the ranges of speed and feed in this lathe are fairly extensive. The tailstock is designed so that whenever necessary, drilling tests can be made on the lathe, it being possible to obtain a spindle speed of 800 revolutions per minute.

On this lathe, many tests of lathe cutting tools of both the plain carbon and high-speed varieties have been made by the present writer; and particular mention should be made of the "speed-increment" or "increasing speed" test for high-speed lathe cutting tools which was originated on this lathe. In this test the cutting speed is not maintained constant, but is started at thirty feet per minute and then increased by an increment of one foot per minute every minute of the test until the point of breakdown of the tool is reached. The criterion value of the tool is the number of cubic inches of metal that it will remove from the test bar under such conditions, the depth of the cut and the feed per revolution being, of course, kept constant in any series of comparative tests. The small increments of speed which are required are obtainable quite easily by means of the two rheostats with which the lathe is provided. To obtain the same results with a single rheostat would involve an unusually large number of contacts, whereas in this case only forty-four contacts are used.

* * *

The report of the Association of German Machine Tool Builders for the last year states that the exports of machine tools from Germany continue to increase, the total being 77,000 tons against 64,500 tons in 1911. The number of men employed in the manufacture of machine tools in Germany is stated to be about 80,000, in addition to which there are over 7000 foremen, superintendents, managers, etc. The value of the total output of the machine tool industry in Germany is estimated to be $55,000,000. The heaviest exports of machine tools from Germany are to Austria-Hungary, Russia and France, which three countries take nearly one-half of the total exports.

STEAM POWER PLANT PIPING DETAILS—4

DANGERS OF WATER SLUGS—DRIP CONNECTIONS—CONDENSATION LOSSES—SEPARATORS

BY WILLIAM F. FISCHER*

In previous articles the writer has, in a general way, called attention to the necessity of keeping live steam mains drained free from water in order to prevent accidents resulting from water-hammer. In the present article the subject will be treated at more length, in order that the designer may have a better idea of the methods employed in caring for condensation and preventing dangerous water pockets. Probably the greatest source of danger to engines of the reciprocating type is the liability of water collecting in the steam piping system, which, unless properly drained off or stopped by a steam separator, eventually finds its way to the engine cylinders in "doses" or "slugs." This is particularly dangerous in high-speed engines, owing to the small clearance space at each end of the cylinder. Water has a great capacity for absorbing heat, and when allowed to accumulate in the steam mains, it has a tendency to condense part of the steam flowing through them. Any steam thus condensed, though small in amount, must be replaced by the boiler, and the cost of generating extra steam for this purpose will amount to a considerable sum of money during the course of a year. Initial condensation occuring in a steam engine cylinder is a good example of this loss. Water lying in the cylinder, or swept in by the steam flow, chills the cylinder walls which, in turn, tend to cool down and condense part of the hot steam entering the cylinder at the next stroke of the piston. Consequently, a greater quantity of steam must be admitted to the cylinder than would otherwise be required to do the work. Initial condensation also causes a corresponding drop in pressure and causes disagreeable and dangerous pounding or knocking in the engine cylinder as the water is driven back and forth by the piston.

Condensation Losses

The presence of water in steam mains is due to the condensation of steam in the pipes, and, in some cases, to priming or foaming of the boilers where water is at times carried over by the steam leaving the boiler at high velocity. Heated surfaces naturally lose heat when brought into contact with a cooler surface or element. Thus between two bodies which are near each other, or in contact with each other, there exists a tendency toward temperature equalization, by radiation, conduction and convexion. A pipe carrying steam at a temperature of from 212 degrees F. and upward, which is in contact with the surrounding atmosphere—the temperature of which seldom exceeds 100 degrees F.—is quite naturally the cause of a rapid radiation of heat from the surface of the pipe to the surrounding atmosphere. This rapid radiation of heat is what causes condensation of the steam in the pipes; it is also responsible for a direct loss of the heat which is derived from the fuel and stored up in the steam, and for this reason radiation should be prevented as far as possible by covering all live steam mains with a good grade of non-conducting pipe covering of some standard make. Experiments by different authorities show that a bare steam pipe surrounded by air, will radiate about three B. T. U. per square foot of pipe surface per hour, for each degree F. difference between the temperature of the steam in the pipe and the temperature of the surrounding air. Tests made by Mr. George H. Brill on an 8-inch standard steam pipe 60 feet long, carrying steam at from 109 to 117 pounds per square inch, gage pressure, and surrounded by air at temperatures varying from 58 to 81 degrees F. show that each square foot of bare pipe surface radiates approximately 2.706 B. T. U. per hour, per degree average difference of temperature between the steam in the pipe and the outside air. This agrees very closely with tests made by Mr. H. G. Stott, who found the loss in bare pipes to be 2.708 B. T. U. per square foot, per hour, per degree difference in temperature between the steam and air. (For results of the tests mentioned see "Kent's Mechanical Engineers Pocket Book," eighth edition, pages 559 to 561 inclusive.)

The actual heat losses in a steam pipe will, of course, depend upon the size of the pipe, its position, the nature of the pipe surface and the velocity of the air surrounding the pipe. Horizontal steam pipes radiate heat more rapidly than vertical pipes, the reason for this being that the heated air surrounding a vertical pipe travels upward along the surface of the pipe, while with horizontal pipes the heated air rises immediately upon being heated, thus making room for cooler air which is, in turn, heated. For all practical purposes, however, it is customary to assume a loss of three B. T. U. per square foot, per hour for each degree F. difference in temperature between the steam in the pipe and the air surrounding the pipe, as previously mentioned. The following examples will serve to illustrate the loss due to radiation in an uncovered steam pipe, and the saving which may be effected by covering the pipe with a good grade of non-conducting pipe covering.

Example 1.—A standard 10-inch uncovered steam pipe, 200 feet long, carrying saturated steam at 150 pounds gage pressure (165 pounds absolute) is surrounded by air at an average temperature of 60 degrees F. How many B. T. U. (heat units) will be given off per hour, and how many pounds of steam will condense in the pipe in one hour?

Answer.—The actual outside circumference of a 10-inch standard steel or wrought-iron pipe is 33.77 inches or 33.77 ÷ 12 = 2.8 feet, approximately. The circumference of standard steam pipes may be found in the manufacturers' catalogues. The circumference of the pipe, in feet, multiplied by the length in feet will give the exposed surface of the pipe in square feet. Therefore: 2.8 × 200 = 560 square feet of outside or exposed surface in this case. The temperature of steam at 150 pounds gage pressure (165 pounds absolute pressure) is 366 degrees F., and the temperature of the air, as previously given, is 60 degrees F. Therefore, the difference in temperature between the steam and air is 366 — 60 = 306 degrees F. Assuming a loss of three heat units per hour, per degree difference in temperature, for each square foot of exposed pipe surface, we have: 3 × 560 × 306 = 514,080 heat units radiated or given off from the 10-inch pipe in one hour.

Putting the above calculation in the form of an algebraic equation, we get:

$$R = 3\,S\,(T-t) \qquad (1)$$

where

R = the number of B. T. U. given off from the surface of a bare steam pipe in one hour;

S = exposed surface of pipe in square feet;

T = temperature of steam in pipe, in degrees F. (Found in steam tables.)

t = temperature of the air surrounding the pipe, in degrees F.

Applying Equation (1) in the preceding example, we get: $R = 3\,S\,(T-t) = 3 \times 560 \times (366-60) = 514{,}080$ B. T. U. per hour.

If superheated steam is used in the piping system, the temperature T of the steam will be higher than for saturated steam, and this should be taken into account when applying the formula for superheated steam.

To find the weight of steam condensed in the pipe in one hour, proceed as follows: From the steam tables we find the latent heat of evaporation for saturated steam at 150 pounds gage pressure (165 pounds absolute) to be 856.8 B. T. U. per pound. This means that 856.8 B. T. U. must be added to each pound of water in the boiler to change it into steam at a temperature of 366 degrees F. and a pressure of 150 pounds (gage) without increasing its temperature during the process of evaporation. In other words, after the water has been evaporated or turned into steam, each pound of steam has absorbed 856.8 B. T. U. during the process of evaporation, but the temperature of the steam still remains the same as the temperature of the water from which it was formed. In the reverse order, if we extract 856.8 B. T. U. from a pound of steam at 150 pounds gage pressure (165 pounds absolute) it will condense or be changed again into the form of water, the water of condensation having the same temperature as the steam from which it was condensed. It follows, therefore, that for every 856.8 B. T. U. that is radiated or given off from the surface of the 10-inch steam pipe in the preceding example, one pound of steam will be condensed. Since 514,080 B. T. U. are given off in one hour, we have 514,080 ÷ 856.8 = 600 pounds of steam condensed per hour, and, consequently, 600 pounds of water per hour to be drained from the pipe and returned to the boilers or the feed water heater, as the case may be. Putting the preceding discussion in the form of an algebraic equation, we have:

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$$C = \frac{R}{V} = \frac{3\,S\,(T-t)}{V} \qquad (2)$$

where R, S, T and t are the same as given in Equation (1).

C = weight of steam condensed in bare steam pipe, in pounds per hour.

V = latent heat of evaporation at the given steam pressure and temperature, as given in the steam tables.

Applying Equation (2) in the preceding example, we get:

$$C = \frac{3\,S\,(T-t)}{V} = \frac{3 \times 560 \times (366-60)}{856.8} = 600$$

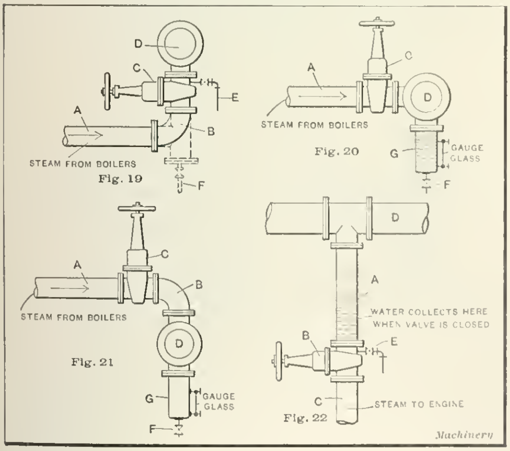
pounds of steam condensed per hour.

Adding 15 pounds to the pressure as recorded on a steam gage gives absolute pressure near enough for all practical purposes. Thus 150 pounds gage pressure = 150 + 15 = 165 pounds absolute pressure.

Saving due to Covering Steam Pipes

In the preceding examples we have determined the heat losses from a bare pipe and the weight of steam condensed as a result of this heat loss. The following examples will show the saving in heat units, condensation and cost of coal by covering the pipe with a good grade of steam pipe covering material. When coal or any other fuel is burned under a boiler, part of the heat passes off in the gases escaping up the stack and is lost in creating draft. With a good grade of steam coal averaging about 14,000 B. T. U. per pound, about 10,000 B. T. U. may be utilized in making steam in a well-designed boiler that is properly fired, the balance of the heat passing off to the atmosphere.

Example 2.—Assuming that 10,000 B. T. U. are utilized from each pound of coal burned in making steam, how many pounds of coal must be burned to supply the heat lost from 200 feet of 10-inch pipe in Example 1?



Figs. 19–22. Methods of draining Water of Condensation from Main Header

Answer.—Since 514,080 heat units are given off per hour, 514,080 ÷ 10,000 = 51.4 pounds of coal per hour which must be burned to make good the heat lost from the bare pipe. One ton = 2000 pounds; therefore, at say $3.00 per ton, 51.4 pounds of coal would cost $\frac{51.4 \times 3.00}{2000} = 0.08$ or 8 cents, approximately. In other words, the heat lost from the pipe in one hour would have a money value of 8 cents. Operating twelve hours per day, the loss would amount to about $1.00 or nearly $2.00 per twenty-four-hour day.

A good grade of asbestos or similar pipe covering will reduce this loss at least 85 per cent, in which case only 77,112 B. T. U. will be given off from the covered pipe per hour, and only 90 pounds of steam will be condensed per hour. The cost of fuel per hour that is required to make good the loss in the covered pipe will be approximately one cent, which represents a saving of seven cents per hour. A 10-inch steam pipe 200 feet long may be covered with a good grade of pipe covering for about $125, including materials and labor, the exact cost depending upon the location of the plant. Therefore, at a saving of seven cents per hour, the covering will pay for itself in about 1800 hours of operation. Knowing the exact conditions in any plant, the condensation losses may be estimated in a similar manner, and after prices are obtained on pipe covering it is a simple matter to estimate the saving made possible by covering the pipes. Outdoor steam pipes should be well protected and heavily insulated, as they are exposed to all kinds of weather, and cold winds sweeping across them at high velocity will cause very rapid condensation of the steam. The saving due to covering outdoor pipes will be considerably greater than for indoor pipe work, but this additional saving is greatly offset by the extra wear and tear on the pipe covering exposed to the elements. Where it is practical to do so, outdoor steam pipes are usually run in pipe tunnels or trenches beneath the ground level and well insulated. As it would require considerable space to describe the different non-conducting pipe coverings now on the market, the writer feels that he can do no better than refer the reader to the manufacturers' catalogues and data, which any pipe covering manufacturer will gladly furnish upon request.

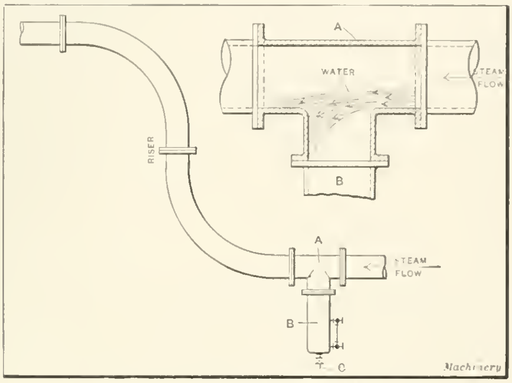


Fig. 23. Riser taken off at End of Header and Method of draining Riser

Superheated Steam

In modern steam power plants, the condensation losses may be reduced to a minimum by the use of superheated steam and the proper pipe covering. In any steam power plant, however, there are certain prime movers which are apt to be shut down over certain periods, especially when the station load is light. In such cases there will be no steam flow in that branch of the piping system which supplies the idle units. If the pipe lines are kept alive under these conditions, the steam will condense and deposit water in the low spots or "pockets" of the system if there are any. When a branch pipe is shut down or cut out of service over certain periods, the live steam remaining in the pipes will gradually condense and the pipes cool down considerably, in which case there is always more or less danger of water forming in them when they are again opened to the steam flow. This is caused by the hot steam coming into contact with the cool surfaces of the pipe and fittings, and thus condensation occurs very rapidly until such a time as the branch pipe is again warmed to approximately the temperature of the steam flowing through it. Condensation occurs less rapidly in pipes carrying superheated steam than in those carrying saturated steam. Before any water of condensation can form with superheated steam in the pipes, the surplus heat units or superheat must first be extracted from the steam, or in other words, the superheated steam must first be reduced to saturated steam at the same pressure, or less, before condensation occurs. Superheated steam is produced by adding heat to saturated steam after it has been removed from contact with the water from which it was formed. This is accomplished by passing the steam through superheater coils after it leaves the boiler drums, the superheater coils being located in the path of the hot gases from the boiler furnace from which the coils absorb a portion of the waste heat as it passes off to the stack.

The thermal conductivity of superheated steam is much lower than that of saturated steam; hence the heat will not be so rapidly transmitted to the walls of the pipe. By adding sufficient superheat before the steam leaves the boilers, it is possible to deliver it to the engines or turbines in a perfectly dry condition. This means that sufficient heat must be added to the steam to make good the heat radiated from the piping system and the heat lost in warming the cylinder walls of the engine at each stroke of the piston. It has been found in practice, however, that even in power plants where highly superheated steam is employed, a certain amount of condensation occurs in the piping system and that water is at times carried over from the boilers during peak loads, this water passing through the superheater and into the steam mains without being evaporated. It is therefore absolutely necessary for the proper precautions to be taken, when designing the piping system, to see that water pockets and low spots in which water can collect are avoided as far as possible, or that they are drained in a manner that will prevent accidents resulting from water-hammer.

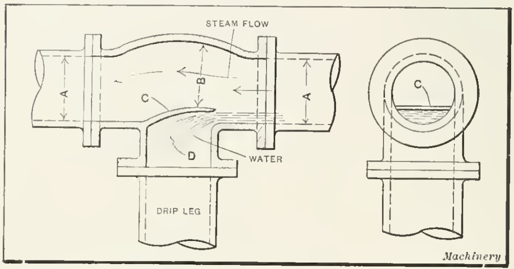


Fig. 24. Special Fitting for diverting Flow of Water into Drip Leg

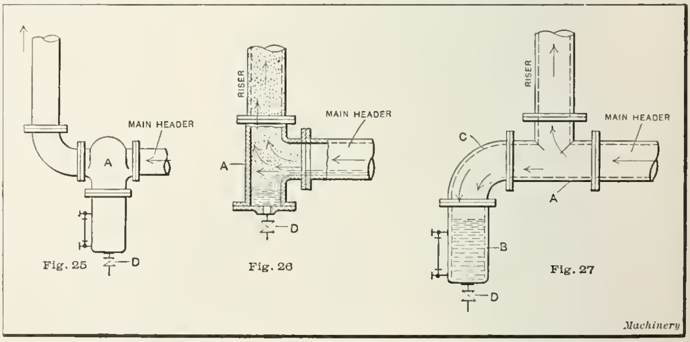
Steam pipes are usually proportioned so that the steam flowing in them travels at a rate of from 6000 to 10,000 feet per minute, and in some cases much faster; hence if a "slug" of water is picked up by the steam and projected against a fitting or blind flange, an accident is likely to result from the rupture of some part of the piping system, or the water may be swept into the engine cylinder and cause an accident to the engine. Even though the quantity of water in the steam mains may not be sufficient to cause serious damage to the system, it may be responsible for disagreeable knocking and hammering in the pipes and engine cylinder which, in turn, causes vibration that may finally cause the joints to leak. The knocking or hammering, so common in steam heating plants where steam is turned into a cold pipe or radiator, is what is known as "water-hammer." The shock or pressure produced by water-hammer in steam mains is many times that which the piping, valves and fittings are ordinarily designed for or expected to sustain. This fact is borne out in practice by the large number of accidents that may be traced to this cause alone. To avoid water-hammer and the other evils which result from condensation in the mains, water pockets in the steam piping system should be avoided as far as possible, or else they should be drained free from water as fast as it collects.

Avoiding Water Pockets in Steam Mains

Fig. 19 shows a very poor method of connecting the boiler leads to the main steam header. With the piping arranged in this manner, the valve *C*, when closed, forms a water pocket in the line above the valve seat. With the valve open, the water of condensation forming in the main steam header *D* tends to flow back to the boilers against the steam flow. This condition should be avoided, wherever it is possible to do so, for if it is attempted to run the water of condensation against the steam flow, water-hammer is likely to occur by the flowing steam holding the water back and driving it over to the header again in large "doses" or "slugs," unless the pipe leading from the boiler is exceptionally large and the velocity of the flowing steam much below the average, as in steam heating plants, etc. If it becomes absolutely necessary to arrange the piping as shown in Fig. 19, the valve *C* should be dripped above the seat as shown at *E*. It might also be advisable to substitute a tee fitting for the elbow *B*, as shown by the dotted lines, and drip the blind flange at the end of the tee at *F*, thus providing a drip leg or well at the low point of the system. Fig. 20 shows a better arrangement of the piping, in which case the steam enters the main header on the side, a drip pocket being provided on the header as shown at *G*.

Fig. 21 shows a far better method of arranging the piping. In this case the steam enters at the top of the header, leaving no low spots or pockets except in the header itself. The drip leg *G*, if properly drained, will keep the main header dry during operation. When steam is taken from the bottom of the main header, as shown in Fig. 22, the stop valve is quite frequently placed some distance below the header as shown at *B*, in order to be within reach of the operator. In this case water will drain from the header *D* into the pipe *A* and collect there when the valve is closed. For this reason valve *B* should be dripped above the seat as shown at *E*. Wherever possible, steam should be taken from the top of the header as in Fig. 21.

In some cases it may be found necessary to offset the main header, or take off a riser (vertical pipe) at the extreme end of the header, as shown in Figs. 23, 25, 26 and 27. In these cases, the header forms a water pocket at the base of the riser where water may collect in sufficient quantities to gradually decrease the effective area of the pipe, in which case the first heavy flow of steam is apt to pick up a large "slug" of water, sweep it up through the vertical riser and project it with great force against the nearest fitting or blind flange, with the danger of causing serious damage to the piping system. In cases of this kind it is always advisable to provide a drip connection at or near the base of the riser, so that the water of condensation may be drained off at this point. Fig. 23 shows the header dripped through a common tee fitting *A*, drip leg *B* and drain *C*. In the enlarged section of the tee, the action of the steam and water in flowing across the opening or outlet of the tee is shown. When the steam is flowing at low velocity, the water passing along the bottom of the header will fall freely through the outlet of the tee into the drip leg *B*. If the steam is traveling at high velocity, however, as is usually the case in high-pressure piping systems, the steam will sweep most of the water across the opening, as shown in the illustration, and carry it up through the riser.



Figs. 25–27. Methods of draining Riser Pipes

In Fig. 24 is shown a special tee fitting which may be used in cases of this kind to prevent the water being swept past the opening in the tee. A partition *C* is cast on the fitting which intercepts the water flowing along the bottom of the pipe and deflects it into the well or drip leg, as shown at *D*, the steam traveling over the partition as shown by the arrows. When designing special fittings of this type, care should be taken to see that sufficient area is provided at any point *B*, so that the steam flow is not restricted. The writer would suggest making the area at *B* from 10 to 25 per cent greater than the effective area of the pipe, and in no case less than the area of the pipe. This fitting is effective only when the steam flow is in the direction of the arrows. In place of the special fitting just described, a separator is sometimes used at this point in the piping system, as shown at *A* Fig. 25. Fig. 26 shows another method of draining the main header at the base of the riser. With this arrangement the water of condensation is swept along at high velocity by the steam flow, and upon striking against the back of the tee *A*, as shown by the arrows, it is suddenly arrested and broken up into fine particles or drops, some of which are caught up again by the flowing steam and carried up through the riser as shown by the dots in the illustration. Fig. 27 shows an improvement on the piping arrangement just described. The tee fitting *A* is placed horizontally in the line, with the riser connected to the outlet and the drip leg *B* connected to the extreme end of the line through the elbow *C*. With this arrangement the water of condensation is swept along to the end of the line, without meeting any obstruction, and falls through the elbow into the drip leg *B*, where it is drained off through drip pipe *D*.

When installing an expansion loop or bend in a steam line, lack of space sometimes makes it impossible to place the bend horizontally as it should be, in which case it may be turned up in a vertical position and the header drained at each side of the bend, as shown in Fig. 28. In this particular case, the installation of a ventilating flue *A* made it necessary to change the main steam piping and carry it above the flue at this point. This was accomplished by removing a straight section of the header, as shown by the dotted lines *B* and substituting tees *C* and bends *D*, *E* and *F*. If the pipe bends were turned down instead of up, bend *E* would form a dangerous water pocket in the line. As it is, water pockets are formed at each side of the bend, at the point *C*, but these are drained free from water in the following manner. Each of the tees *C* is fitted with a blind flange drilled and tapped for a drip connection; and the drip pipe *M* makes connection between these two points through the drip valves *G* and *H*. These drip valves are provided for emergency use only, in case of accident to the drip piping, and should always remain open during operation. The drip main *M* should be connected to a steam trap or other drip return system, through valve *J*. In addition to this drain connection, it is well to provide an open bleeder, or emergency "test drain" connection, as shown at *K*. This connection leads to an open funnel-shaped fitting, and will be found useful in draining the piping system before turning on steam over night, or in testing the system to see that the piping is being properly drained during operation. A bend should be provided in the drip main, as shown at *L*, in order to relieve the expansion and contraction strains in this section of the piping and prevent leakage at the pipe joints.

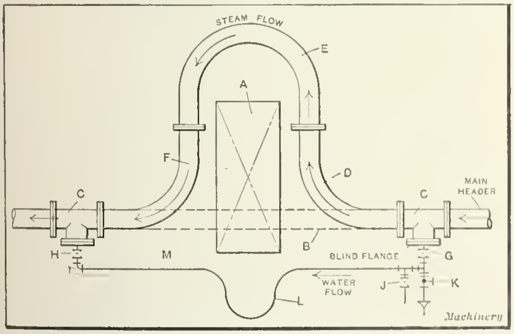


Fig. 28. Method of carrying Expansion Bend over an Obstruction and draining Header

The operation of this system is as follows: With valves *G* and *H* open, the steam flowing in the direction of the arrows will travel through the bends *D*, *E* and *F*, as indicated, while the water of condensation flowing along the bottom of the pipe will travel through drip main *M* underneath the flue, as indicated by the arrows marked water flow, and join the steam flow again at the second tee *C*, if drip valves *J* and *K* be closed at the time. If either drip valve *J* or *K* is open, the water will, of course, be drained off at this point during operation. In this way, the water of condensation may be carried on past an obstruction with the steam flow without danger of water-hammer, whereas, if the drip main were not provided, or if the drip valves *G* and *H* were to be closed during operation, water would gradually collect at the first tee *C* and decrease the effective area of the steam main. In this case the first heavy draft of steam would pick up large "slugs" of water and carry them through the bends into the piping beyond, probably causing serious damage to the system.

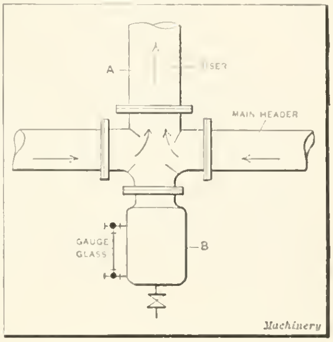


Fig. 29. Method of draining Header at Base of Riser

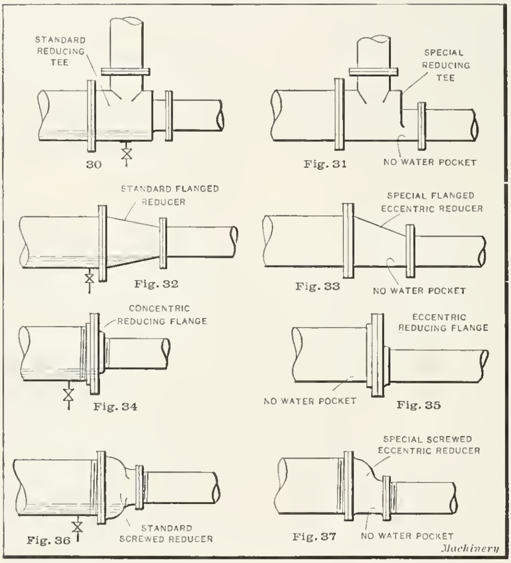
Fig. 29 shows a method of draining the main steam header at the base of a riser at *A*. In this case, the steam flow is in the direction of the arrows, tending to sweep the water of condensation from both ends of the header toward the riser. When the draft of steam is heavy and the flow very rapid, as is usual in high-pressure steam mains, it is advisable to install a drip pocket *B* at the base of the riser to take care of the water and prevent it collecting at this point and being carried up through the riser by the steam flow.

Figs. 30, 32, 34, and 36 show several ways in which water pockets are formed in a steam main by the use of concentric reducing fittings. Figs. 31, 33, 35 and 37 show how these water pockets may be avoided by using special eccentric reducing fittings. Wherever a water pocket is formed it should be drained as indicated. The concentric fittings shown in Figs. 30, 32, 34 and 36 are manufacturers' standard fittings, whereas the eccentric fittings shown in Figs. 31, 33, 35 and 37 are "specials," which may be obtained at a slightly increased cost.

Steam Separators

Steam separators are used in connection with steam power plant pipe work for the purpose of intercepting the moisture in the steam and the water of condensation that flows along with it, before it reaches the engine cylinders or turbines, thus protecting them from damage by water. It is a well known fact that steam engines and turbines operate more economically and at higher efficiency when supplied with dry steam than when supplied with moisture-laden steam of poorer quality. For this reason, a steam separator will effect a saving in fuel which will be sufficient to pay for itself in a few years' time, and at the same time insure a fair return on the money invested. Besides the saving in fuel, a steam separator effects a considerable saving in oil and engine repairs. Where moist steam enters a steam engine cylinder, the moisture is deposited upon the metallic rubbing surfaces of the pistons and on the cylinder walls, thus washing away the oil intended for purposes of lubrication and carrying it out through the drain pipes or exhaust ports. The cutting action of wet steam upon metallic surfaces is generally recognized. In the case of a reciprocating steam engine it has a tendency to cut and score the cylinder walls, pistons, valves and valve seats very rapidly; and in a steam turbine, the water impinging on the blades at high velocity will wear them out in a comparatively short space of time, making frequent renewals necessary.

Besides intercepting the moisture in the steam, a separator performs another function of great value in providing a reservoir near the engine cylinder where a large volume of steam is stored when the steam valves close at each stroke of the engine piston. This insures a more uniform pressure in the engine cylinder up to the point of cut-off, and also provides a cushion of steam near the cylinder which absorbs the shock caused by the quick cut-off in the steam chest, thus preventing any vibration being transmitted to the piping system. Steam separators also aid in securing a steady and continuous flow of steam in the direction of the engine, without making it necessary to stop and start the flow with every movement of the engine valve. This steady flow of steam toward the engines reduces the pressure-drop between the boilers and engines, at the same time reducing the tendency of the boilers to prime during momentary heavy demands for steam, which quite frequently occur during peak-load periods. By using steam separators of the "receiver" type, having a capacity three or four times that of the high-pressure cylinder, it is possible to reduce the size of the engine supply pipe to one or two sizes smaller than the one called for by the engine builders. This reduction in pipe size should be made at the inlet side of the separator, or the pipe connecting the header with the separator. The pipe connecting the separator with the engine should be the same size as specified by the engine builder, the reason for this being that the steam flow is almost constant in the pipe supplying the separator, while the steam flow is intermittent in the pipe connecting the separator with the engine due to the cut-off in the steam chest. This does not apply to steam turbines, as the conditions under which they operate are different. The flow of steam is more nearly uniform throughout; therefore the pipe should be the same size at the inlet and discharge sides of the separator, and should be made the size called for by the turbine manufacturers.



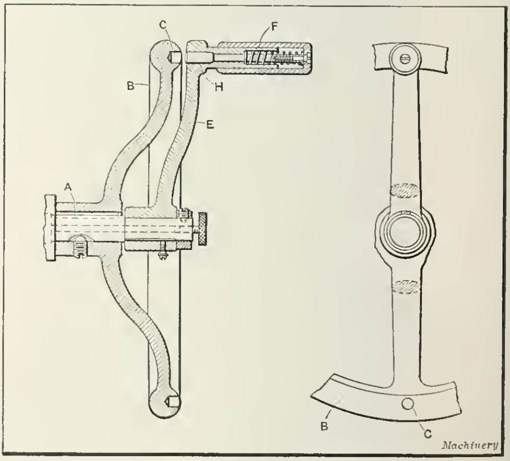
Figs. 30–37. Application of Special Fittings to avoid Water Pockets

Mechanics are sometimes careless in erecting new pipe work, frequently leaving bolts, nuts, wrenches, cold chisels, oil cans and even old shoes and overalls inside the piping system as the sections of pipe are being bolted together. The writer has seen mechanics hiding away tools, old shoes and overalls in the open end of a pipe (pushed in arm's length to hide them from view) when quitting work for the day. If the mechanic neglects to return in the morning and remove his belongings, the steam fitters are apt to bolt on four or five additional lengths of pipe, with the result that the operating engineer makes the acquaintance of the mechanic's "loose junk" some few months later, when called upon to take down and repair a globe valve that refuses to close, and finds a loose bolt or nut, a wrench, or an old shoe wedged tightly beneath the seat. Such "junk" left in the piping system during erection eventually finds its way into the engine cylinder, unless stopped by a steam separator, strainer, or similar device. A small nut carried over by the steam flowing to the engines would, unless stopped, lodge in the engine cylinder scoring and cutting it so badly that in a very short time it would be necessary to dismantle the engine and re-bore the cylinder. A small nut, if carried to the nozzle of a steam turbine, would rip the blades from the turbine rotor before the machine could be shut down. Owing to the small clearance space between the blades and casing of a steam turbine, the supply pipe is usually supplied with a strainer to prevent small iron chips, etc., from getting into it. As a general rule the turbine manufacturer supplies this strainer with each machine. A good separator will remove most of the small "junk," iron chips, etc., left in steam mains during erection, thereby preventing such material from reaching the engine cylinders or turbine inlet.

* * *

MACHINE TOOL SAFETY HANDLE

The accompanying illustration shows an arrangement recently patented by Alfred Herbert, Ltd., Coventry, England, for rotating the shafts of machine tools by hand, particularly where the shaft is also at times rotated by power, as in the case of milling machines, etc. To enable delicate adjustments of the shafts to be obtained, it is desirable that a handwheel be fitted to the shaft, and for quick winding a crank with a handle is preferable. In the arrangement illustrated, the crank is mounted outside the handwheel and the handle moves axially to engage the handwheel. To the shaft *A* is fixed a handwheel *B*, the rim of which is provided with a number of notches or holes *C*. On the shaft is loosely mounted a crank *E*, the outer end of which carries a handle *F* which can be caused to engage with the holes in the rim of the handwheel by means of a sliding pin *H* contained within the handle grip and pushed into place when the handle grip is slid towards the crank. It will be seen that as soon as the grip is released the catch becomes disengaged and the handle is freed from the wheel, which may continue to revolve or not. The wheel is always ready for operation to engage for minute adjustments and the effort required by the operator is very small.—*Mechanical Engineer.*



Machine Tool Safety Handle

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In working to limits of one-ten-thousandth inch the thickness of the oil film in bearings is a factor to be reckoned with. In fact under certain conditions the oil film must be eliminated and metal-to-metal contact established. When journals are rotating under pressure this means the use of ball or roller bearings of a high degree of perfection. Metal-to-metal contact with a high-grade ball bearing is possible both for radial and axial thrusts.

MACHINE FORGING—2

MACHINES AND METHODS EMPLOYED IN THE MANUFACTURE OF BOLTS, RIVETS, NUTS, MACHINE PARTS, ETC.

BY DOUGLAS T. HAMILTON*

In the type of bolt and rivet making machines described in the first installment of this article, the head was formed by hitting the heated bar on the end and forcing it into suitably shaped impressions in the gripping dies. In the following, attention will be given to a type of bolt heading machine in which the end of the bar is first upset and the head is then formed to the desired shape by the combined action of the upsetting punch and hammer dies operating from all four sides. This article will also deal with the construction and operation of continuous-motion bolt and rivet making machines, both of the hand-feed and automatic-feed types.

Hammer Type of Bolt Header

In the hammer type of bolt header, shown in Figs. 19, 20 and 21, the head of the bolt is formed by an end-working upsetting punch and four hammers which are operated from all four sides at right angles to the axis of the bolt. In operation, the heated blank, which has previously been cut to length, is placed in a seat (when the bolt is long enough to be thus accommodated) and between the gripping dies, being located lengthwise by the adjustable stop *A*. Then by a movement of the hand-lever *C*, the dies (one of which is shown at *B* in Fig. 21) are closed and the machine is started. The stock is not moved during the forging operation, but butted up against the adjustable stop, and the gripping dies are not opened until the head is completely formed. From three to five blows are struck, depending upon the size of the bolt and the finish desired, whereupon the machine is stopped and the dies are opened by operating the hand-lever, allowing the finished work to drop from the machine. The side-forming hammers *D*, Fig. 20, give two blows to every blow struck by the heading tool *E* and the vertical hammers *F*.

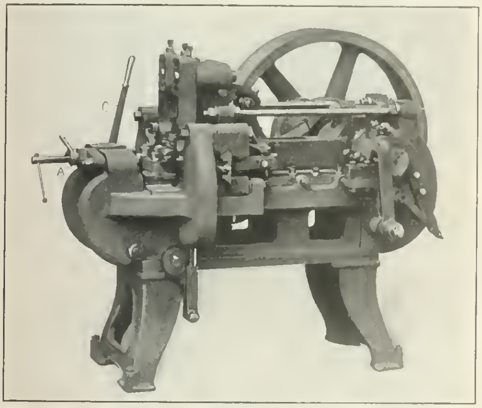

Fig. 19. Type of Hammer Header made by the National Machinery Co., Tiffin, Ohio

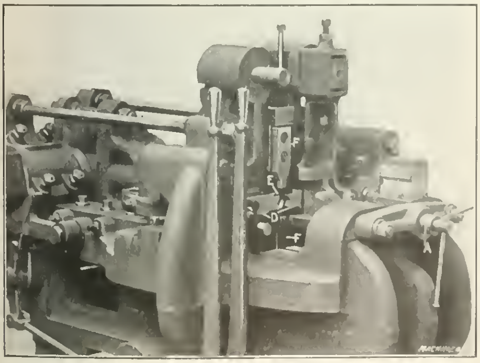

Fig. 20. View of Hammer Header showing Both Gripping Dies removed, and One Die Hanger

The 1½-inch size of this type of hammer header is provided with two hand controlling levers, as shown in Figs. 20 and 21. One of these levers operates the arms carrying the gripping dies, and the other operates the clutch for starting and stopping the machine. On the smaller sizes of machines, one lever controls both of those movements. Fig. 20 shows one of these hammer headers with the gripping dies removed and also the left-hand gripping die hanger; this view also shows clearly the upsetting punch and the four forming hammers. Fig. 21 shows the same machine with one of the gripping dies in place and the left-hand gripping die hanger removed. The tools used in this machine are more clearly illustrated in Fig. 22; the various members bear the same reference letters as used in connection with the description of the machine. For making a square-headed bolt, the side-working hammers, of course, are of the same shape as the vertical hammers.

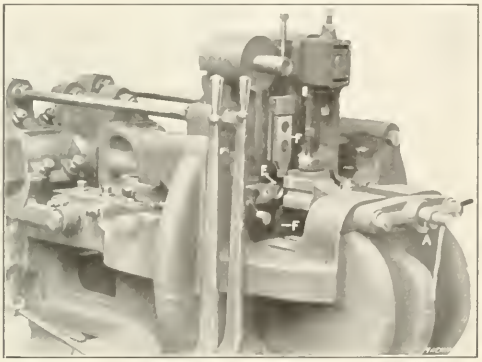

Fig. 21. View of Hammer Header showing Left-hand Die Hanger removed, and One Gripping Die in Place

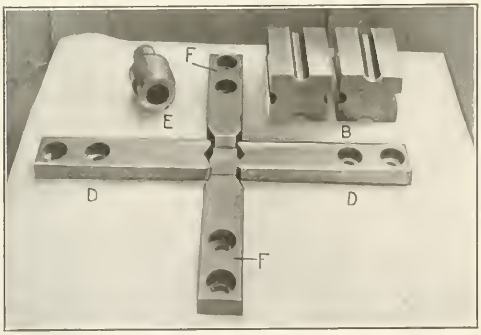

Fig. 22. Type of Dies, Hammers and Heading Tool used in the Hammer Type of Bolt Header shown in Fig. 19

The type of hammer header illustrated in Figs. 19, 20 and 21 is limited in its scope to the production of square, hexagon and tee-head bolts as shown in Fig. 23. These, however, can be produced in large quantities at a low cost, and what is more important, the product is entirely free from fins and burrs, and is shaped as accurately as is possible by the forging method. The fact, however, that it takes longer to change the dies from one size to another in this type of machine militates against its installation in preference to the other types of bolt headers, where frequent changes in the sizes of dies are necessary.

Continuous-motion Bolt and Rivet Headers

Continuous-motion bolt and rivet headers are made in two types, one being hand-fed and the other provided with an automatic roll feed. A machine of the hand-fed type is shown in Fig. 24. In operating this type of machine, the bar, which has been heated for a length of four or five feet, is fed through a shear in the faceplate block of the machine, and as the movable gripping die closes on the bar, a blank of the required length is cut off and held rigidly in the gripping dies. The head is then formed by the forward movement of the ram which carries the heading tool. After heading, the ram of the machine recedes, the gripping dies open, and a kicker, actuated by a connecting-rod *c* from a cam on the main shaft, ejects the finished work from the dies, depositing it through a chute into a box. As the dies open, the operator again pushes in the heated bar until it strikes the stop, and as the movable die advances, another blank is cut off and headed as before. The machine runs continuously until the heated portion of the bar has been exhausted, when the operator takes a freshly heated bar from the furnace and proceeds as before.

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*Associate Editor of MACHINERY.

A bolt or rivet made in a machine of this type receives only one blow, but for work within the capacity of this machine, the production is greatly increased over that obtained from the plain type of forging machine. One of the chief requisites in a machine of the continuous-motion type is that of securing a rigid grip on the work while the head is being formed. If the grip is not satisfactory, that is, if the dies separate, it causes the shank of the bolt or rivet to become tapered or out of round, and also results in fins being produced on the shank and under the head. Furthermore, unless the machine is provided with suitable slides which can be kept in proper alignment, it is difficult to secure work on which the heads are centrally located with the shanks, and also to keep the shear and movable die in correct working relation.

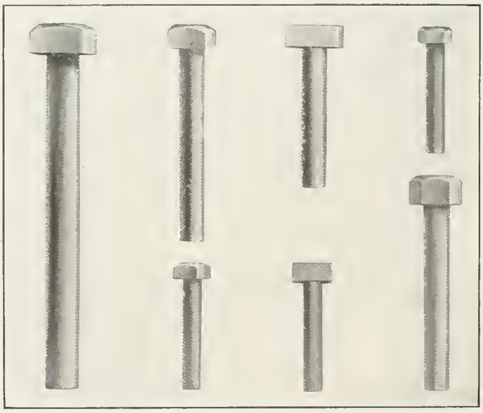

Fig. 23. Some Examples of Work produced in National Hammer Headers

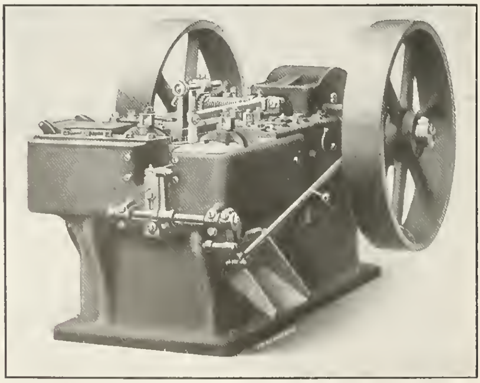

Fig. 24. Continuous-motion Wedge Grip Bolt and Rivet Header built by the National Machinery Co.

The type of tools used in the bolt and rivet machine of the continuous-motion type is illustrated in Fig. 25. The two gripping dies *A* and *B* are held in the die space of the machine by heel clamps as shown in Fig. 24. They are provided with four grooves making them interchangeable, so that when one groove wears out, it is only necessary to reverse the blocks. The heading punch *C*, which is held in the holder *D* in the ram of the machine, is cupped out to suit the shape of the bolt or rivet head, and is arranged so that it will be in perfect alignment with the gripping dies. *E* is the shearing blade which is held in the faceplate block, and is used in cutting off the stock to the desired length. The length of the gripping dies is governed by the length of the bolt required; they are made shorter than the blank from which the bolt is made, thus allowing for sufficient extra stock to form the head. This subject will be dealt with more fully in a future article.

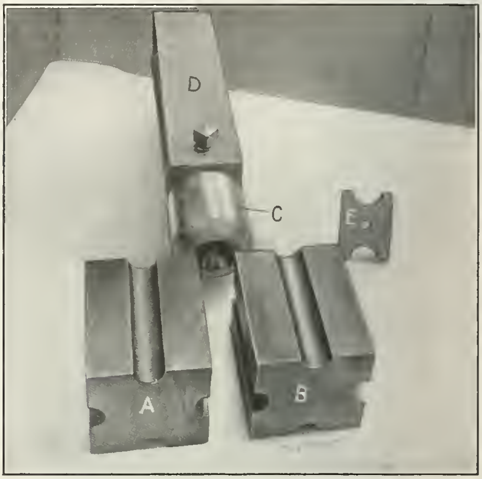

Fig. 25. Type of Dies and Tools used in the Continuous-motion Bolt and Rivet Header shown in Fig. 24

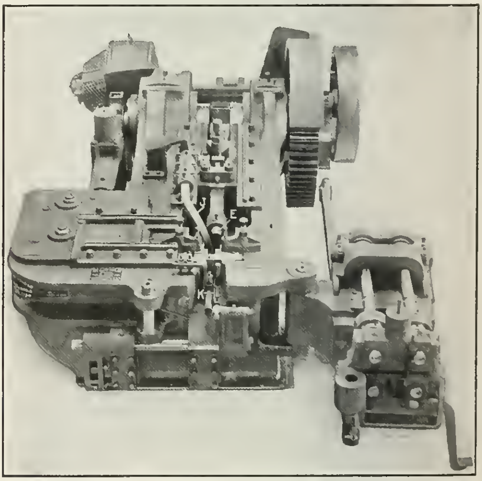

Fig. 26. Continuous-motion Bolt and Rivet Header built by the Ajax Mfg. Co., Cleveland, equipped with Roll Feed Attachment

Continuous-motion Bolt and Rivet Header with Automatic Feed

Fig. 26 shows a continuous-motion bolt and rivet header furnished with a roll feed attachment, which, as can be seen, consists of four rollers provided with suitably shaped grooves in their peripheries. This view shows the roller feed attachment swung back out of the way to illustrate the dies and tools clearly. This machine is similar to that shown in Fig. 24, with the exception of the roll feed attachment for handling the bars automatically. The tools used are shown in Fig. 29, together with an example of work produced in them. The shearing die *A*, in this case, is steel bushed and is circular instead of oblong in shape. The gripping dies *B* and *C* are provided with four grooves each, as previously described, but to change the blocks for presenting a fresh groove, they are inverted and turned end for end, there being no grooves in the top faces. *D* is a ¾ by 4 inch track bolt, and *E* is the heading tool that is held in the ram of the machine.

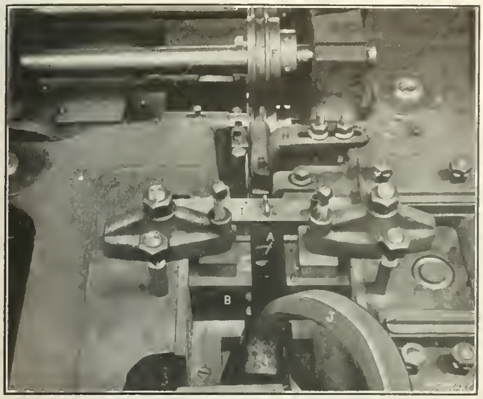

Fig. 27. View looking down into Die Space of Ajax Continuous-motion Bolt and Rivet Header

A close view looking down into the die space of the machine shown in Fig. 26 is illustrated in Fig. 27. This view shows clearly the relative positions of the feed rolls, shearing die, gripping dies, etc. The heated bar is fed by the rolls *F* through the guide pipe *G*, held by bracket *H*, and through the shearing bushing *A*. This bushing is retained in the faceplate *I* which is held in grooves in the machine bed. The bar is fed directly through the cut-off bushing *A* and is gaged to length by the swinging stop *J*, see Fig. 26. The movable die *C* then advances, cuts off the blank and carries it into the groove in the stationary die *B*, gripping it while the heading tool *E* advances and upsets the end of the bar forming the head. The stationary and movable gripping dies are held in place by straps, as shown in Fig. 27, and are located by tongues fitting in grooves in their lower faces. The length of feed is governed by the travel transmitted to the rolls through the feeding mechanism, which receives power from the main crankshaft through a connecting-rod, ratchet, pawl, gears, etc., and is adjustable at the will of the operator.

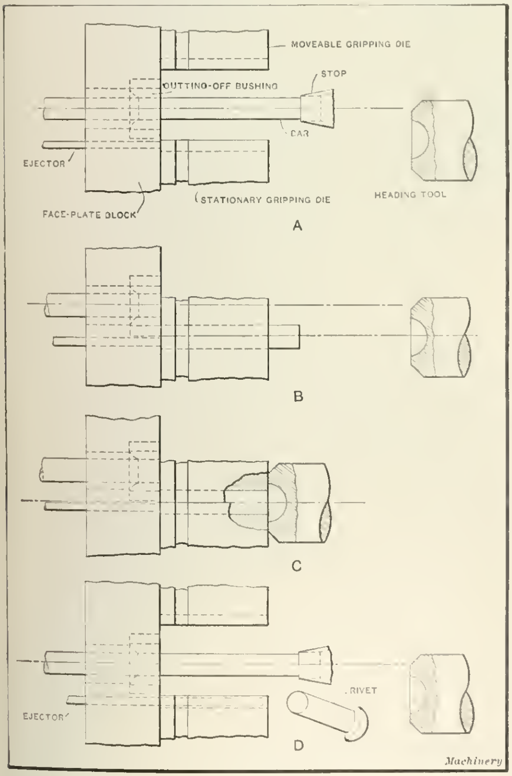

Fig. 28. Successive Steps in the Formation of a Round-head Rivet in a Single-blow Rivet Machine of the Continuous-motion Type

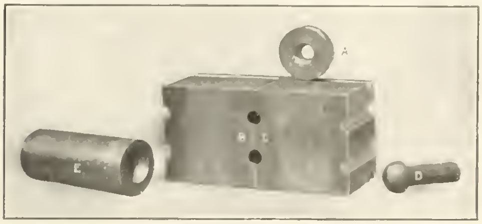

Fig. 29. Type of Dies and Tools used in Bolt and Rivet Making Machine shown in Fig. 26

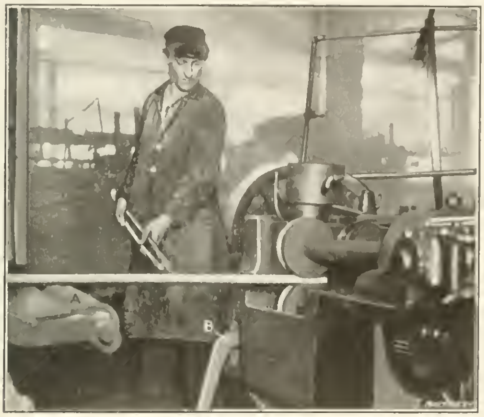

Fig. 30. Ajax Continuous-motion Bolt and Rivet Machine in Action making 1½-inch Rivets

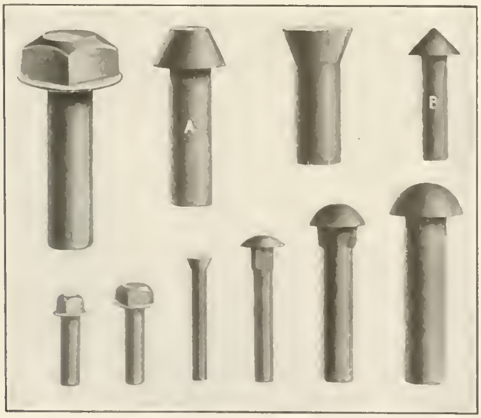

Fig. 31. Some Examples of Work which come within the Range of the Continuous-motion Type of Bolt and Rivet Headers

The various steps in the production of a round-head rivet by the continuous-motion single-blow bolt and rivet machine, are clearly illustrated in the diagram Fig. 28. At *A*, the feed rolls have operated and have fed the heated bar out against the gage stop; at *B* the movable die has advanced, sheared off the end of the bar (projecting through the shearing bushing) and carried the blank into the groove in the stationary die. When the blank is held rigidly, or in other words, when the movable die has reached the end of its forward movement, the heading tool advances, as shown at *C*, and upsets the end of the bar, forming the head. At *D*, the movable die and heading tool have retreated, the ejector pin (see *K*, Fig. 26) has advanced, pushing out the completed rivet, and the bar has been fed out again ready for a repetition of the operations.

Some idea of the methods pursued in the making of bolts and rivets by the continuous-motion machine process can be obtained from Fig. 30, which shows an operator attending to one of these automatic machines. The furnace in which the bar is heated (in the condition in which it comes from the mill) is located anywhere from 3½ to 4 feet from the feed rolls of the machine, and is provided with a roller *A* over which the heated bar passes. The heating furnace, as a rule, is 30 feet long so that the entire length of bar can be accommodated.

As soon as the bar in the furnace has reached the proper temperature, the operator grips it with a pair of tongs, as indicated in Fig. 30, draws it out, and places it between the feed rolls. Then he presses down the foot-lever *B*, thus starting the machine. The heated bar is then drawn in by the rolls, fed through the cutting-off die, gripped in the gripping dies, headed and ejected at the rapid rate of forty to seventy pieces per minute.

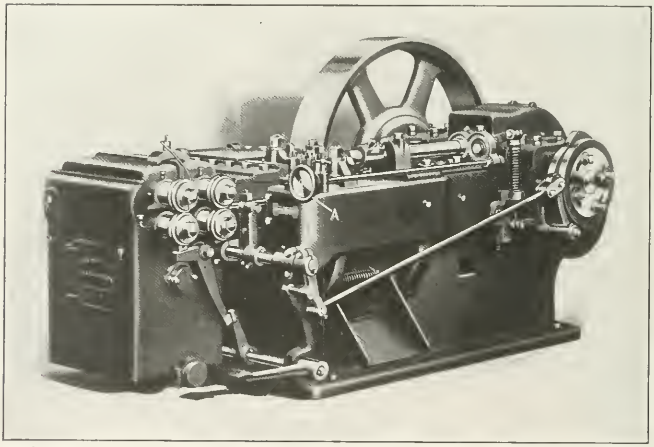

Fig. 32. National Continuous-motion Bolt and Rivet Making Machine equipped with Roll Feed and Adjustable Stop Gage

In the manufacture of rivets, as a rule, steel containing from 10 to 12 points carbon is more frequently used than wrought iron, although the latter material is used in considerable quantities in some manufacturing establishments. Wrought iron for making rivets is heated almost to a white heat, but steel which contains from 10 to 12 points carbon is heated to only about 1400 degrees F.—a bright red color. When the head of a rivet makes it necessary to carry the stock down far into the heading tool, the temperature to which the bar is heated has to be increased, in order to make the metal flow more readily and prevent buckling.

In making rivets having long tapered heads, the operator generally finds it necessary to change the length of feed, so that a rivet having a full head without flash is formed. The reason for this is that the bars sometimes vary in size and temperature which makes this adjustment necessary. A continuous-motion bolt and rivet making machine, which is provided with means for taking care of the fluctuations in size and temperature of stock, is shown in Fig. 32. In this machine the position of the stop is controlled by a handwheel *A*, within convenient reach of the operator, which he adjusts either way, depending upon the size of the bar, temperature of the metal, the shape of the part to be produced and the material from which it is made. When an over-size bar is encountered, the operator shortens the length of feed, as it is evident that too much stock would then be supplied. When the bar is under size, the reverse is the case. Again, when the bar is too hot, it is upset more on the end by the rolls forcing it against the stop, and of course more metal is provided than when the bar is not so hot and consequently harder. The operator watches the pieces as they drop from the machine, and then adjusts the stop to keep the work as uniform as possible—having a full head and without flash.

The feed rolls in the machine shown in Fig. 32 are made of chilled iron castings, and are kept cool by water jackets, insuring even temperature and minimum wear. They are operated from the main shaft of the machine, through a ratchet feed, by a connecting-rod as shown, which is adjustable for securing variations in the feeding time of the rolls. The movements of the machine are timed so as to allow the gripping dies to remain open a comparatively large part of the revolution, thereby allowing more time for the stock to be fed in and gaged and the dies to be well flooded and cooled at the completion of each stroke.

Examples of Continuous-motion Bolt and Rivet Work

Inasmuch as only one blow can be struck in a continuous-motion bolt and rivet making machine, it is impossible to produce parts which cannot be completed in one blow. Fig. 31 shows a representative group of bolts and rivets for which the continuous-motion machines are especially adapted. These machines will also handle a great variety of special work, such as square and hexagon head single-blow bolts, track bolts, etc. The cone-shaped rivets *A* and *B* illustrate the point mentioned in a previous paragraph regarding the difficulty encountered in producing work which is carried down far into the heading tool. Of course, these are not by any means extreme examples, but they serve to illustrate the point.

Making Bolt and Rivet Dies

Bolt dies which are used in a forging machine are as a rule made from steel containing from 60 to 80 points carbon, and are hardened and drawn. The gripping dies are tempered hard, so that the sharp corners on the edges of the dies will not wear away rapidly. It is customary to harden these dies in either oil or water, and then draw the temper so that a file will just take hold. The heading tool, which is comparatively small in diameter, and is called upon to perform heavy duty, must be much tougher than the gripping dies. Ordinarily the heading tool is made from a tough steel containing from 40 to 50 points carbon, and is drawn considerably more than the gripping dies.

In making the impressions in the gripping dies for heading ordinary sizes of bolts, no allowance is made for the shrinkage of the metal. However, in drilling the hole in the dies which grip the stock when it is being headed, a liner is placed between the two halves of the die, so that when they come together on the stock, the latter will be securely held. For dies with a ¼- to ⅝-inch hole, a liner 1/64 inch thick is placed between the opposing faces, when drilling the hole. For holes larger than ⅝ inch and up to 1 inch, a liner 1/32 inch thick is used. For bolt dies from 1 inch up to 1½ inch in diameter, a liner 3/64 inch thick is used, and from 1½ inch up to and including 3 inches in diameter, a grip of 1/16 inch is allowed. Double-deck type dies are made from six blocks of steel bolted and keyed together to facilitate machining.

In making bolt and rivet dies, which are used in continuous-motion machines, it is customary when making ordinary sizes of rivets from ½ to 1 inch in diameter, to use bar stock which is rolled 1/64 inch under size. The dies referred to are shown in Figs. 25 and 29. The holes in the gripping dies are drilled to exact size (not 1/64 inch under size, which is the diameter of stock used), and the expansion of the iron in heating gives sufficient grip as it is only necessary to prevent the rivets from being pulled out of the dies by the return stroke of the heading tool. The reason for this is that in the continuous-motion type of bolt and rivet machine, the work is supported on the sides by the gripping dies, and is backed up by the shear, so that it is practically held in a box while the head is being formed. The same grade of steel is used for making rivet tools as for making tools for producing bolts, and the heat-treatment is also carried on in a similar manner.

EXHAUST SYSTEMS FOR GRINDING, POLISHING AND BUFFING WHEELS*

SPECIFICATIONS PRESCRIBED BY THE NEW YORK STATE DEPARTMENT OF LABOR

The New York State Department of Labor has issued specifications for the design, construction and operation of exhaust systems for grinding, polishing and buffing wheels prepared by Mr. William Newell, mechanical engineer. The specifications were issued with the view of bringing about the efficient removal of dust from grinding and buffing wheels and preventing the construction of exhaust systems of faulty design. Faulty designs include (1) making the suction duct much too small and not infrequently of the same size throughout its length; (2) running the branch pipes into the main at right angles and sometimes at the bottom of the main; (3) providing a fan too small for the service; (4) providing a discharge pipe too small for the fan; (5) providing a cyclone separator or dust separator too small for the system. The result of such mistakes in design is that the suction is entirely inadequate to carry off the dust which then clogs the ducts and spreads about the room to the detriment of the workmen's health.

The importance of efficient exhaust systems is obvious as regards the preservation of health and proper working conditions. An efficient system is productive of higher efficiency of both men and machinery. It has been proved time and time again in actual practice that the output of workmen working under healthy atmospheric conditions is higher than when the conditions are bad. Freedom from dust promotes longer life of machinery and reduces fire risk. The following specifications for the design, construction and operation of exhaust systems conform to Section 81 of the Section Labor Law of New York State.

TABLE I. MINIMUM SIZES OF BRANCH PIPES ALLOWED FOR DIFFERENT SIZED EMERY OR OTHER GRINDING WHEELS

Diameter of Wheels	Minimum Grinding Surface, Sq. Ins.	Minimum Diameter of Branch Pipe in Ins.
6" or less, not over 1" thick	19	3
7" to 9" inclusive, not over 1½" thick	43	3½
10" to 16" inclusive, not over 2" thick	101	4
17" to 19" inclusive, not over 3" thick	180	4½
20" to 24" inclusive, not over 4" thick	302	5
25" to 30" inclusive, not over 5" thick	472	6

1. In case a wheel is thicker than given in the above tabulation, or if a disk instead of a regular wheel is used, it must have a branch pipe no smaller than is called for by its grinding surface, as given above.

TABLE II. MINIMUM SIZES OF BRANCH PIPES ALLOWED FOR DIFFERENT SIZED BUFFING, POLISHING, OR RAG WHEELS

Diameter of Wheels	Maximum Grinding Surface, Sq. Ins.	Minimum Diameter of Branch Pipes in Ins.
6" or less, not over 1" thick	19	3½
7" to 12" inclusive, not over 1½" thick	57	4
13" to 16" inclusive, not over 2" thick	101	4½
17" to 20" inclusive, not over 3" thick	189	5
21" to 24" inclusive, not over 4" thick	302	5½
25" to 30" inclusive, not over 5" thick	472	6½

2. Buffing wheels six inches or less in diameter used for jewelry work may have a three-inch branch pipe. The thickness given for buffing wheels just above applies to the thickness of the wheel at the center. In case the wheel is thicker than given in the above tabulation, it must have a branch pipe no smaller than is called for by its grinding surface.

3. Branch pipes must be not less than the sizes specified in the foregoing throughout their entire length.

4. All branch pipes must enter the main suction duct at an angle not exceeding forty-five degrees and must incline in the direction of the air flow at junction with main.

5. Branch pipes must not project into main duct.

6. All laps in piping must be made in the direction of the air flow.

7. All bends, turns, or elbows, whether in main or branch pipes, must be made with a radius in the throat at least equal to one and one-half times the diameter of the pipe on which they are connected.

8. The inlet of the fan or exhauster shall be at least twenty per cent greater in area than the sum of the areas of all the branch pipes, and such increase shall be carried proportionately throughout the entire length of the main suction duct, *i. e.*, the area of the main at any point shall be at least twenty per cent greater than the combined areas of the branch pipes entering it between such point and the tail end or dead end of the system. If such increase is made greater than twenty per cent, the area of the main at any point, except that portion of it between the branch entering it nearest the fan and the fan, shall bear approximately the same ratio to the combined areas of the branches preceding that point (*i. e.*, between it and the tail end of the system), as the area of the main at the branch nearest the fan bears to the combined areas of all the branches. (This provision is made to permit the use of a fan having a larger inlet area than the area of the main at the branch pipe nearest to the fan, if desired.) See accompanying Table III, showing what the size of the main suction duct should be at any point for any number of uniform-size branch pipes when the main duct is made twenty per cent greater than the combined areas of the branches entering it—the minimum required by these specifications.

9. The area of the discharge pipe from the fan shall be as large or larger than the area of the fan inlet throughout its entire length.

TABLE III. DIAMETERS OF SUCTION DUCT WITH BRANCH PIPES

Number of Branch Pipes	Diameter of Branch Pipes in Inches								
	3	3½	4	4½	5	5½	6	6½	7
	Area of each Branch Pipe in Square Inches								
	7.07	9.62	12.566	15.9	19.635	23.758	28.274	33.183	38.485
	Area of each Branch Pipe plus 20 per cent (square inches)								
	8.481	11.544	15.08	19.08	23.562	28.51	33 93	39.82	46.182
1	3 5/16	3 13/16	4⅜	5	5½	6	6 9/16	7⅛	7⅝
2	4⅝	5 7/16	6 3/16	7	7¾	8½	9 5/16	10 1/16	10⅞
3	5 11/16	6⅝	7 9/16	8 9/16	9½	10 7/16	11⅜	12 5/16	13¼
4	6 9/16	7 11/16	8¾	9⅞	11	12 1/16	13⅛	14¼	15 5/16
5	7⅜	8 9/16	9 13/16	11	12¼	13½	14 11/16	16	17⅛
6	8 1/16	9⅜	10¾	12 1/16	13 7/16	14¾	16⅛	17 7/16	18¾
7	8 11/16	10⅛	11 9/16	13 1/16	14½	16	17⅜	18 13/16	20¼
8	9 5/16	10⅞	12⅜	14	15½	17 1/16	18 9/16	20⅛	21 11/16
9	9⅞	11½	13⅛	14 13/16	16 7/16	18 1/16	19¾	21⅜	23
10	10⅜	12⅛	13⅞	15 9/16	17 5/16	19 1/16	20¾	22½	24¼
11	11	12¾	14½	16⅜	18 3/16	20	21 13/16	23⅝	25 7/16
12	11⅜	13 5/16	15 3/16	17 1/16	19	20⅞	22¾	24⅝	26 9/16
13	11⅞	13 13/16	15 13/16	17¾	19¾	21¾	23 11/16	25 11/16	27⅝
14	12 5/16	14 11/32	16⅜	18 7/16	20½	22 9/16	24⅝	26⅝	28 11/16
15	12¾	14⅞	17	19 1/16	21¼	23 5/16	25 7/16	27 9/16	29 11/16
16	13¼	15 5/16	17½	19¾	22	24⅛	26 5/16	28½	30⅝
17	13 9/16	15 13/16	18 1/16	20 5/16	22 9/16	24⅞	27⅛	29⅜	31⅝
18	14	16¼	18 9/16	21	23¼	25 9/16	27⅞	30 3/16	32½
19	14 5/16	16 11/16	19⅛	21½	23⅞	26¼	28⅝	31 1/16	33 7/16
20	14 11/16	17⅛	19⅝	22 1/16	24½	27	29⅜	31⅞	34 5/16
21	15 1/16	17 9/16	20 1/16	22 9/16	25⅛	27⅝	30⅛	32⅝	35⅛
22	15 7/16	18	20 9/16	23⅛	25 11/16	28¼	30 13/16	33⅜	36
23	15¾	18⅜	21	23⅝	26¼	29	31½	34⅛	36¾
24	16⅛	18 13/16	21½	24⅛	26 13/16	29½	32 3/16	34⅞	37 9/16
25	16 7/16	19 3/16	22	24⅝	27⅜	30⅛	32⅞	35⅝	38 5/16
26	16¾	19 9/16	22⅜	25⅛	28	30¾	33½	36 5/16	39⅛
27	17 1/16	20	22¾	25⅝	28½	31 5/16	34⅛	37	39⅞
28	17⅜	20 5/16	23 3/16	26 1/16	29	32	34¾	37 11/16	40 9/16
29	17 11/16	20⅝	23⅝	26 9/16	29½	32 7/16	35⅜	38⅜	41 5/16
30	18	21	24	27	30	33	36	39	42

The foregoing duct table gives the diameter in inches of the main suction duct at any point for any number of uniform size branch pipes when the area of the main at any point is made equal to the combined areas of the branch pipes preceding that point plus twenty per cent—the minimum required by these specifications.

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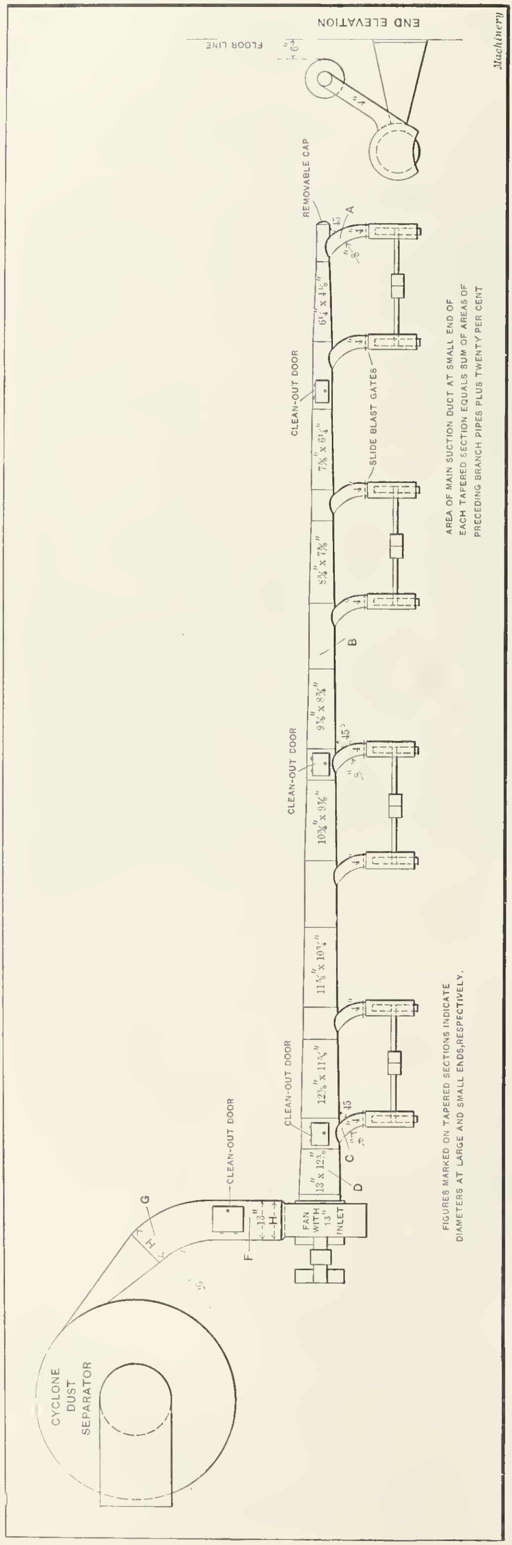
* From specifications for the design, construction and operation of exhaust systems compiled by Mr. William Newell and published by the New York State Department of Labor, 381 Fourth Ave., New York City.



AREA OF MAIN SUCTION DUCT AT SMALL END OF EACH TAPERED SECTION EQUALS SUM OF AREAS OF PRECEDING BRANCH PIPES PLUS TWENTY PER CENT

FIGURES MARKED ON TAPERED SECTIONS INDICATE DIAMETERS AT LARGE AND SMALL ENDS, RESPECTIVELY.

Plan of Exhaust System for Eight Fourteen-inch Grinding Wheels

10. The main trunk lines, both suction and discharge, shall be provided with suitable clean-out doors not over ten feet apart and the end of the main suction duct shall be blanked off with a removable cap placed on the end.

11. Sufficient static suction head shall be maintained in each branch pipe within one foot of the hood to produce a difference of level of two inches of water between the two sides of a U-shaped tube. Test is to be made by placing one end of a rubber tube over small hole made in pipe, other end of tube being connected to one side of U-shaped water-gage. Test is to be made with all branch pipes open and unobstructed.

12. Plans for all exhaust system installations, showing location and sizes of all wheels, hoods, main and branch pipes, fan, and dust separator, should be submitted to this department in duplicate for approval before work is begun and it must be clearly specified that the system is to be installed in strict accordance with the above specifications. The test specified above positively must be obtained before the system will be acceptable to the Department of Labor. Plans should be addressed, "Chief Factory Inspector (Engineering Department), Department of Labor, 381 Fourth Ave., New York City."

13. The contract for the installation of an exhaust system should contain a provision to the effect that payment will be withheld until the above test shall have been made and the system accepted by this department.

In addition to the above specifications, which are compulsory, a number of recommendations are given below, which if observed, will make for still more efficient operation and longer life of the system.

Recommendations

1. Emery wheel and buffing wheel exhaust systems should be kept separate owing to danger of sparks from the former setting fire to the lint dust from the latter, if both are drawn into the same suction main.

2. In the case of undershot wheels (when the top of the wheel runs toward the operator), which is almost always the direction of rotation of both emery and buffing wheels, the main suction duct should be back of and below the wheels and as close to them as is practicable; or it should be fastened to the ceiling of the floor below, preferably the former. If behind the wheels, it should be not less than six inches above the floor at every point to avoid possible charring of the floor in case of fire in the main duct and also to permit sweeping under it. For similar reasons it should be at least six inches below any ceiling it may run under.

3. Both the main suction and discharge pipes should be made as short and with as few bends as possible, to avoid loss by friction. If one or the other must be of considerable length, it is best to place the fan not far beyond where the nearest branch enters the large end of the main, as a long discharge main is a lesser evil than a long suction main.

4. Avoid any pockets or low places in ducts where dust might accumulate.

5. The main suction duct should be enlarged between every branch pipe entering it, whenever space permits, and in no case should the main duct receive more than two branches in a section of uniform area. All enlargements in the size of the main should be made on a taper and not by an abrupt change of diameter.

6. If there is a likelihood of a few additional wheels being installed in the future, it is advisable to leave a space for them between the fan and the first branch and to put in an extra size fan. Or a space may be left beyond the fan so that the fan may be moved along and the main extended when it is actually decided to install additional wheels, provided the fan is of sufficient size to still comply with these specifications after the additional branches are added.

7. Branch pipes should enter the main on the top or sides—never at the bottom. Two branches should never enter a main directly opposite each other.

8. Each branch pipe should be equipped with a shut-off damper, or blast-gate as it is also called, which may be closed, if desirable, when the wheel is not in use. Not more than twenty-five per cent of such blast-gates should be closed at one time; otherwise the air velocity in the main duct may drop too low and let the dust accumulate on the bottom.

9. It is very important that the lower part of the hood shall

come far enough forward beneath the front of the wheel so that the dust will enter the hood and not fall outside of it altogether, even if the accomplishment of this result necessitates leaving considerable space between the wheel and the lower part of the hood in order that the hood shall not interfere with the work.

10. Branch pipes should lead out of the hood as nearly as possible at the point where the dust will naturally be thrown into them by the wheels. This is very important.

11. An objectionable practice sometimes found where small work is polished is the use of a screen across the mouth of the branch pipe where it enters the hood. Such screens are an obstruction to the passage of material and the ravelings from buffing wheels are held against the screen by the suction, with the result that in a short time the draft is almost entirely cut off.

12. The use of a trap at the junction of the hood and branch pipe is good practice provided it is cleaned out regularly and not allowed to fill up with dust. This will catch the heavier particles and so take some wear off the fan. It will also serve to catch any nuts, pieces of tripoli, etc., dropped by accident, and in the case of work on small articles, will enable them to be recovered when dropped in the hood.

13. All bends, turns, or elbows, whether in main or branch pipes, should be made with a radius in the throat of twice the diameter of the pipe on which they are connected, wherever space permits.

14. Elbows should be made of metal one or two gages heavier than the pipe on which they are connected as the wear on them is much greater.

15. The withdrawal of air from a room by an exhaust system naturally tends to create a slight vacuum and for this reason inlets for air at least equal to the sum of the areas of the branch pipes should be left open.

16. Recommendations for the size of the cyclone separator or dust collector, as it is often called, are hard to give, as the separator must be proportioned to suit operating conditions, light dusts requiring a larger separator than heavy dusts. A separator should be selected the area of whose inlet is at least as large as the area of the discharge pipe from the fan. For light buffing dusts, lint, etc., the air outlet from the top of the separator should be so large that the velocity of discharge will not exceed 300 to 480 feet per minute; then select a separator of which the other dimensions are proportionate. The air outlet should be provided with a proper canopy or elbow to exclude the weather but should be otherwise unobstructed. There should be ample clearance under the separator for the accumulation or storage of the dust which should never be allowed to pile up as high as the bottom of the separator.

The accompanying illustration shows an exhaust system laid out in conformity with these specifications for eight fourteen-inch emery wheels. For eight fourteen-inch buffing wheels, the branch pipes would have to be not less than four and a half inches diameter, and the increased size of the main suction duct and the fan determined in accordance with Section 8. The main discharge pipe would also have to be larger and the cyclone separator should be considerably larger for buffing wheels than for emery wheels.

* * *

A NEW MACHINE FOUNDATION

BY J. P. SCHROETER*

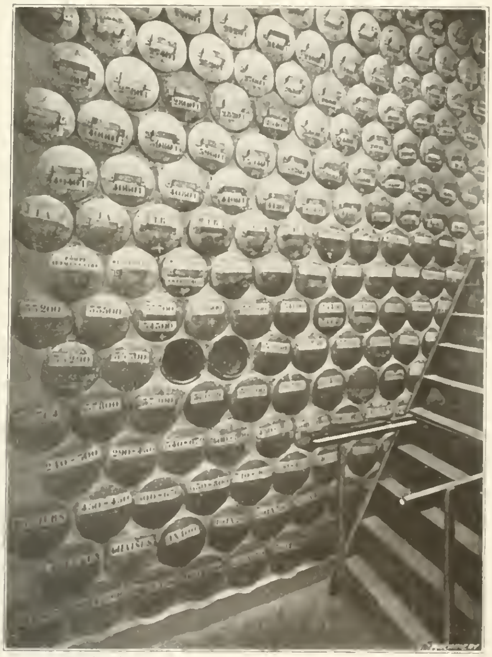
A very convenient method of foundation construction has recently been developed by the Rügen Machine Fundament Co., Berlin, Germany. This new method dispenses with all anchoring, bolting, etc., and the floor, consisting of concrete, wood or asphaltum, generally remains just as it is, although it must be leveled up when necessary. Between the machine foundation plate and the floor, an India rubber mat is laid. This mat is of special composition, and as a result of the weight of the machine acting upon it a vacuum is produced. The machine is held firmly in position by the displacement of the air and the adhesion of the mat, so that no anchoring or other means of fastening is necessary. This type of foundation is, of course, especially suitable for small machines, although it works well on large ones which have to be erected on a substructure. In such cases all that is necessary is a small layer of concrete with the foundation plate on the top.

The advantages of this new Rügen foundation are as follows: There is considerable saving in the expense of the foundation construction. A great saving in time is effected, as it is not necessary to wait for several days until the cement foundation has hardened. All damage to the floor or ceiling is avoided because the use of foundation bolts in the floor or stays from the ceiling is unnecessary. It is possible to remove the machine easily and inexpensively, if necessary. All shocks and noises are absorbed, which results in greater precision in manufacturing and an increased life of the machine. Electrical machines are entirely insulated so that no ground connections are possible. The rubber mats may be employed for the same purpose and with the same results in another place, in case the machines are removed. A great number of machines have been erected on this type of foundation in all industrial branches, and they have given the greatest satisfaction.

* * *

FIREPROOF VAULT FOR DRAWINGS

The illustration shows a unique storage vault for drawings, built by Société Anonyme des Ateliers de Construction, H. Bollinckx, Brussels, Belgium, which provides for the segregation of the drawings, and has the merit of being simple, cheap to construct and probably efficient in case of ordinary fire. The vault is designed for the protection of original drawings and tracings only. The drawings used by the company are 0m.80 by 1m.20 (31½ by 47¼ inches). The vault consists of rows of earthenware tubes set in concrete, one row above another as shown in the illustration. The tubes are inclined so that the mouths are slightly lower than the rear. This is done to prevent the easy entrance of water spray in case of fire. The mouths of the tubes are closed with sheet-iron lids on which the numbers of the drawings within are stenciled.


Bollinckx Fireproof Storage Vault for Drawings

The ladder shown at the right is provided to enable all the tubes to be easily reached. It is made with two guides in front which carry a lattice (seen in the rear), on which to spread out the drawings when it is desirable to inspect them at the storage vault.

The company states that drawings kept in this vault are remarkably unchanged by age, the reason being ascribed to the regularity of temperature and the absence of light.

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* Address: 1321 E. 56th St., Chicago, Ill.

MAKING THE RED-E TOOL-HOLDER

AN EXAMPLE OF SPECIALIZED MANUFACTURE IN WHICH BROACHING PLAYS AN IMPORTANT PART

BY CHESTER L. LUCAS*

In the manufacture of tool-holders, it would not seem at first thought that there could be many specially interesting operations, but the way the Ready Tool Co., of Bridgeport, Conn., has applied modern methods to making good tool-holders has resulted in the use of interesting jigs and fixtures worthy of description. The Ready Tool Co. makes many different types of tool-holders for lathe and planer use, but the manufacture of its latest style, known as "Type X," furnishes interesting methods enough for one article. This tool-holder, which is shown in the phantom illustration, Fig. 1, is provided with a square hole at an angle of fifteen degrees with the base to receive the tool-bit. The tool-bit is held in place by a setscrew, bearing against it at right angles, and an important feature is the inserted tool-steel seat against which the tool-bit bears.

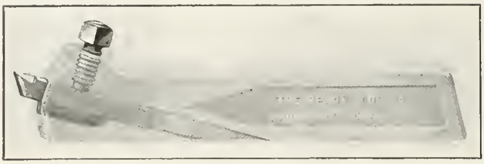
Fig. 1. Red-E Tool-holder "Type X"

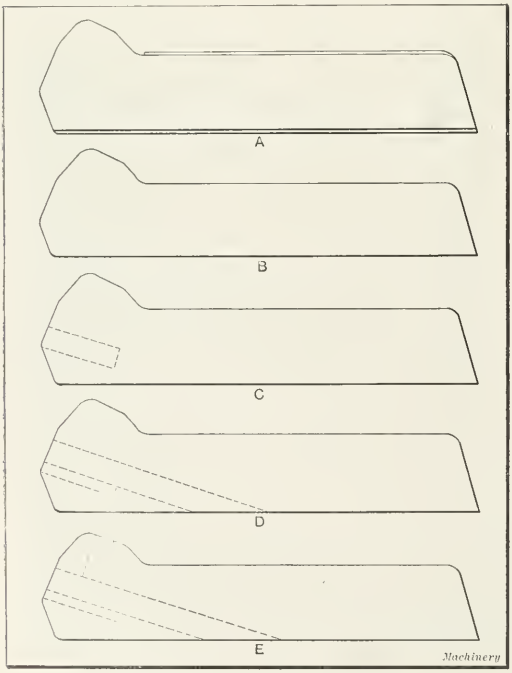

Fig. 2. Steps in making the Tool-holder

Milling off the Edges

Fig. 2 gives an idea of the different operations through which the tool-holders pass before they reach completion. At *A* we have the drop-forging upon which the work starts. This is made of chrome-nickel steel, and the first operation is that of milling the flat top and bottom. This operation is necessary because the parting line of the forging comes along the edge of the tool-holder and the draft which the dies require leaves the edges of the forging convex. The special milling fixture illustrated in Fig. 3 is employed for milling off this convexity, and six tool-holder blanks are accommodated. By referring to Fig. 4 it will be seen how this fixture operates.

There are three units to the fixture, each of which is provided with a central stationary rib *A*, shown on the unit of the fixture illustrated in Fig. 4; against this central rib the forgings *B* are clamped from each side. The clamping jaws *C* are drawn against the forgings by means of a right- and left-hand screw *D*. The four contact points of jaws *C* are indicated at *E*. These parts are pivoted two in each of the jaws so that they can adjust themselves to any irregularities of the forgings. As the jaws *C* slide loosely over screw *D*, they also have considerable latitude in adjusting themselves to the clamping position. It should be noticed that the clamping jaws have a three-point bearing, the two upper points being at *E* and the lower point against the side of the fixture.

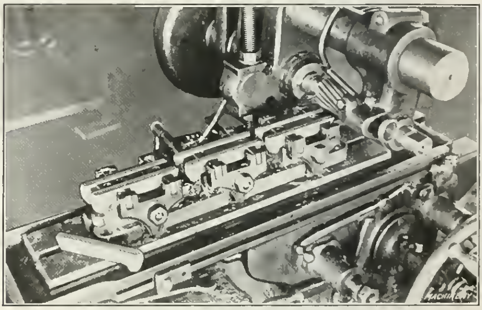
Fig. 3. Milling Fixture in which the Edges are machined

The operation of this fixture is rapid and efficient. By simply tightening the nut on the screw from one side, both forgings are securely clamped in place. The various bearing parts are, of course, hardened on their working faces.

Drilling for the Tool-steel Plug

The result of the milling operation is shown at *B* in Fig. 2, and the succeeding step is that of drilling the end of the tool-holder for the reception of the tool-steel plug. After this plug has been welded in place, as will be described later, the upper half is drilled and broached away leaving a tool-steel seat, semicircular in section, against which the cutting strain of the tool-bit is received.

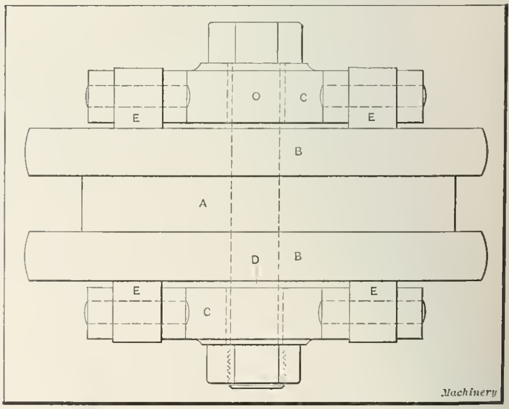

Fig. 4. Showing the Principle of Milling Fixture

The type of jig upon which the drilling of these holes is accomplished is extremely interesting, due to the fact that it is used for many different operations, of which the drilling for the plug is but one. One of these jigs is shown in Fig. 5, in a vertical position at the left and in a horizontal position at the right. When used in the position shown at the left, resting upon corners *A* and *B*, the hole for the tool-steel plug may be drilled in the right-hand off-set tool-holders. By simply swinging the jig over, as on a pivot, so that it rests upon corners *B* and *C*, it is in position for drilling the plugs in the left-hand off-set tool-holders. The forgings are held in the jig by means of two clamps *D* which bear against the edge of the tool-holder, and a clamp *E* which bears against the side of the tool-holder. When drilling right-hand off-set tools, the bushing *F* is used, and when drilling left-hand off-set tools bushing *G* is in use. This jig is used for all the drilling operations on the off-set tool-holders; there are three of these operations and the other two will be described later. The straight-shank tool-holders are drilled in a jig of simple design which is shown in use in Fig. 6. The tool-holders are clamped in position in the same manner as in the previous jig.

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*Associate Editor of MACHINERY.

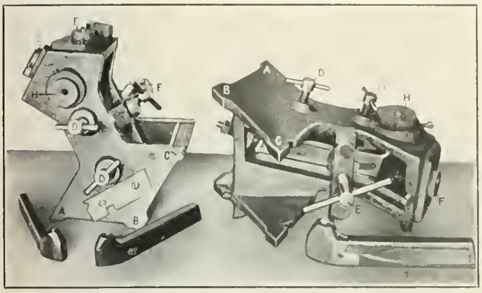


Fig. 5. Drill Jig, illustrating Both Positions

Welding the Plug

As has been stated before, after the drilling of the tool-holder for the insertion of the tool-steel plug the tool-holders go to a Thomson electric welding machine to have the plugs welded in position. This machine works on the same principle as other Thomson electric welding machines and is shown as a whole in Fig. 7. Referring to this illustration and Fig. 8, which shows the working parts of the machine at close range, *A* is the tool-holder into which the plug is being welded. The plug is shown in place, and at *B* may be seen another plug. The electrodes of the machine are represented by *C* and *D*. These electrodes are kept cool by a circulation of water through pipes *E*. The upper electrode *C* is supported in a movable slide so that when the tool-holder and plug have reached the welding heat it can be pressed down upon the side of the tool-holder, compressing the metal in the tool-holder against the steel plug and causing them to unite. The slide is operated by means of a toggle mechanism and lever *F*, shown in Fig. 7, which is actuated by the operator. It should be stated that the forgings are adapted for this welding operation by leaving the sides very full at the points opposite the plug, so that there is plenty of metal to press against the plug without altering the finished shape of the tool-holder.

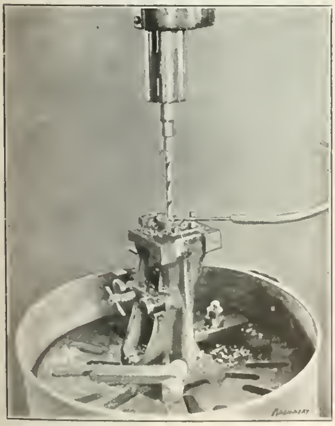


Fig. 6. Drilling for the Tool-steel Plug

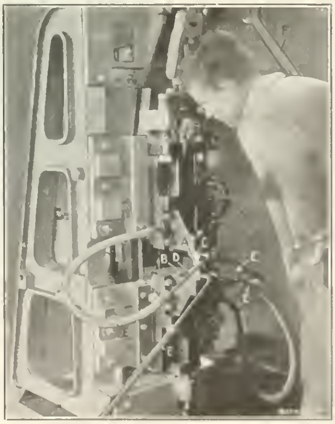


Fig. 7. Thomson Electric Welding Machine

The drilling of the hole for the tool-holder bit, which takes place after the tool-steel plug has been welded in position, is performed on the jig illustrated in Fig. 6. This jig, it will be remembered, is the same one that was used for drilling the holes for the plugs. To prepare the jig for this operation, it is only necessary to turn the bushing a half turn and clamp it solid again by means of simple clamps provided. As the holes in these bushings are off-set, when located in one extreme position they are properly located for drilling the plug, and when turned to the other extreme are so situated that they drill away one-half of the plug and thus form the correct location for the tool-bit hole. This jig is used only on the straight tool-holders, the off-set types being taken care of by the jig shown in Fig. 5. When using the jig for this operation, bushings *F* and *G* are given a half turn and again clamped, and the jig is ready for use.

This drilling operation is particularly hard on the drill as it will be remembered that half the hole being drilled is through the tool-steel plug, while the other half is through the chrome-nickel steel forging, and as this division is made longitudinally there is a tendency for the drill to "run." Also by referring to *D* in Fig. 2, which shows the plugged and drilled tool-holder, it will be noticed that this hole emerges from the under side of the forging at an angle so that the drill is under more strain when breaking through. The drills used are of the hot twisted type.

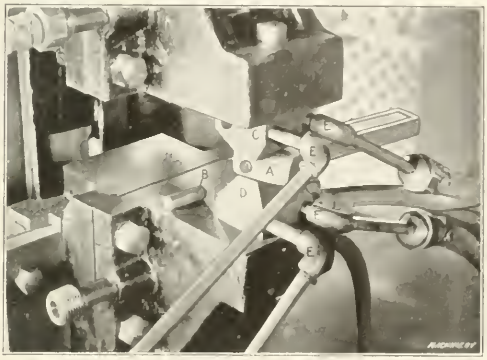


Fig. 8. Welding the Plug in Place

Broaching the Square Hole for the Tool

One of the most interesting operations connected with the manufacture of the "Red-E" tool-holder is that of broaching the square hole. This operation is performed on a broaching machine made by the J. N. Lapointe Co., New London, Conn., and has been conceded by broaching experts to be a most difficult proposition. The difficulty lies in the fact that the square hole is of small diameter and must be broached to the limit of the corners, and in addition, the length of the hole is great in comparison with the diameter. The fact that the cut is at an angle with the base of the tool-holder gives more trouble, because the cut is longer on one side of the hole than on the other. In Fig. 9 a general view of the broaching operation is illustrated, and in Fig. 10 a closer view of the working parts of the machine and broaching fixture is shown. Two types of jigs are used for broaching the square holes, the one shown at the left in Fig. 11 being employed for the straight tool-holders, while that at the right is used for the off-set tool-holders, both right- and left-hand. These fixtures are designed to be bolted to the faceplate of the broaching machine after the manner illustrated in Fig. 10. The tool-holders are held in position from both sides by clamping screws, as may be clearly seen in Fig. 11. Stops are provided to gage the position of the tool-holders with respect to the previous drilling operation, for it is essential that the broaches cut evenly at the corners of the drilled holes. The broaches themselves are shown in the foreground of this illustration. They are three in number. The first broach starts from the round and cleans out part of the metal from the corners; the second approaches the square still more; and the third completes the work, sizing and finishing the hole entirely. On most square broaching jobs the corners may be left with slight fillets, but on this work the metal must be removed right in to the corner. In Fig. 11, an off-set and a straight tool-holder may be seen. Of these two, the straight holder is more difficult to broach because of the long length of hole.

Fig. 12 illustrates the method used in making the broaches. Round steel is employed for the broach blanks and the first operation consists in cutting the teeth. These are turned by holding the broach in a collet, turning several teeth, and then advancing the work for turning a few more teeth. After the teeth have been turned the broach is mounted in a milling machine as illustrated in Fig. 12, and the teeth are milled to the square shape. A high quality of tool steel is used for these broaches and they are hardened, of course, and drawn to a medium straw color. It is only by using the utmost care and the best of steel that the broaches will last for any length of time upon this work. The pulling strain is so great that unless properly made they are quickly broken.

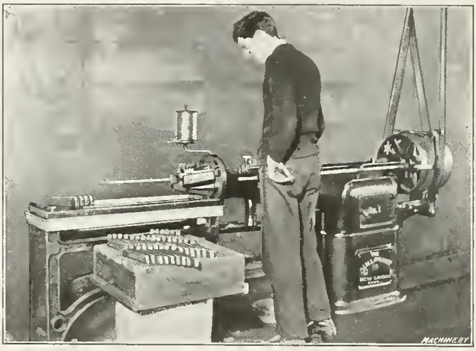


Fig. 9. Broaching the Square Hole

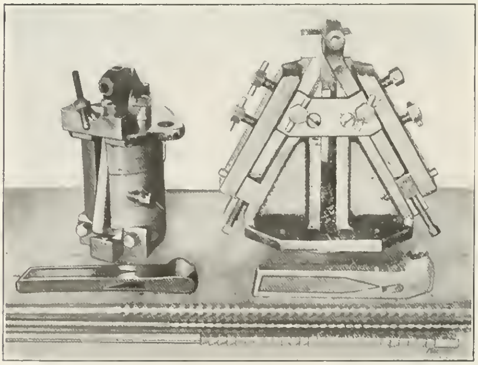


Fig. 11. Fixtures used in broaching Straight and Off-set Tool-holders

The broaching operation leaves the tool-holder in the condition shown at *E* in Fig. 2 except for drilling and tapping for the set-screw used for clamping the tool-bit.

When drilling the hole for the set-screw in the off-set tool-holders, the jig shown in Fig. 5 is employed. On this operation the jig is used in the horizontal position shown at the right, and the drill is inserted through bushing *H*. When drilling the left-hand off-set tool-holders it is used in the position shown, and when drilling the right-hand off-set tool-holders the bushing is reversed and reclamped by the set-screw shown at the side, the jig being tilted to the opposite horizontal position. Taken all together, there are six distinct drilling operations which may be performed upon this one type of jig.

The tool-holders are now finished by putting them through a casehardening process which hardens the tool-steel seat and at the same time the case of the entire tool-holder. After the tool-holders pass through this process they are hard enough to withstand the rough use they are likely to get. The hardening process imparts the familiar mottled blue finish when wanted, but the company has lately been sending out its tool-holders with a new "spring blue" finish.

* * *

LIGNITE AS A LOCOMOTIVE FUEL

It is possible that lignite will become an important locomotive fuel in those sections of the country where coal is not available. The International Railway Fuel Association has appointed a committee to report on this subject at its annual convention in Chicago next May. The American Locomotive Co. has produced a spark arrester especially designed for engines burning lignite, and this has been applied to twenty-one locomotives on the Chicago & Northwestern R. R. The Chicago, Burlington & Quincy R. R. has also developed an apparatus so that lignite may be burned without danger of sparks causing fires along the right of way. As the cost of a good grade of coal in the western sections of Nebraska, Wyoming and Colorado ranges between $5 and $6 per ton, it would be of great advantage to be able to use lignite from the mines in North Dakota, which could be bought at a price of $1.75 per ton. The disadvantages of lignite are that in its raw state it must be used a very short time after it is mined, because if long exposed to the weather, it crumbles into small particles. As a means of overcoming this difficulty, briquetting has been resorted to successfully.

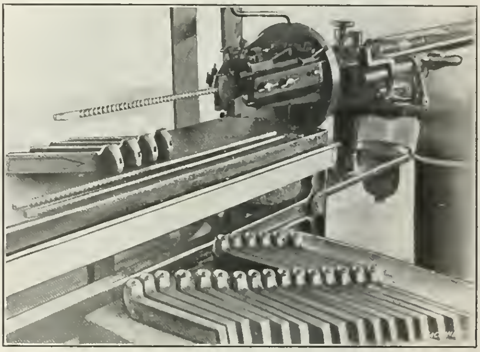


Fig. 10. A Closer View of the Broaching Operation

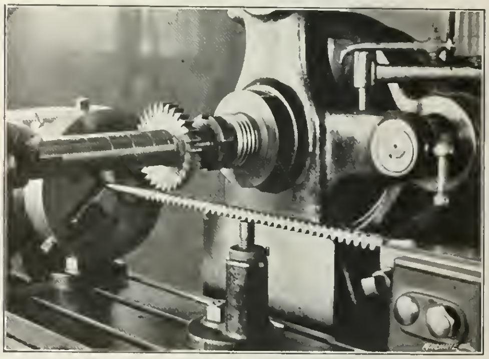


Fig. 12. How the Broaches are made

* * *

Fire losses and the cost of fire prevention in the United States amounts annually to $450,000,000, which is more than the total American production of gold, silver, copper and petroleum in a year.

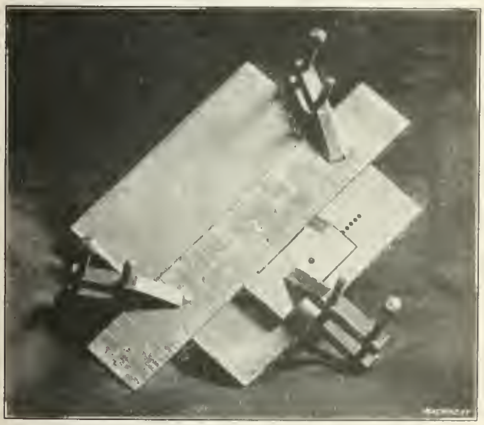
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

TO DRILL SMALL HOLES IN ROWS AT EQUAL DISTANCES APART

No doubt the majority of machinists and toolmakers are well aware of the time required to lay out a row of small holes, say for a No. 60 drill, and drill the holes accurately. For example, take a row of holes 1/16 inch diameter and ⅛ inch pitch; the average machinist will scribe a center line, find his first center and proceed to lay out the other holes from it with dividers, scribing each circle off with dividers. Everyone knows how difficult it is to drill the small circles accurately, but I have seen machinists do this work in the ordinary way, and they were good men too; they did not realize that it was possible to save their time and eyes by a simple means.

We will take, for example, a row of holes 0.025 inch diameter, 1/16 inch pitch, which must be drilled with no variation exceeding 0.001 inch, the holes to be in a straight line, and another row of the same size and pitch, drilled on a line at an angle to the first row. The job can be accomplished simply and quickly as indicated in the illustration, which practically explains itself. The method is as follows: Lay out the first holes on each line and drill them. Then take a small piece of steel for a drill guide, bevel one corner and scribe a line on the bevel section as shown in the illustration. Line up the hole drilled in the guide with the hole drilled in the work while the scale is clamped so that one of the sixteenth graduation marks matches the line on the drill guide, placing the scale with the edge exactly parallel to the center line of the row of holes to be drilled. Now proceed to drill the holes, setting the drill guide each time to the next sixteenth graduation and using a glass to accurately line the graduation mark with the line on the drill guide. If two or more rows of holes are to be drilled parallel, the drill guide block can be drilled to suit. The drill guide block should be relieved slightly in the center so as to insure the ends of the block bearing against the scale.



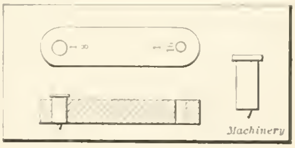
To Drill Small Holes in Rows at Equal Distances Apart

A toolmaker can drill a row of holes accurately in the manner described in the time required to lay them out in the usual way. Even if the holes do not require to be drilled so very accurately, it is quicker to drill them in this way than by the common method.

Philadelphia, Pa. FRED HENKE

METHOD OF ACCURATELY LOCATING DRILLED HOLES

The tool illustrated herewith affords one of the most accurate methods which the writer has seen for quickly locating and drilling work which has been laid out with a height gage and center-punch. The illustration shows this tool full size for drilling holes ⅛ and 1/16 inch in diameter. It was made from a piece of 3/16 by 5/16 inch cold-rolled stock which was ground top and bottom and had the holes drilled and reamed slightly under size. The sizes of the holes were next stamped on the tool which was then hardened, after which the holes were lapped to the exact size. Two plugs—one of which is shown in place in the tool and the other separate on an enlarged scale were made from drill rod. These plugs were first roughed out and partly cut from the rod; they were next hardened, ground and lapped on the body and point, and then broken off and ground on the top.



Device used for locating and drilling Holes

In using this tool the work is first laid out with a height gage or by some equivalent method according to the accuracy that is required. The centers for the holes are next punched, and the tool is placed on the work with the point of the plug in the center-punch mark and securely clamped to the work, after which the plug is removed. The work is then spot-drilled, drilled with a reamer size drill, and finally reamed with a special reamer, all of these operations being performed through the hole in the tool. The reamer used for this purpose must be a nice fit in the tool, and those used by the writer are made like a rose reamer except that they have only one flute and consequently but one cutting edge. If these tools are properly made, the degree of accuracy which can be obtained with them is in exact proportion to the degree of accuracy with which the work is laid out and center-punched.

The writer has found that the best method of laying out the work is as follows: After grinding the surface of the work to a good finish, the lines are laid out on this surface and then, to make the intersections more distinct, a fine oilstone (instrument hone) is rubbed lightly over the lines. This operation is continued until the slight burr which is left by the scribing point has been removed. When lines prepared in this way are looked at through a magnifying glass the intersection of the lines will stand out sharp and clear without the usual "fuzzy" appearance. Instead of using the usual center-punch and hammer for centering, the writer has ground and stoned a small round file to a point. With the aid of a magnifying glass the point of this tool is placed on the intersection of two lines and a little pressure is then applied on the tool while it is twirled between the thumb and finger. A small center mark is made in this way and if a careful inspection shows it to be slightly off center, the error can be remedied by tipping the file slightly and repeating the operation. It will be found advisable to make this center mark as light as possible, as only a slight indentation is required to hold the point of the locating plug in place. This method insures locating a hole within 0.0005± inch, and for die work the writer knows of no better method of obtaining accurate results. It will be obvious that the tools can be made up in any size to meet the requirements of different classes of work. DONALD BAKER

Beverly, Mass.

LAPPING CALENDER ROLLS

The writer recently made a successful experiment in lapping a set of chilled calender rolls for a paper making machine. There were five rolls in this set, the working surface being 7 feet long, the diameter of the bottom roll 16 inches, and of the upper rolls 12 and 10 inches. These rolls become worn in the middle, in course of time, with the result that the paper is squeezed thinner at the outer edges than at the center; and this causes the reels of paper to run badly in subsequent operations. When the rolls have worn 0.001 inch hollow they are considered to be in bad condition and have to be reground. The usual method is to grind them in a machine of the J. Morton Poole type, but as we have no such machine in this part of the world, we have to box up the rolls and send them 14,000 miles to get this work done.

It occurred to the writer that it might be worth while to try the effect of lapping, since there was not more than 0.001 inch to remove from any of the rolls. This method would not be successful if the body had worn out of true with the journals, but as the rolls had been ground in the regular way several times, this was unlikely. An arrangement was rigged up as shown in Fig. 1, with the roll driven by a "wabbler" *A*, and although this was hardly necessary, it was found convenient. The pulley *B* carried a 6-inch belt and was driven from a countershaft with fast and loose pulleys. The lap *C* was made by casting a sheet of lead 9 inches wide, ⅜ inch thick, and long enough to embrace one-third of the circumference of the roll. This lead sheet was beaten carefully to make it fit the surface of the roll. A rough wooden box was then fitted around it and concrete filled in, an iron spindle being bedded in the top to hold the lever *D* that was used for moving it back and forth and for applying the necessary pressure. This lever was about 8 feet long, and the batten shown nailed to the posts was used to hold down the short end of the lever. Emery and oil sprinkled on the lap was used as the abrasive.

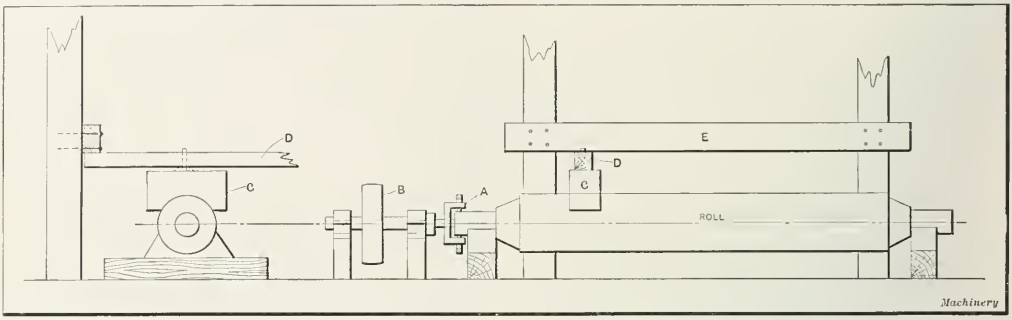


Fig. 1. Improvised Equipment for lapping Calender Rolls

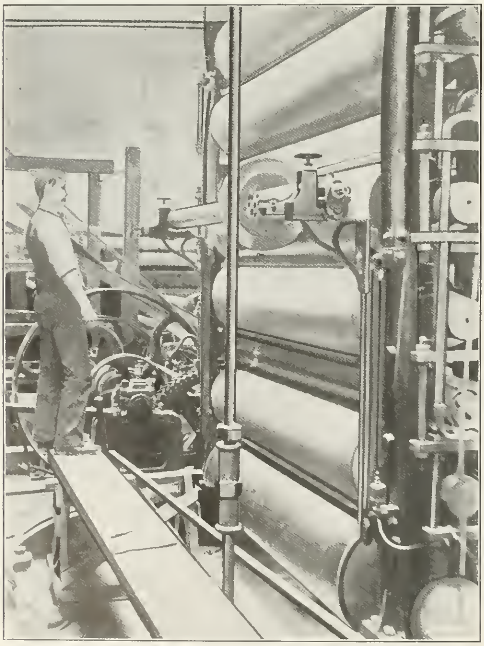


Fig. 2. Use of the Roy Portable Grinder on the Rolls of a Glazing Calender

In a stack of rolls such as this, it is the custom to make the bottom roll barrel shaped an amount which experience has shown to be necessary to cause it to be straight on top when under working pressure. The other rolls are made cylindrical. In this case we lapped the top roll first and made it as nearly cylindrical as possible, using a special sensitive caliper for making measurements. We next lapped the roll that worked with it, and after making it as nearly cylindrical as possible we placed the first roll in position on top of it with cigarette papers between. When these papers were nipped evenly from end to end, we went on to the next roll. The required camber was then put on the bottom roll, as nearly as we could judge, using the line of light as a guide.

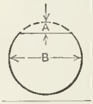
At first we ran the journals, which were five inches in diameter, in hardwood bearings, but as they heated considerably we afterward lined them with babbitt, and then they ran much cooler. The rolls were run at about a hundred revolutions per minute. The resulting set of rolls seems to have given as much satisfaction as if they had been ground in the orthodox way. We have also used the Roy portable grinder, made by B. S. Roy & Son, Worcester, Mass., for truing up the cotton rolls of a glazing calender without taking them out of the frame. Fig. 2 shows the grinder in position for doing this work.

Christchurch, New Zealand. JOHN PEDDIE

TABLE OF DEPTHS OF CUT FOR FLATS ON SHANKS

In the December issue of MACHINERY a correspondent recommends the standardization of set-screw flats on round tool-shanks, making their width three-eighths the diameter of the shank. The writer would like to suggest that the man who mills this flat needs the dimension *A*—the depth of cut—and that a depth of 0.0365 *B* will give the desired width of flat, where *B* is the diameter of the shank. The table gives the depth *A* for the sizes enumerated in the contribution published in the December issue.

TABLE OF DEPTHS OF CUTS FOR FLATS ON SHANKS

		B	A	B	A	B	A	B	A
		9/32	0.010	3/4	0.027	1 7/16	0.053	2 1/8	0.078
		5/16	0.011	13/16	0.030	1 1/2	0.055	2 3/16	0.080
		11/32	0.013	7/8	0.032	1 9/16	0.058	2 1/4	0.082
B	A	3/8	0.014	15/16	0.034	1 5/8	0.060	2 5/16	0.084
		13/32	0.015	1	0.037	1 11/16	0.062	2 3/8	0.087
		7/16	0.016	1 1/16	0.039	1 3/4	0.064	2 7/16	0.089
1/8	0.005	15/32	0.017	1 1/8	0.042	1 13/16	0.067	2 1/2	0.091
5/32	0.006	1/2	0.018	1 3/16	0.044	1 7/8	0.069	2 5/8	0.096
3/16	0.007	9/16	0.021	1 1/4	0.046	1 15/16	0.071	2 3/4	0.100
7/32	0.008	5/8	0.023	1 5/16	0.048	2	0.073	2 7/8	0.105
1/4	0.009	11/16	0.025	1 3/8	0.051	2 1/16	0.075	3	0.110

New London, N. H. GUY H. GARDNER

ERASING INK FROM TRACINGS

In a large tracing department it is often necessary to do wholesale erasing. This is not only due to errors but also to changes that have to be made in tracings after they are done. To properly remove this ink requires careful work and some time, if the work is done by hand. This is due to the necessity for pressing lightly on the cloth to prevent tearing. In such cases a power-driven eraser is of considerable value, and one can be made from a fan motor and a piece of flexible shaft with a screw and nut to clamp the circular eraser to the shaft. By pressing very lightly, the high speed of the eraser removes the ink without loss of time.

F. W. H.

ETCHING FLUID FOR STEEL

Some years ago, a formula for etching fluid for steel was published in Machinery, by Mr. W. S. Leonard. This called for nitric acid, 60 parts; water, 120 parts; alcohol, 200 parts; and copper nitrate 8 parts. The writer tried this fluid, but did not have success with it. After some experimenting, however, he found that by using 8 parts of the mixture made according to Mr. Leonard's formula and adding 1 part of muriatic acid, a very satisfactory etching fluid can be obtained. After having poured the muriatic acid into the other solution, the bottle must be left uncorked for about fifteen minutes to allow the gases produced to escape and prevent an explosion.

New Britain, Conn. W. C. Betz

PIVOT BEARINGS IN TYPEWRITER WORK

One of the most important items in typewriter manufacture is the producing of an accurate pivot bearing. The most successful way of doing this is to swage the soft bearing to the form of a hardened pivot. The bearings are first countersunk as closely as possible to the finished form. An excellent device for gaging them after this operation is shown in Fig. 1. This gage is made from a micrometer of the ½-inch size, the end of the spindle being ground to the shape of the pivot; this allows the depth of the bearing to be gaged to 0.001 inch, or if necessary, to 0.0001 inch. After the bearing or pivot holder has been countersunk, the hardened pivot is placed in it and the bearing is swaged to the form of the pivot by the fixture shown in Fig. 2.

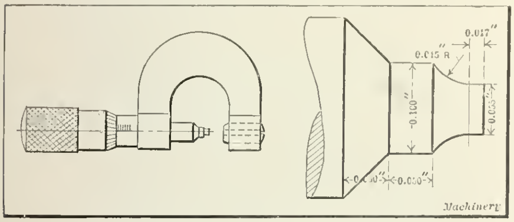


Fig. 1. Special Gage for measuring Pivot Bearings

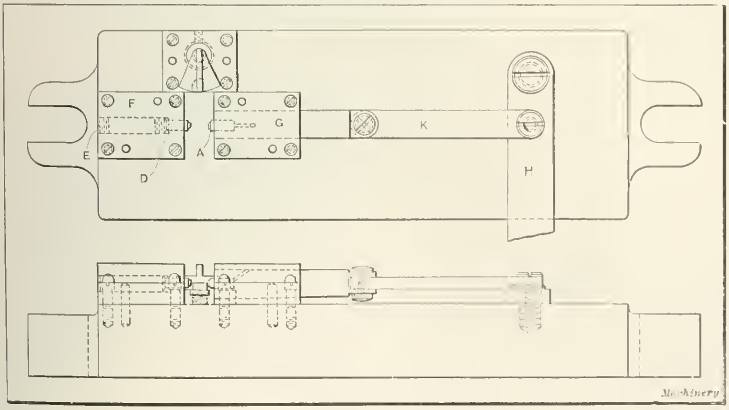


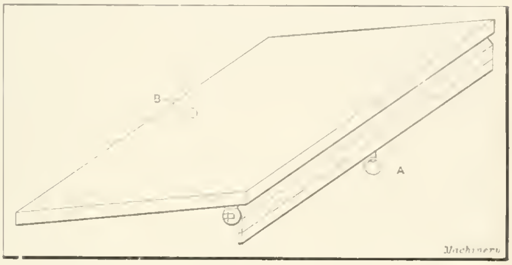
Fig. 2. Swaging Fixture for forming Pivot Bearings

The anvils for the swaging operation are shown at *A* and *D*. The ends must be cup-shaped, although this is not shown in the engraving. The stationary anvil *D* is carried in block *F* and adjusted by screw *E*. The other anvil is held in plunger *G*, operated by handle *H* by means of connecting-rod *K*. The bearing is not formed by pressure, but by the striking of a quick steady blow.

A. Gray

DRAWING BOARD DUST CURTAIN

In the following article is described a little kink for keeping dust and dirt from settling on a drawing-board during the night or whenever the draftsman leaves it for any length of time. It is simply a window shade roller of about the right length to suit the drawing-board. The roller is attached to the under side of the board by the usual form of brackets, and has a wire across the open bracket to keep the roller in place, as shown in the illustration. Whenever the draftsman has occasion to leave his board for any length of time he simply reaches over and takes hold of the small ring *A* and pulls the curtain up over the board so that the ring can be secured by a screw *B* on the under side of the board near the front edge. This completely covers the drawing, so that it is protected from dust and dirt. The writer has used this attachment for over a year and has found it to be well worth the trouble which was taken in setting it up. As he has never seen a similar device he thought it might be of interest to other draftsmen.



Curtain for keeping Dust off a Drawing-board when not in use

Chicago, Ill. A. H. Wilson

ECONOMICAL DRAFTING-ROOM PRACTICE

There is a chance for a lot of lost motion to occur in the average drafting-room due to the use of methods which are too conventional. The average draftsman likes to do a good job and he will do one if left to himself, but he should be watched to see that he does not do too good a job. The principal fault to be found in most drafting-rooms is that pencil drawings are made with too much care, because they are simply used to make tracings. There is no reason why the draftsman should take pains with the lettering, cross-sectioning and general appearance of a drawing. The cross-sectioning should be put in free-hand, and the tracer ought to know enough to put on the "pretty work." This is one of the places where the principle of "good enough" applies. It is the practice of many drafting-rooms to make pencil drawings and tracings where the parts could just as well be drawn directly on the tracing cloth or on a good grade of bond paper at a considerably reduced cost.

Whenever the writer sees a fine drawing out in the shop he thinks of an anecdote told by old man McGuiness who owns a big cement mill out in California. One of his men took McGuiness up to a rival mill and showed him a very fine switchboard which had been installed in the power plant. The old man seemed interested and was told about the uses of the board. At his mill things were rather primitive, and it was hoped that he would show some spirit of emulation after seeing the fine outfit in his competitor's plant. When he turned away from the marble and polished brass front of the big switchboard the man who was showing him around asked him what he thought of it. The old man grunted. "Huh," said he, "that thing don't make no cement." The same sort of comment would apply to the practice followed in many drawing-rooms; there is a lot of work done which does not produce results.

Los Angeles, Cal. F. W. Harris

HOW TO FIGURE THE VOLUME OF CURVED FLANGES

In figuring the volume of large curved flanges, to get the weight, the following methods will give good results:

The developed surface of the curved flange shown in Fig. 1 would be an ellipse with an elliptical hole. D and d are the large and small outside diameters, respectively, and D_1 and d_1 the large and small inside diameters. We first find the angles x and x_1, by

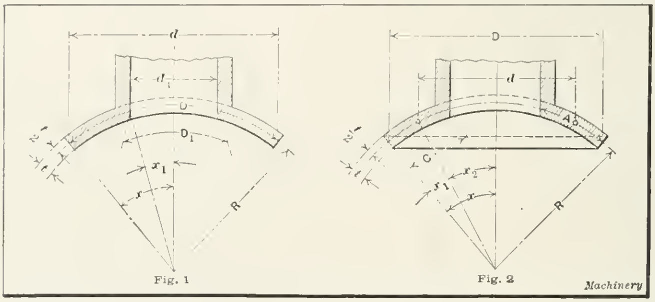


Fig. 1 Fig. 2

Figs. 1 and 2. Two Types of Curved Flanges showing Method of figuring their Volumes

$$\sin x = \frac{d}{2R}$$

$$\sin x_1 = \frac{d_1}{2R}$$

$$D = \frac{2x}{360} \times 2\pi R = 0.0349Rx.$$

Then the area of the flange, if it were solid, would be $0.7854dD = 0.7854d \times 0.0349Rx = 0.0274dRx$. Similarly, $D_1 = 0.0349Rx_1$ and the area of the hole $= 0.0274d_1Rx_1$. Then the exact volume of the flange $= (0.0274dRx - 0.0274d_1Rx_1)t = 0.0274Rt(dx - d_1x_1)$.

The spherical flange as shown in Fig. 2 may be figured as follows: First we find the angles x and x_1, by

$$\sin x = \frac{D}{2R}$$

$$\sin x_1 = \frac{C}{2R}$$

$$A = \frac{2x_1}{360} \times 2\pi R = 0.0349Rx_1.$$

The area of the cross-section of the flange is $At = 0.0349Rtx_1$. d is the diameter of the circle that passes through the center of gravity of all right sections of the flange. This center of gravity is taken at the point which bisects the arc A. Although this is not strictly correct, the difference would be so small that it may be neglected.

$$d = 2R \sin x_2.$$

The circumference of this circle $= 6.2832R \sin x_2$. Then the volume of the flange $= 6.2832R \sin x_2 \times 0.0349Rtx_1 = 0.2193R^2tx_1 \sin x_2$.

McKees Rocks, Pa. August H. Anger

A SIMPLE RULE FOR ESTIMATING TENSILE STRENGTH

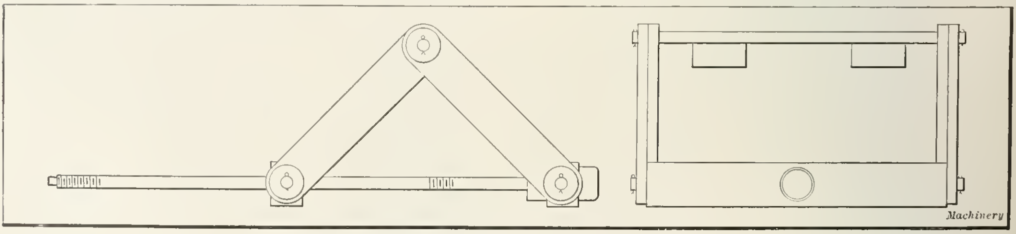
The following gives a simple rule for estimating the tensile strength of steel forgings. A strength of 40,000 pounds per square inch, which is about the tensile strength of ordinary iron, is used as a basis, and an additional 1000 pounds per square inch is added for each point of carbon in steel. For instance, the tensile strength of a 20-point carbon steel would be 40,000 plus 20,000 equals 60,000 pounds per square inch. Similarly a 60-point carbon steel would have a tensile strength of 40,000 plus 60,000 equals 100,000 pounds per square inch. While this method of estimating tensile strength is not absolutely exact, it is near enough for ordinary purposes where open-hearth steel forgings or bars of open-hearth steel are being dealt with.

Cleveland, Ohio. R. L. Tappenden

A USEFUL JACK-SCREW

The illustration shows a jack-screw which has been used by the writer for over ten years for lowering grindstones weighing from 2500 to 4000 pounds into their bearings, and to raise stones which have become cracked or loose on the shaft. Existing conditions made it impossible to use hoisting apparatus for this purpose and the old method was to roll the grindstone up an inclined plank until the shaft was over the bearings. Boards were next placed over the bearings and the block knocked out from under the end of the inclined plank. A lever was then used to raise the shaft, first at one and then at the other, to allow the boards to be removed from the bearing and the shaft to be lowered into place. This method was obviously crude and very hard on the babbitt bearings.

The jack shown in the accompanying illustration was designed to take the place of this method. When down, this jack is only 3 inches high and it can be used to raise a weight to a height of 9 inches, or more than three times the height of the jack. The design will be readily understood from the illustration, in which connection it may be mentioned that the screw has an Acme thread. Although this jack was designed for the particular class of service referred to, it would be equally suitable for a variety of other purposes. E. H. C.

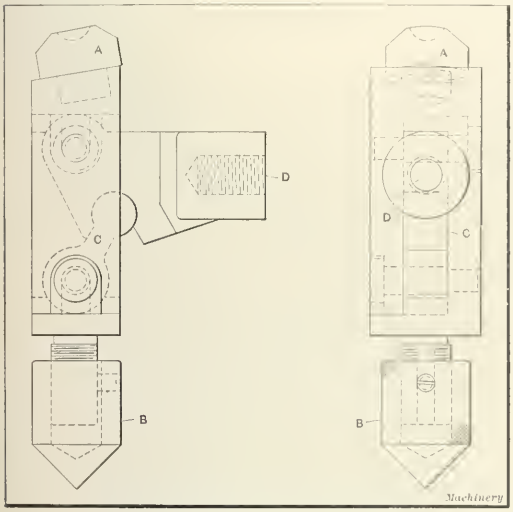


Jack-screw with Range of Three Times its Height when Closed

[This form of jack is, no doubt, an effective means for lowering weights where the clearance is small, but it can hardly be efficient for lifting purposes when starting from the lowest position, because of the toggle action which multiplies the pressure on the screw and consequently the frictional resistance.—Editor.]

TOGGLE-JOINT HOLDER-ON FOR 12-INCH CHANNELS AND I-BEAMS

In the January issue of Machinery the writer had an article on a toggle-joint holder-on for use in riveting structural steel. This holder-on proved very satisfactory for all classes of service which did not require the tool to be used in close quarters. In trying to get up into a corner, however, it was found that the nuts on the sides of the tool made it impossible to get into such locations. To avoid this difficulty the tool shown in the accompanying illustration was designed. It consists of the two holders *A* and *B* that are forced against the work by means of the toggle-joint *C* which is actuated by a lever arm screwed in at *D*. In this tool the toggle-joint is located within the tool body, instead of being on the outside, and is secured in place by rivets instead of bolts and nuts. The present construction is quite strong enough for all practical purposes and is much more compact than the design illustrated in the January number of Machinery. The tool is used in the manner described in the previous article. M. W. W.



Improved Type of Holder-on for working in Close Quarters

MAKING UNIFORM CAMS

The method of cutting cams having a uniform rise-and-fall is a very simple operation, when once the principles are well understood. The first point to be determined is the required amount of rise which you wish to impart to the follower. When this amount of rise has been determined, the spiral head of the milling machine should be geared to produce a lead of double the required rise, *i. e.*, with a rise of 6 inches the head should be geared for a 12-inch lead. The rise of the cam will take up 6 inches of this lead, and the uniform fall a like amount.

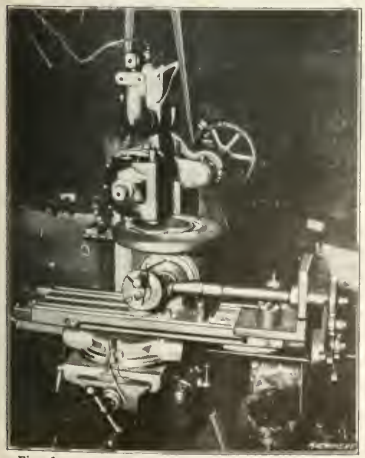


Fig. 1. Method of cutting Uniform Rise-and-fall Cams on the Milling Machine

As shown in illustration, the index head of the milling machine should be located at the center of the platen. This makes it necessary to use the gear extension shown, which is simply a keyed shaft having its bearing in the angle plate. The starting point of the rise of the cam is now determined and a hole of the proper size for the cutter should next be drilled; this hole may afterward be plugged up, if necessary. The hole should be brought to a position where a line dividing the cam movement into equal parts would be in a direct line with the feed-screw. The work may now be brought up to the cutter. The writer has found it advisable to cut the slot in one cut, especially if the machine used is an old one. The work is fed carefully until the maximum position is reached; the machine is then stopped, the gears reversed, and the cutter brought back to the starting point; the other half of the cam is then finished in the same way. A concentric arc, or "rest" may be milled at any desired point in the cam by simply stopping the feed, and indexing through the required number of divisions.

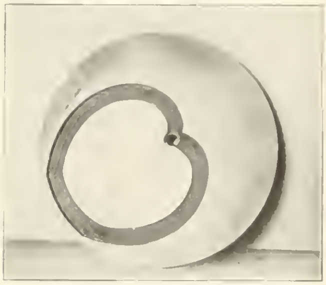
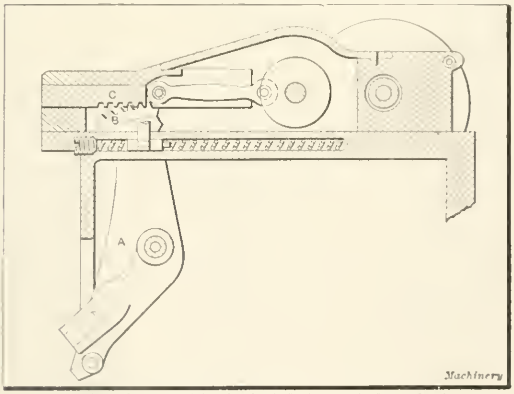


Fig. 2. Cam for producing Uniform Rise-and-fall with a Rest between the Rise-and-fall

West Lafayette, Ind. W. H. Addis

TAKING OUT THE BACK-SHAFT OF A B. & S. AUTOMATIC SCREW MACHINE

In the February issue of Machinery, Mr. J. Harmon criticises an article published in the November issue of Machinery, dealing with the subject of "Taking Out the Back-shaft of a B. & S. Automatic," and requests Mr. Bacon to admit that in case a back-shaft is not replaced with each gear in the position which it formerly occupied, tooth for tooth, the machine will not be in operating condition because no matter to what extent an operator may change his job on the machine, all of the clutches, gearing, etc., will refuse to do their work. Mr. Harmon then asserts that all operators will agree with him, but the writer is engaged in operating a Brown & Sharpe automatic screw machine and knows a few others who will not agree with Mr. Harmon because the dogs which govern the feeding of the stock, revolving of the turret and reversing of the spindle may be set in any position around the circumference of their carriers. The writer cannot speak for Mr. Bacon, but will say that he has operated B. & S. automatic screw machines with the back-shaft slightly misplaced in order to complete a "hurry up job" or until it was again convenient to remove the back-shaft and replace it correctly.



Mechanism of Turret Slide of a B. & S. Automatic Screw Machine

What, then, really are the conditions when a back-shaft is not replaced with the gears meshed tooth for tooth? The error is usually one, two or three teeth and the result is that the turret-revolving crank will not be on a dead center, as shown in the accompanying illustration. Consequently, the distance between the spindle and the turret is lengthened and the job will have to be set out further from the spindle, which will necessitate resetting the turret-revolving dogs. The error resulting from a slight misplacement of the gear which rotates the cam-shaft for feeding the stock may be corrected sufficiently by resetting the tripping dogs but, of course, such a condition should not be allowed to exist except in cases of emergency. The writer has also used the method described by Mr. Harmon for machining long parts, and has noticed the binding of the rack as mentioned in the editor's note. The stop which is used for stopping the return of the turret and carriage was removed, and washers were inserted underneath for replacing it, but this method should only be used temporarily.

Elam Whitney

[Those who have had wide experience in the operation of the Brown & Sharpe automatic screw machine find that it is not required to take out the back-shaft more frequently than once a year—except in cases of accident—and even then it would not, as a rule, be necessary. Instances are on record where machines of this type have run for four or five years without requiring the removal of the back-shaft, but this naturally depends upon the character of the work being done by the machine. The removal of the back-shaft for cleaning is dependent to a large extent on the grade of cutting oil or compound which is used.—Editor.]

COMBINATION PUNCHING, CUTTING AND FORMING DIE

The illustrations show a combination punching, cutting and forming sub-press die that produces cleats from No. 24 galvanized iron at one stroke of the press. These cleats, one of which is shown in Fig. 1, are used for the reinforcement of metal window frames. Fig. 1 also shows the front view of the punch and die, with the punch in the lowest position, and a separate view of the cutting and forming tool *E*. Fig. 2 shows a plan view of the die and Fig. 3 a cross-section of the punch and die in position for the piercing operation. The machine used in this particular case was a Loy & Nawrath No. 2 press, running at 125 R. P. M. The punch- and die-holders are made of cast iron; the punch-holder *A* is provided with a shank which fits into the press slide, and the base *B* is fastened to the press bolster by two screws. Two guide-pins *C* are used to provide for accurate working, permanent and perfect alignment, and a rapid means of setting the die. The punch-holder carries the punches *D* and D_1 which are of 3/8 and 3/16 inch diameter, respectively, and the cutting and bending tool *E*, shown separately in Fig. 1. The die-holder *B* has the punch-plate *F* fastened to it, as shown in Fig. 3; this punch-plate has a cutting edge *G*, Fig. 2. A spring pad *H*, which forms the cleat, slides in back of the punch-plate; two dowel-pins *I* hold it in line and two springs *J* support it. A fixed stripper-plate *K* and two gages *L* hold the work in position.

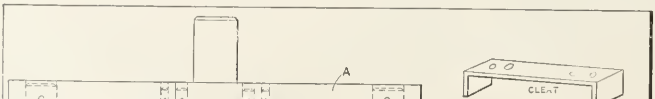


Fig. 1. Punch and Die with Punch in Lowest Position; also Finished Cleat and Cutting and Forming Tool E

The operation is as follows: The material is cut in long strips of the proper width to fit between the gages *L*, a squaring shear being used for this purpose. One of these pieces is then placed under the stripper *K* so that a small portion will stick through at the cutting edge *G*. The punch, in descending, pierces the material and also trims the end square. The strip, thus squared and punched, is next pushed against the stop-pin *M*. The second stroke punches the four holes in the next piece; at the same time, the previously punched part is cut off and bent to the required form by the combination cutting and bending tool *E*. A finished cleat is thus produced at each stroke of the press. The spring-pad *H*, which is the female bending member in this case, supports the cleat while it is being separated from the strip of stock and as soon as the spring pad comes into contact with the extending lug of the base *B*, the two edges of the cleat are drawn down. The finished cleat is pushed through the back of the press when the stock is advanced for the next operation. This die works very efficiently as it combines the three single press operations of cutting, bending and piercing, and also saves the time that would be required to transfer the blanks from one press to another, if the operations were performed singly.

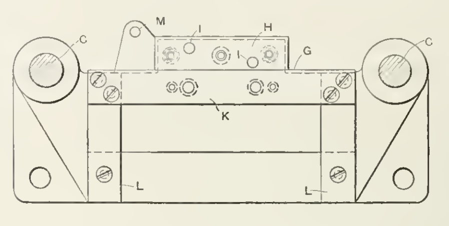


Fig. 2. Plan View of Punching, Cutting and Forming Die

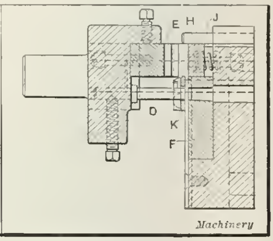
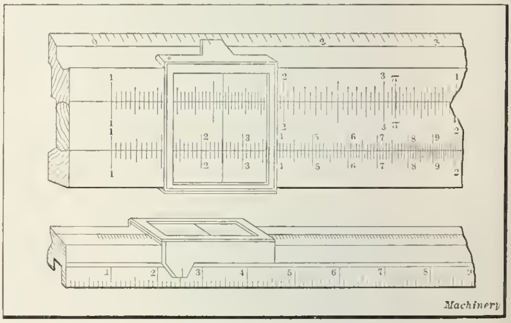


Fig. 3. Cross-section of Punch and Die

Irvington, N. J. F. Sparkuhl

ANOTHER USEFUL SLIDE-RULE CONSTANT

The writer read an article in the November, 1912, issue of Machinery by A. Laurens entitled "Slide-Rule Constants." The following describes and illustrates another useful constant for the regular slide-rule. An extension on the runner projects down on each side of the rule with an etched line marked on it. This line projects down onto the scale of inches on the front of the rule and onto the scale of millimeters on the back of the rule, and by setting the runner to any desired position, the equivalent of any number of inches may be read off on the millimeter scale; conversely, millimeters may be converted to inches without the necessity of using the regular conversion factors. The writer has found this to be a very useful addition to his slide-rule and hopes that it may be of service to other readers of Machinery.



Slide-rule Constant for converting Inches to Millimeters or Millimeters to Inches

Poughkeepsie, N. Y. H. A. Duncan

THE DESIGN OF CLUTCH RELEASE SHOES

The writer was much interested by Mr. Terry's article on the design of clutch shoes appearing in the January issue of MACHINERY, and fully agrees with his deductions. It is the object of the present article to give in a single equation the equivalent of Mr. Terry's method, but presented in a simpler form; an approximate graphical method will then be given, which should appeal to those designers who are not mathematically inclined. Referring to Fig. 1, let:

A = area of complete circle $LMNV$;
M_a = moment of this area about line o–o;
B = area of semicircle FGH;
M_b = moment of this area about line o–o;
C = area of rectangle $EFHI$;
M_c = moment of this area about line o–o;
D = area of circular segment LNV;
M_d = moment of this area about line o–o;
S = area of shoe, *i. e.*, of figure $LMNIGEL$;
M_s = moment of this area about line o–o;
z = distance from line o–o to center of gravity of area S.

R, r, f, x and β_0 are given in Fig. 1.

The following equations can now be written:

$$A = \pi R^2 \qquad (1) \qquad\qquad M_a = 0 \qquad (2)$$

$$B = \frac{\pi r^2}{2} \qquad (3) \qquad\qquad M_b = \frac{2}{3} r^3 \qquad (4)$$

$$C = 2 r f \qquad (5) \qquad\qquad M_c = r f^2 \qquad (6)$$

$$D = \frac{\pi R^2 \beta_0}{360} - f x \qquad (7) \qquad\qquad M_d = \frac{2}{3} x^3 \qquad (8)$$

Then

$$S = A - B - C - D = \pi R^2 - \frac{\pi r^2}{2} - 2 r f - \frac{\pi R^2 \beta_0}{360} + f x$$

$$S = \pi R^2 \left(1 - \frac{\beta_0}{360}\right) - \frac{\pi r^2}{2} + f (x - 2r) \qquad (9)$$

$$M_a = M_s + M_b - M_c - M_d$$

$$M_s = M_a - M_b + M_c + M_d = -\frac{2}{3} r^3 + r f^2 + \frac{2}{3} x^3 = \frac{2}{3} (x^3 - r^3) + r f^2 \qquad (10)$$

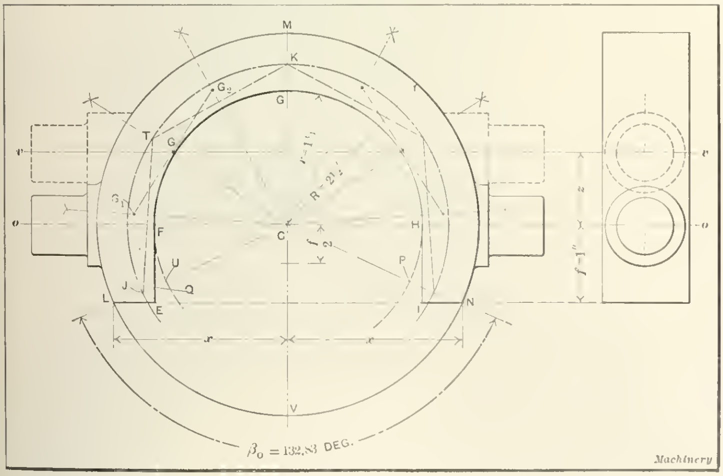


Fig. 1. Diagram used in locating the Center of Gravity of the Clutch Release Shoe by Analytical and Graphical Methods

$$z = \frac{M_s}{S} = \frac{\frac{2}{3}(x^3 - r^3) + r f^2}{\pi R^2 \left(1 - \frac{\beta_0}{360}\right) - \frac{\pi r^2}{2} + f (x - 2 r)} \qquad (11)$$

Equation (11) looks rather formidable but as πR^2 is the area of a circle whose radius is R, and $\frac{\pi r^2}{2}$ half the area of a circle whose radius is r, these values may be taken directly from a table, while the values of x^3, r^3 and f^2 may be taken from a table of squares and cubes. In the example given,

$R = 2.5$ inches, $r = 1.75$ inch, $f = 1$ inch.

$x = \sqrt{R^2 - f^2} = 2.291$ inches, $\beta_0 = 132.83$ degrees.

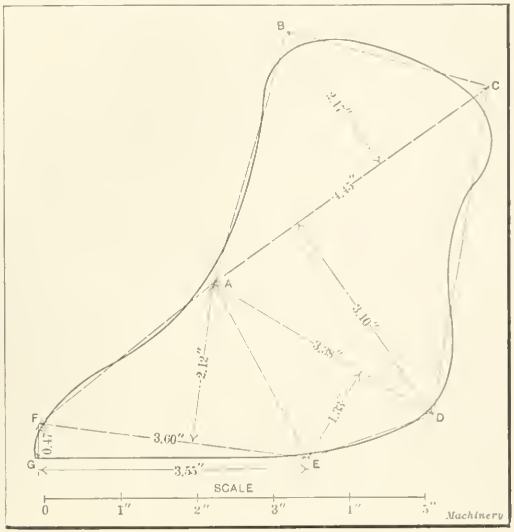


Fig. 2. Example of the Accuracy that can be obtained by Careful Approximation

Substituting these values in Equation (11) and solving,

$$z = 0.972 \text{ inch.}$$

Mr. Terry's result was $z = 0.978$ inch.

An approximate method, sufficiently accurate for all practical purposes, is as follows: Draw CJ so that, judging by the eye, the area of triangle EQL is approximately equal to or slightly less than the area of FQU. Draw arc JK with a mean radius, bisect this arc and draw CT. Next bisect arcs TJ and TK, and then draw the chords TJ and TK. Locate the points G_1 and G_2 so that they appear to be slightly nearer to the arc than to the chord. Connect G_1 and G_2 by a straight line cutting CT at G and draw line v–v through G parallel to o–o. The line v–v passes approximately through the center of gravity of the figure $ULMNPGU$, and the center of gravity of this figure is approximately coincident with that of the wearing face of the shoe $ELMNIG$; therefore, the proper location of the pins for equal distribution of wear has been located. Fig. 1 was drawn full size and the dimension z scaled 15/16 inch, a result about 1/32 inch less than that calculated by Equation (11).

To the precise, this method may seem little better than a crude guess, but the designer's eyes are educated to such approximations. Another example of a somewhat similar nature involving judgment of the eye is illustrated in Fig. 2. Here it is required to find the area of the irregular figure bounded by the curved line. The figure is first divided into triangles approximately equaling the area of the figure. The altitude and base of each triangle, as scaled, are given in the figure, the resulting area being 18.62 square inches. Going over the figure with three planimeters gave results as follows:

No 1. One trial only	18.7 square inches
No. 2. First time around read	18.3 square inches
No. 2. Second time around (36.5 ÷ 2)	18.25 square inches
No. 3. First trial	18.45 square inches
No. 3. Second trial	18.50 square inches
Average of three planimeters	18.44 square inches

Taking this average as correct, the error is:

$100\,[\,(18.62 - 18.44) \div 18.44] = 0.98$ per cent.

If we take the reading of 18.25 square inches as correct, which was the result obtained with the most modern instrument, the error is

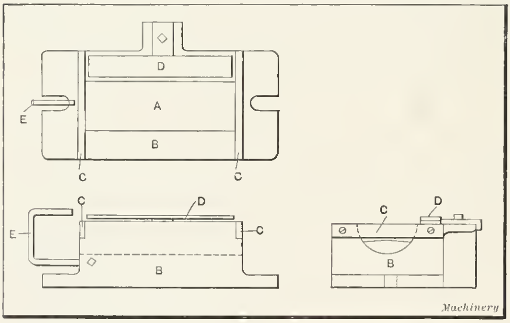
$100\,[\,(18.62 - 18.25) \div 18.25] = 2.03$ per cent.

There are many approximate methods applied in the drafting-room which depend largely upon the eye-judgment of the designer and yet, in their final results, such methods are all that could be desired. In fact, it is generally the chief's "eye-judgment" which approves or disapproves the finished design, for he has learned that when a thing looks wrong there generally is a "bug" in it somewhere.

Philadelphia, Pa. **John S. Myers**

SELF-ALIGNING FIXTURE FOR A STAMPING MACHINE

In the shop where the writer is employed a variety of steel and cast-iron work is marked with the company's name, the date on which the patent was granted, etc. This marking is done on a roll stamping machine of the type which was illustrated and described in the January, 1912 issue of Machinery. Continued service results in the arbor and bearings of this machine becoming worn and after trouble of this sort is once encountered, it is only a short time after adjustment is made before the machine will again be out of alignment. The result of this wear is that the impression made by the stamp will be heavier at one side than it is at the other, or in the language of the press-room, it is "running light" on one side. To remedy this fault, the light side of the work was raised by placing a strip of paper under it, and by this means fairly satisfactory results were obtained before the bearings had become sufficiently worn to make adjustment absolutely necessary. As many as six sheets of paper would sometimes be used for this purpose, and the amount of time spent in "papering up" would frequently have paid for the cost of renewing the bearings.



Fixture for adjusting Alignment of Work in a Stamping Machine

As this method of securing alignment by use of sheets of paper was not satisfactory, it was decided to design a fixture which would automatically adjust itself to take care of any error of alignment in the arbor or its bearings. At the same time, it was desired to have this attachment of such a nature that it would be equally serviceable when the arbor alignment was perfectly accurate. The fixture designed for this purpose is illustrated herewith and will be seen to consist of the swivel bed device which is mounted on the regular work table of the machine. The base of the fixture consists of a cast-iron piece *B* which is planed on the bottom and bored out on the upper face to receive the turned steel piece *A*, which is planed off so that when in position its flat face is in the same plane as the upper surface of the piece *B*. The bearing surface between the pieces *A* and *B* is scraped to an accurate fit and kept carefully lubricated so that there is very little friction. In order to keep *A* in the required longitudinal position, and to prevent it from rotating too far, the stops *C* are screwed to the ends of the piece *B*. The ends of *A* extend under these stops and are milled off at an angle—as shown in the illustration—so that the piece *A* has just the required play in either direction from the center line. One-sixty-fourth inch movement in either direction is provided for by this means.

It will also be seen that an adjustable gage *D* is provided which may be set for different widths of work and that an end stop *E* provides for locating the work longitudinally. The gage *D* is set slightly above the bed so that it will not interfere with the rotation of *A*. In setting up the machine for any particular job, the gage *D* is set so that the work is approximately under the center of the marking roll. Then if the bearings are worn so that any error up to 0.005 inch exists, the work levels itself automatically under the pressure of the stamping roll without any effort on the part of the operator. The base *B* is bolted to the machine and is also centered under the roll.

Middletown, N. Y. **Donald A. Hampson**

HINTS FOR DRAFTSMEN

From time to time a number of rules for use in the drafting-room have been published in the columns of Machinery, but the writer has found the following to be a particularly satisfactory method of procedure for general routine work.

When designing a machine or part of a machine, the first step is to endeavor to see it clearly in your "mind's eye" before starting work; next make a few rough pencil sketches on scratch paper showing a general outline. An accurate assembly drawing can now be made and a list of the different parts that will be detailed is then made up from this assembly drawing. If it is found that the design of any detail will change any other part or parts of the machine, a list of such parts should be made. This work will occupy but a very short time and affords a safeguard against overlooking any part or change. When using such a system it will always be possible for the draftsman to give an immediate answer to questions regarding changes in design which have been made and the date when such changes become effective.

In checking up a design, the writer has found it useful to use a standard set of "test questions," which are given below:

Are all press fits on the right part to be most easily machined?

Do all parts correspond with the assembly?

Are the sizes of taps correct and are right- and left-hand threads provided in the proper places?

Are the over-all dimensions correct?

Are the ribs too heavy or too light, or are they just right?

Will each casting be as light as possible without being under undue strain?

What parts can be best produced by casting and what parts are most suitably produced by some other method?

Are all screws properly detailed?

Can all parts be easily assembled?

Has the list of commercial parts been made out?

Is the name, material and pattern number correct for each piece?

Is the title of each sheet correct?

Have any finish marks been omitted?

Have any arrow heads been omitted?

In preparing drawings enough views should always be shown to make the design readily understood by men in the shop. When it is necessary to make erasures on tracings, it will be found advisable to first use a knife to scrape the heavy coating of ink off, then use an ink eraser to remove the bulk of the line and a pencil eraser for the final part of the work. This method of erasing saves time and leaves a smooth finish on the tracing, so that it is unnecessary to use soapstone, and the tracing will not collect dust and dirt at the point where the erasure was made.

Springfield, Ohio. **Harold G. Smith**

* * *

Private interests have applied to the municipality of Buenos Aires for permission to erect on public lands a tower similar to the Eiffel Tower in Paris. The proposed tower is to be 1067 feet high, to which is added a statue 106 feet high carrying a light to have an illuminating power of 1,000,000 candle-power. The total height thus would be 1173 feet as compared with 984 feet of the Eiffel Tower.

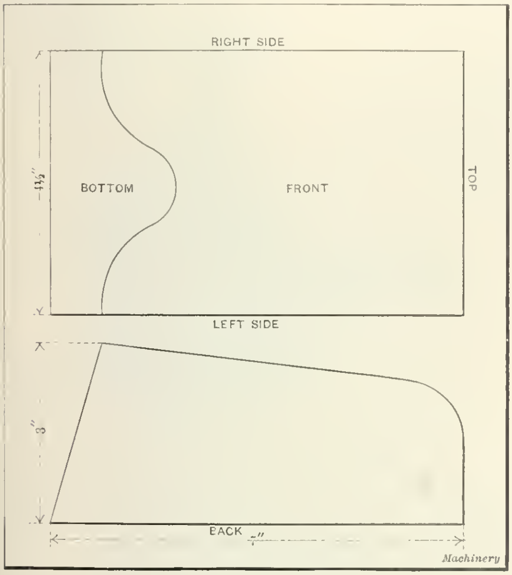
HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

A PROBLEM IN PRESSWORK

P. B.—I wish to make a set of dies for drawing a steel shell like that illustrated in the sketch. The material is 0.030 inch sheet steel. In referring to the sketch it should be stated that the bottom and back are open, thus the shell has a front, top, right and left sides only (no bottom or back). The finished piece must have sharp corners as indicated. I would like suggestions as to the proper method of drawing this piece, the number of operations that will be required and any other points that will be helpful.



The Shell to be drawn

This question is submitted to our readers.

HOW TO CALCULATE THE POWER OF A PRESS

C. O. S.—The accompanying illustration Fig. 1 shows a press which is used for compressing springs and the writer would like to know how to calculate the power developed by the press, or, in other words, what spring tension would be sufficient to prevent the press from turning over. The press is driven by four-inch double leather belting and has a 30-inch balance wheel which weighs 420 pounds and runs at 100 revolutions per minute. The length of the stroke is 10 inches.

Answered by William L Cathcart

A.—The data in this case are insufficient for wholly accurate results but, by reasonable assumptions, a fairly satisfactory answer can be given. There are two questions to be considered. First: What power is available in the stored or kinetic energy of the balance wheel and the gears driven by it for spring-compression by the plunger? Second: What spring-pressure, acting on the plunger, will hold the balance wheel stationary against the maximum pull of the belt?

Kinetic Energy

The stored or kinetic energy of a body rotating about a fixed axis—as the balance wheel does in this case—varies directly as the moment of inertia of the revolving mass about that axis, and the magnitude of the moment of inertia increases with the weight of the body and with the distance of that weight from the axis. In this case, the balance wheel *A*, the spur gears *B* and *C*, and the eccentric disk *D* revolve together, and hence they all have kinetic energy. To calculate with accuracy its amount for all of these parts is impossible, owing to lack of dimensions, and is unnecessary for practical purposes, since nearly all of the kinetic energy is stored in the rim of the balance wheel. This is due to the fact that the arms or disk of the balance wheel between the rim and hub are light and located near to the axis as compared with the rim, that the hub of the wheel and the whole of gear *B* are too near the axis to have any material effect, and that gear *C* and disk *D* run at only 26.7 revolutions per minute. An allowance of 10 per cent of the stored energy of the rim of the balance wheel should be ample to cover the similar energy of these parts.

The balance wheel is 30 inches in diameter and weighs 420 pounds. In similar wheels for heavy work, the weight of the rim is from 70 to 75 per cent of the total weight. On this basis, the maximum weight of the rim will be 420 × 0.75 = 315 pounds. If we assume that the rim has a 5-inch face and is 2¾ inches thick, its weight (cast iron = 0.26 pound per cubic inch) will be 306 pounds, which is close enough. The moment of inertia of this rim is 12.43. Its kinetic energy at 100 revolutions per minute is 681.28 foot-pounds.

Belt-pull and Turning Moment

According to the experiments of F. W. Taylor on oak-tanned and fulled leather belts, a double belt having an arc of contact of 180 degrees will give an effective pull on the face of the pulley of 35 pounds per inch of width of the belt. On this basis, the four-inch double belt used in this press will give a maximum effective pull of 35 × 4 = 140 pounds at the pulley-face, with a leverage of 15 inches. This corresponds to a pressure, at the line of contact *P* of gears *B* and *C*, of $140 \times \frac{15}{4} = 525$ pounds. The maximum pull of the belt will therefore drive gear *C* with a force of 525 pounds, acting with a leverage of 15 inches.

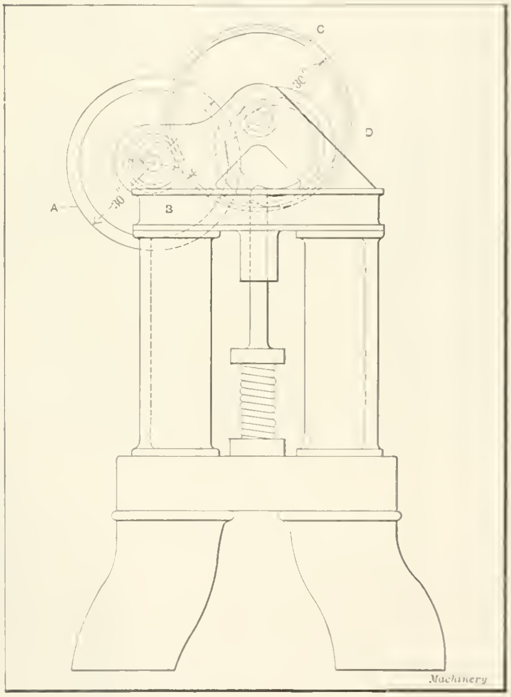


Fig. 1. Diagram of Press used for compressing Springs

Brake Action

In compressing a spring under the press, the spring reacts on the plunger with the same force as that with which it is compressed. This force *Q* acts upward along the plunger and produces pressure and resulting friction, both in the eccentric cam-way *D* and in the bearing of gear *C*, to which the eccentric disk is fixed. The resisting force of friction F acts along, or tangent to, the surfaces in contact. It is equal to the perpendicular pressure on those surfaces, multiplied by the coefficient of friction f. This coefficient is a factor which is theoretically indeterminate. Its value depends on the character of the surfaces in contact, their temperature, lubrication, etc., and differs in different machines, in different parts of the same machine, and often at different times in the same bearing. Various values of f have been found, ranging from 0.12 to 0.6. The calculation of the friction of a press during the downward stroke of the plunger would be a complex process. For simplicity, take $f = 0.3$ and assume the entire friction to be concentrated at the top of the roller in the plunger. The distance of this point from the center of gear C is at least 11 inches when the plunger is at the bottom of its stroke. At this time the resisting force of friction F is equal to $f \times Q$ or $0.3\,Q$, which acts with a leverage of 11 inches.

If the kinetic energy has already been expended in compressing the spring, so that the belt alone is driving the plunger, the force F will just stop the press when its moment is equal to that of the driving force on gear C, due to the belt alone, that is when:

$$F = 525 \times \frac{15}{11} = 716 \text{ pounds}$$

$F = 0.3\,Q$ and hence:

$$Q = 716 \times \frac{10}{3} = 2387 \text{ pounds.}$$

The safe working load of a helical spring of ¾-inch round steel and 4¾ inches outside diameter, is approximately 2475 pounds so that such a spring, under these conditions, would just about stall the press at the lower end of the stroke.

Work of the Kinetic Energy

The energy stored in the rim of the balance wheel is 681.3 foot-pounds. Allowing an additional 10 per cent for the kinetic energy of the other rotating parts, gives 750 foot-pounds as the total kinetic energy. The stroke of the plunger is 10 inches or $\frac{10}{12}$ foot. If spring compression occurs during the entire stroke, the average load on the plunger during the stroke will be:

$$750 \times \frac{12}{10} = 900 \text{ pounds.}$$

At the beginning of the stroke the load is zero, so that the load at the end will be $900 \times 2 = 1800$ pounds, which should not exceed the safe working load of the spring thus compressed. This calculation neglects the resisting effect of the force of friction F, which may be considered thus: If Q is the *average* pressure during the plunger-stroke, then $F = 0.3\,Q$ pounds will act at an average radius from the center of gear C of at least $\frac{11 + 1}{2} = 6$ inches during the semi-revolution of that gear in which spring-compression occurs. The 750 foot-pounds of kinetic energy are equivalent to a force of 478 pounds acting through the semi-circumference whose radius is 6 inches = ½ foot and whose length is 1.57 foot. The net driving moment is then:

$$(478 - 0.3\,Q)\ 1.57 \text{ foot-pounds,}$$

and this moment must be equal to the work done in compression by the plunger, which work is

$$Q \times \frac{5}{6} \text{ foot-pounds.}$$

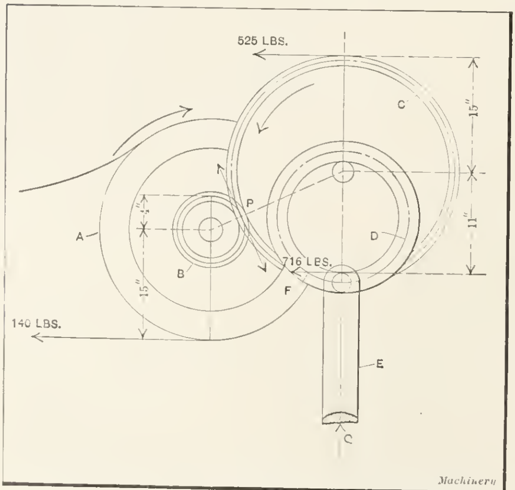


Fig. 2. Diagram showing Direction of Forces acting on the Press

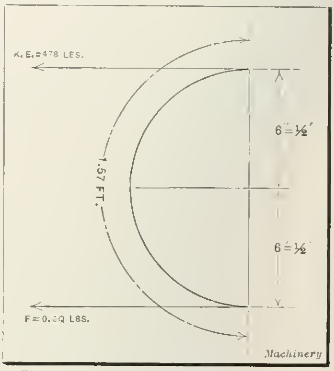


Fig. 3. Diagram showing Effect of Friction on the Power of the Press

Since the pressure of the plunger is equal to the reaction of the spring, we have:

$$(478 - 0.3Q)\ 1.57 = Q \times \frac{5}{6} = Q \times 0.83$$

$Q = 577$ pounds = average pressure during plunger-stroke.

The maximum pressure at the end of this stroke is $Q \times 2 = 1154$ pounds, which should not exceed the safe working load of the spring thus compressed.

Work of Kinetic Energy and Belt-pull Combined

If the kinetic energy of the press is assumed to be wholly expended during the compression of the spring, the maximum pressure produced at the lower end of the plunger stroke will be as follows:

Pressure due to kinetic energy,	1154 pounds
Pressure due to belt-pull,	2475 pounds
Total	3629 pounds

This is the safe working load of the spring thus compressed. This pressure may be exceeded somewhat, since the maximum belt-pull is assumed to act only at the end of the stroke, while it would probably restore, to some extent, the failing kinetic energy during the stroke.

It should be observed that these calculations are based on somewhat broad assumptions, due partly to lack of dimensions but mainly to the effect of friction on the work of the press. This latter question is complex and presents problems whose solution for such a machine can be but approximate. Practical tests are required for their determination.

* * *

The use of ball bearings in machine tools is growing rapidly. One make of heavy vertical grinding machine has a "three-quarter ball bearing," that is, radial ball bearings at the top, ball thrust bearings at the bottom, and a phosphor-bronze bearing to take the radial load. Ball bearings are used in the idler pulleys of this machine, a position for which they are admirably suited. Friction losses are much reduced and narrow bearings can be used which, in itself, is often a consideration of much importance in the design of high-power machines. The use of ball bearings in machine tools is by no means new. Mr. John Becker, president of the Becker Milling Machine Co., Hyde Park, Mass., tried them in 1893, but the inaccuracy of balls and the low grade of steel then used caused so many failures that he abandoned their use. The advent of balls accurate to one-ten-thousandth inch, made of alloy steel having high physical characteristics and ball races of the same high-grade metal, has completely changed the situation. What was unreliable twenty years ago is now probably the most durable thing in the way of bearings that has ever been made.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

WELLS BROS. CO.'S SELF-OPENING DIE

Wells Bros. Co., Greenfield, Mass., has recently placed on the market a new form of self-opening die. The design of this die has been worked out with the view of combining the advantage of an opening die which does not have to be backed off the work, with the accuracy of a solid die. The chasers of this die are hinged at the back and supported by a sleeve which engages a tapered section located directly behind the cutting edges. In this way a solid and unyielding support is provided at the back of the chaser, directly opposite the cutting edges which do the heaviest work. In addition, the chasers are given lateral support on each side by the body of the die. The result of this construction is a die that possesses practically the same strength as a solid die. The shell which holds the chasers to their work slides over the body of the die longitudinally instead of having a rotary motion. The position of this shell is adjusted by a ring fastened to it. By this means, adjustments as fine as 0.00025 inch can be made. This adjustment is provided to take up slight variations from the standard size of the die. For this purpose, it is merely necessary to loosen the locking nut $\frac{1}{8}$ turn and then move the graduated ring through one point for each 0.001 inch of adjustment that is required. After this adjustment has been made the nut is re-tightened.

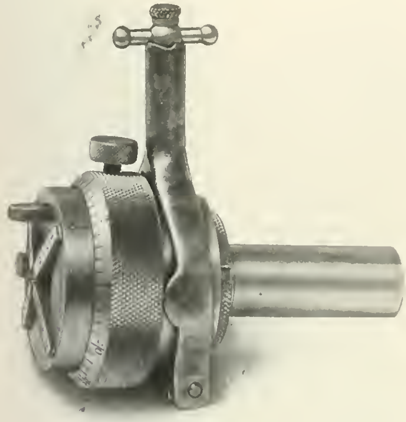


Fig. 1. The Wells Self-opening Die

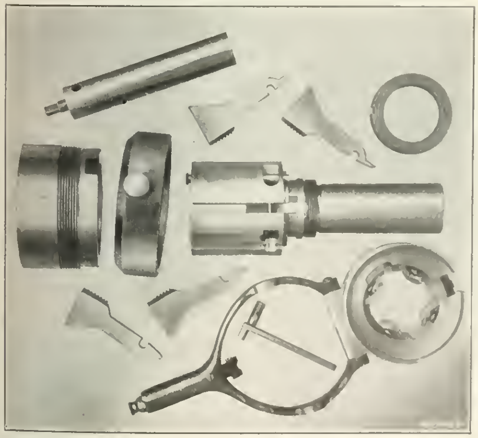


Fig. 2. Parts of the Wells Self-opening Die

This die is made in several different styles in which different types of tripping devices are used for automatically opening the die. This makes it adaptable for service on a variety of machines. One trip is operated by a pin which projects from the face of the die. When this pin comes into contact with the chuck or some other stop arranged on the machine for that purpose, it releases the latch and allows the springs to open the chasers. Another form of trip is internally operated. The advancing end of the work strikes a projection in the center of the die which releases the latch and opens the chasers. Still another form of trip is placed on the rim of the head. The latter type is particularly adaptable for use on drill presses and other machines which require the head to revolve. In this form of die head, a projection on the side strikes the latch in the rim and causes the die to open. In addition to the tripping mechanisms previously referred to, nearly all models of die heads are provided with a hand lever trip which is found to be a great convenience in setting up the die head. The releasing springs which open the die operate directly upon the chasers, causing them to fly apart with "catlike" quickness which would be impossible with any rotary method.

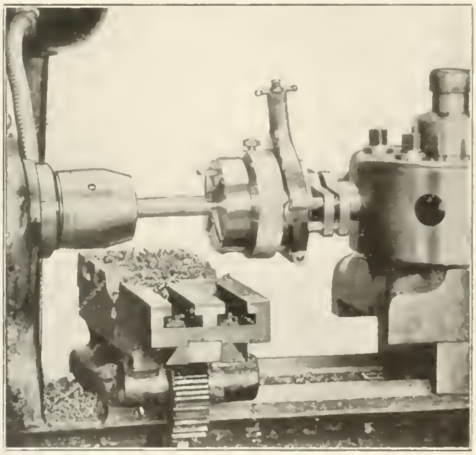


Fig. 3. Wells Self-opening Die in Use

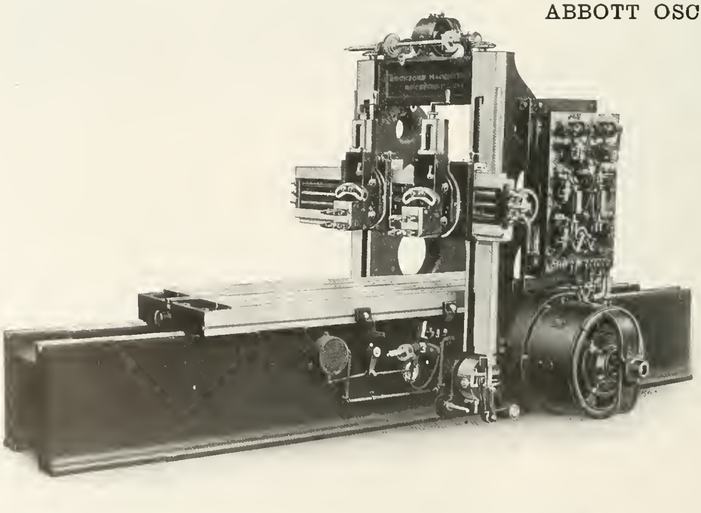
The tripping mechanism is entirely separate from the releasing springs, thus enabling a very light "hair trigger" latch to be adjusted. This minimizes the pull on the thread to such an extent that it never disturbs the lead of the thread, is absolute in operation, and opens so quickly that the thread is not scratched. Some models of this die head are mounted on an independent shank which permits the die to carry its own lead unaided by the machine. Experience has shown that a die will reproduce its own thread unless hindered by the machine or by some other external means. It is a very difficult matter to cam a screw machine so that the advance of the turret will be in exact time with the lead of the die. The resulting thread is always a compromise and imperfectly formed to that extent. By utilizing the independent shank, which permits a lateral float, it is possible to cut a $\frac{1}{2}$-inch-13 or a $\frac{1}{2}$-inch-12 thread on the same machine without making any changes or adjustments. One-half inch rods have been threaded for a distance of 28 or 30 inches with this die. Allowing the die to carry its own lead, the total variation in the lead of the threads for the entire distance is 0.010 inch.

Fine chips and metal dust will work into the parts of any mechanism. The construction of this die head is so easily understood that it can be quickly opened and cleaned by an unskilled employe. The die has few parts and is extremely simple in design and construction. The parts are easily assembled. As lubricant is brought to the work through the shank, the flow washes chips and dirt away before there is any chance of their lodging between the parts.

This die is made in the following styles: The Model V is equipped with the internal trip, face trip and hand trip. One exception to this standard equipment is that from 1½ inch up, the internal trip is not furnished. The Model VV is the same as Model V with the addition of a separate shank which enables the head of the die to float (longitudinally only). The Model X was designed to meet the demand for a die in which the chasers could be quickly changed from one size or style to another. At the base of each chaser, there is a small pawl held in position by a spring, the entire mechanism being mounted on the inside of a collar. The hand lever is attached to this collar and by turning the lever about ⅛ of a revolution to the left, the pawls slide off the bases of the chasers, enabling them to be taken out by hand. A new set of chasers is then placed in position and the hand lever turned back to fasten them in position. This model has the same tripping mechanisms as the Model V. The Model XX is the same as the Model X, except that it is also provided with the shank to enable the die to float longitudinally. The different forms of die heads which are provided for by these models will undoubtedly meet the requirements of a great variety of threading operations on different classes of machines.

ROCKFORD PLANER WITH REVERSING MOTOR DRIVE

The 36-inch by 36-inch by 10-foot planer shown in the accompanying illustration is a product of the Rockford Machine Tool Co., Rockford, Ill. This machine is equipped with reversing motor drive and its design represents the result of a careful study which has been made with the view of simplifying the construction as far as possible. The motor is designed with a special type of frame which is bolted to a pad on the housing of the planer. This makes the machine a self-contained unit and does away with the trouble of keeping the planer and motor in perfect alignment with each other when the two units are mounted on separate foundations. The length of the shaft is also shortened and the use of a coupling is avoided so that considerable floor space is saved. The danger arising from an exposed coupling is also done away with. When it is necessary to dismantle the motor for repairs or inspection, the armature is easily removed by driving out the gib head key and taper pin from the main driving pinion and set collar, and then removing the outside head from the motor frame. A separate motor is used for raising the cross-rail which is operated from the left-hand side of the machine.



Rockford 36-inch by 36-inch by 10-foot Planer with Reversing Motor Drive

THE GREENERD ARBOR PRESS

The No. 7 Greenerd arbor press, illustrated herewith, is the largest equipment of this type that has been brought out by Edwin E. Bartlett, 326 A St., Boston, Mass. This press receives work up to 36 inches in diameter. The only change from preceding presses of this type lies in the greater power and capacity of the No. 7 press. This machine has a leverage of 250 to 1, and a pressure up to 25 tons is easily obtainable.

No. 7 Greenerd Arbor Press with Leverage of 250 to 1 and Capacity up to 25 Tons

When the lever is in the position shown in the illustration, the rack or ram may be easily moved up or down by means of the handwheel. The knee is operated by a crank which rotates the screw through a pair of miter gears. This screw runs in a nut at the base of the machine and the design is such that the knee can be lowered to its extreme position without the screw reaching the floor. This makes it possible to place a press in any position without cutting the floor to provide clearance for the screw. The knee is held to the frame by two studs and nuts. These nuts are adjusted and locked in place in such a way that the knee can be easily moved. The pitch of the elevating screw is such that these nuts do not require to be tightened to hold the knee under the heaviest pressure.

ABBOTT OSCILLATING BURNISHING BARREL

In order to meet the demand for a burnishing barrel that will take work over 16 inches in length, the Abbott Ball Co., Elmwood, Hartford, Conn., has brought out a new form of oscillating burnishing and tumbling barrel. The machine is shown in different positions in Figs. 1, 2 and 3, from which a general idea of its design can be obtained. The inside dimensions of the barrel are 12 inches in width by 30 inches in length. It is octagon in shape and lined with hard maple. One end of the barrel can be removed by loosening four nuts on swing bolts, thus releasing the cover so that it can be lifted from the barrel.

The barrel is supported on trunnions in a yoke, the sides of which are made of channel irons. The most important feature of the design is the locking mechanism which secures the barrel in place. This consists of two gear segments, one of which is carried on the spindle which supports the barrel in the yoke and the other by a bolt which slides in a slot in the yoke. By this means the axis of the barrel can be set at an angle of 5, 10 or 15 degrees with the plane of the yoke, and clamped in this position by bringing the gear segment on the yoke up so that it meshes with the corresponding segment on the spindle, and then clamping it in place by tightening the bolt. In the parallel position, the barrel is clamped by a slot in the opposite end of the sliding lock member which engages with a lug cast on the barrel. Fig. 1 shows the barrel clamped parallel with the yoke; Fig. 2 shows it clamped at an angle; and in Fig. 3 the clamp has been released, the cover removed and the barrel swung down to discharge its contents.

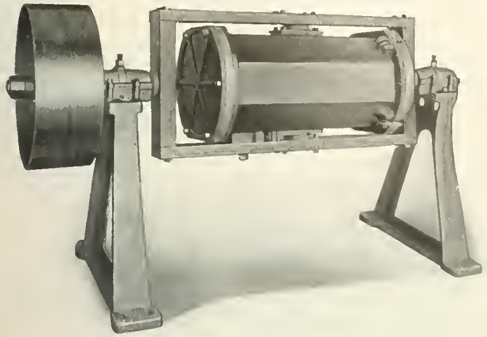


Fig. 1. Abbott Burnishing Barrel clamped Straight in Yoke

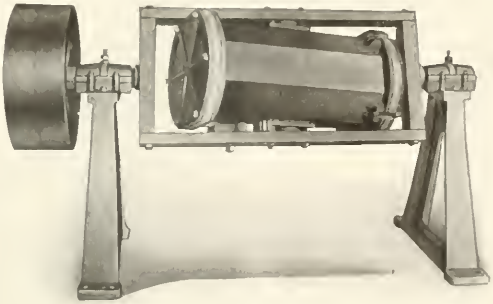


Fig. 2. Abbott Burnishing Barrel clamped at an Angle in Yoke

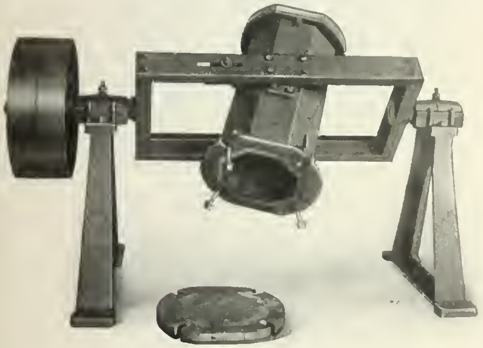


Fig. 3. Abbott Burnishing Barrel swung down to discharge Contents

This method of taking the end out of the barrel greatly facilitates loading or unloading the contents which are to be burnished in it.

When the barrel is locked in either of the angular positions, it imparts an oscillating motion to the contents. Experience will show the most desirable angle for different classes of work. Instead of filling the barrel one-half or two-thirds full of work and balls, as in the case of other types of burnishing barrels, this barrel should be almost entirely filled. The special soap-chips and water are used in the customary manner. In this way the work has no chance to turn on end or to move as it would do in a barrel of smaller diameter which is only partially filled. Small work, however, can be more satisfactorily finished in the regular type of burnishing barrel, the purpose of the oscillating barrel being merely to take care of larger sizes of work such as sash rods and similar pieces.

HISEY-WOLF PORTABLE ELECTRIC REAMER

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has placed on the market a portable electric reamer adapted for use in boiler shops, structural and steel works, etc. In the manufacture of structural iron and steel, boiler plate and similar work, it is the practice to cut, shape and punch the parts according to specifications which are furnished to the mills. It is not practicable, however, to punch holes with sufficient accuracy to have them line up properly for making riveted connections. This has led to the practice of punching holes under-size, thus leaving sufficient metal for them to be lined up and sized by a reaming operation at the time that the riveting is done. It is for this kind of work that the new Hisey-Wolf reamer has been designed.

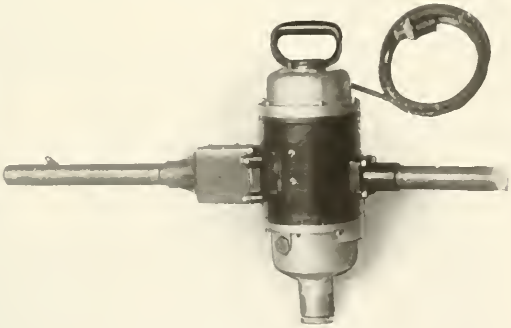


Fig. 1. Hisey-Wolf Portable Electric Reamer

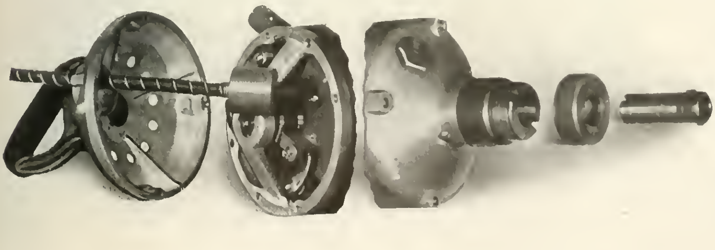


Fig. 2. Details of the Commutator End of the Motor and of the Socket

This tool consists of a compact electric motor with speed reduction gears which drive the socket at a suitable speed for the class of work for which the tool is intended. A long handle is provided at each side of the tool and a short handle at the end opposite the reamer socket. A switch of special construction is mounted in one of the side handles, which affords a simple and effective means of making and breaking the electric contact quickly and without danger of short circuiting or shocks. By this means the motor is kept under control of the operator at all times. The motor is designed especially for driving this tool. It is of the bipolar type and made as light as is consistent with the power requirements of the service for which the tool is intended. The motor is air-cooled by a specially designed fan placed on the rotor shaft close to the gear-box. This fan discharges through a series of small openings near the circumference of the end-housing, the inlets being through openings in the opposite end-housing. These openings are covered by fine wire mesh to protect the motor from having borings and other material drawn into it. The motor windings are heavily compounded to provide a strong starting and operating torque at a low speed, and without danger of damage from racing when the tool is free.

The gears are cut from steel and carefully hardened and mounted in an enclosed gear-box which is an integral part of the motor housing. The gears run in grease and have self-aligning ball bearings. Referring to Fig. 2, which shows the construction of the commutator end of the motor, it will be seen that the bearing is mounted on a casting which is entirely independent of the end-housing. With this construction the frictional load of the bearing is not increased or affected by pressure applied on the handle. The motor terminals are protected by a fiber insulating cap.

The socket is of the slip type and is machined to Morse tapers of the proper dimensions for standard sizes of reamer shanks. The construction is such that the reamer may be easily removed, it being merely necessary to unscrew the knurled cap by hand. This releases the slip socket into which the shank fits. No spanner or wrench is necessary, as the slip socket which holds the shank fits loosely into the socket of the driving spindle and engages it positively by means of recesses provided for that purpose. Excessive pressure resulting from severe work cannot affect the proper alignment of the shank.

SIXTEEN-INCH CINCINNATI ENGINE LATHE

The illustrations show a 16-inch lathe which has been placed on the market by the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio, and the arrangement of the reverse plate and apron with which the machine is equipped. This lathe is provided with any one of three types of headstock; the first has a three-step cone pulley with double back-gears and the other two, four- and five-step cones with single back-gears. The spindle is of high carbon forged steel, ground and lapped to an accurate fit. The spindle bearings are bushed with a special grade of bronze which is made for this purpose. The thrust is taken by a bearing at the rear of the spindle, which is provided with a hardened tool-steel collar for taking up wear. The thrust is taken against the front end of the rear bearing. Lubrication of the spindle bearings is provided for by self-closing dust-proof oilers located on the bearing caps.

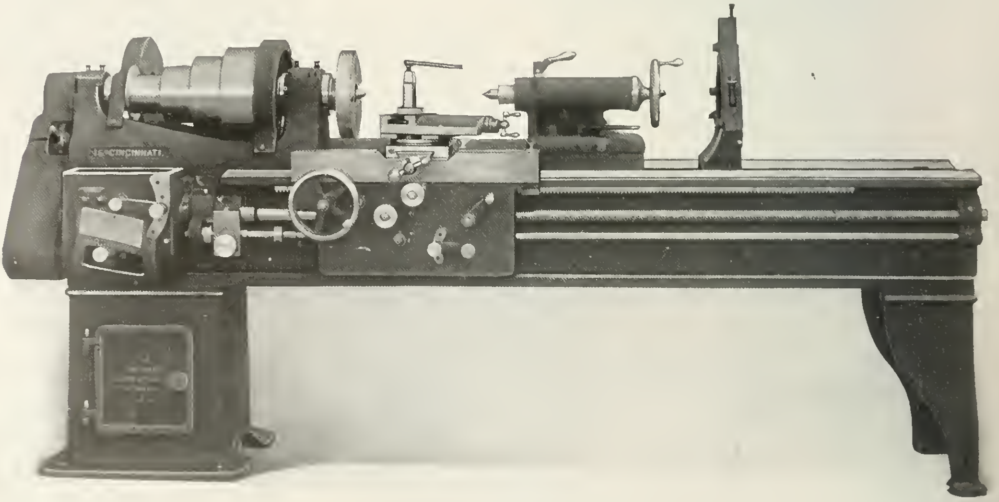


Fig. 1. Cincinnati 16-inch Lathe

The machine side of the apron is shown in Fig. 2. This apron is of the double-wall type and is rigidly bolted to the carriage of the lathe. The double-wall construction gives additional support to all shafts and studs in the apron, thus providing accuracy as well as long life for all of the working parts. All of the gears are of ample pitch to withstand any cut that the main driving belt will pull. Motion is transmitted by compound gearing and the longitudinal and cross feeds can be started, stopped or reversed while the lathe is running. These feeds cannot be engaged, however, when the lathe is employed in screw cutting operations and this provision constitutes a safeguard against damage to the machine when it is being operated by an inexperienced mechanic. A thread-chasing dial is provided, which permits the halfnuts to be opened, the carriage run back by hand and the thread picked up at any point without reversing the lathe. This makes a backing belt unnecessary. An automatic stop has also been provided for tripping the feeds at any required point. The carriage is gibbed at both the front and back and has a bearing on the vees of the bed for its entire length.

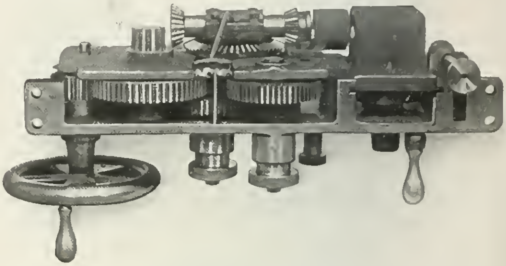


Fig. 2. Apron of the Cincinnati 16-inch Lathe

The reverse plate for cutting right- and left-hand threads is located on the outside of the headstock and is only used for reversing the lead-screw when cutting threads and not for reversing the feed. The feed reverse for the lathe is in the apron. A combination of metric pitches with a U. S. Standard lead-screw or *vice versa*—besides those obtained in the gear-box—may be obtained by simply shifting two levers. This arrangement gives the facilities of a standard lathe, and each gear not only provides for cutting the pitch required but also the other pitches which may be obtained through the series of gear-box changes. All changes can be made while the lathe is running under a heavy cut. The screw-cutting and feeding mechanism is characterized by its simplicity, compactness and ease of manipulation. The device is a complete unit assembled in a box mounted on the front of the bed where it is easily accessible. The gears are made of steel and the shafts are of liberal proportions. All of the bearings are bushed with bronze and designed along lines which will enable them to withstand severe treatment. Provision for different threads is made without removing a gear, by simply operating two levers which are conveniently placed within a few inches of each other. The index plate is attached to the box, and so placed that the operator sees at a glance the required setting for any thread or feed.

The tailstock is of the off-set type and has a long bearing on the bed. The spindle is securely supported and has a bronze nut for the screw. A clamp device is used to lock the spindle in any position, the design of which has done away with the necessity of splitting the barrel.

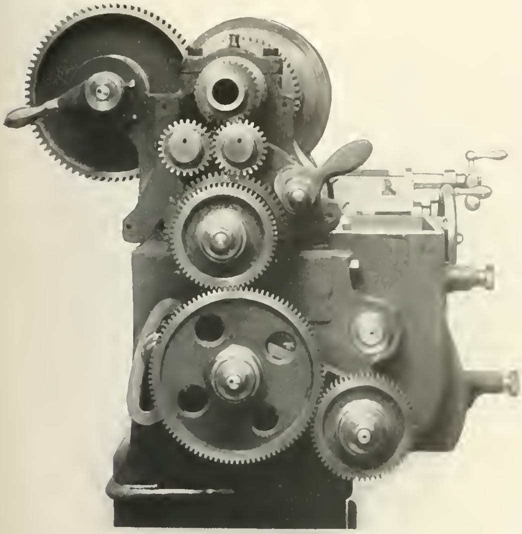


Fig 3. End View of Cincinnati Lathe showing Reverse Plate and Segment

The countershaft is equipped with double friction and self-oiling clutch pulleys. It is not necessary to throw off the driving belts nor stop the countershaft when filling the reservoirs which carry the supply of lubricant. The hangers are of pressed steel and are of the double-brace type, provided with ring oiling bearings. On ordinary commercial work the countershaft is operated at 140 R. P. M.

ATLAS BALL GAGES

The Atlas Ball Co., 203 Glenwood Ave., Philadelphia, Pa., has recently found a new use for the balls of its manufacture. This consists in using them for plug gages of the kind commonly employed in machine shops. For this purpose, a knurled handle is electrically welded to the ball as shown, which makes it a very convenient tool. These gages are being made in sets of assorted sizes, and they are guaranteed round and accurate to 0.0001 inch. Two important advantages are secured by them. First: The substitution of a ball in place of a cylindrical plug enables the gage to be entered into the work in any position, instead of requiring the axis to be parallel with the axis of the gage. Second: The scale on which these balls are manufactured enables gages of this kind to be offered at a price which is not prohibitive.

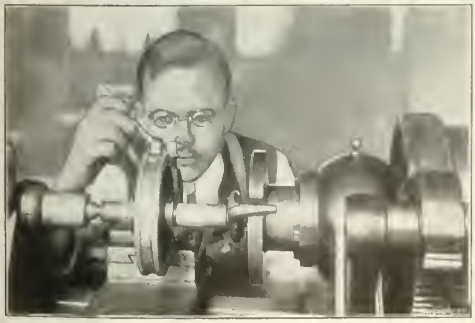
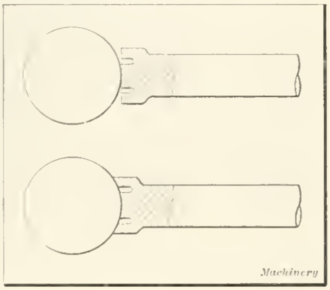


Fig. 1. Measuring the Radius of a Sheave Pulley with the Atlas Ball Gage

In the manufacture of its regular line of balls, the Atlas Ball Co. has used the Johannsens Swedish gage blocks to calibrate the measuring instrument which is used to check their accuracy. That this is a most delicate instrument will be readily appreciated from the fact that its entire range of measurement is only 0.002 inch. It is used to measure balls during the process of manufacture and especially after the precision grinding has been performed on them. Experience showed that constant use resulted in a slight hollow being worn in the points of the machine, which was responsible for a corresponding error in the reading obtained with it. To avoid this difficulty the method of setting the instrument with the Swedish gage block and then making subsequent calibrations with a master ball was adopted. As this ball was of the same shape and contour as the standard ball, the slight wear on the points of the machine was compensated for and enabled measurements to be made more accurately and more rapidly than could otherwise be done. While perfecting these measuring devices, Mr. Otto W. Schaum, president of the Atlas Ball Co., conceived the idea of attaching a handle to the ball for two reasons: First, it would facilitate handling the master ball: and second, it would eliminate errors due to expansion and contraction caused by holding the master ball in the hand for too long a period.



Figs. 2 and 3. Shank and Ball ready to be welded and the Welded Joint

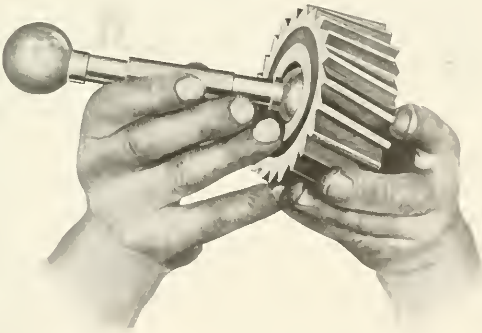


Fig. 4. Double End Atlas Ball Gage used as a Limit Gage

The convenience of this tool suggested the application of the same idea in making the usual form of plug gages and similar tools. Tools of this kind can be conveniently used for setting a micrometer, thus preventing the chance of having a workman read it incorrectly. They can also be used as a radius gage for rolling mill rolls of the type used for producing round sections, or for measuring the radius of a sheave wheel, as shown in Fig. 1. Probably the most important application of these tools will be found in measuring internal diameters on ball bearings, circular saws, form cutters, gear wheels, flywheels, pulleys, hollow mills, collars, bushings, and a variety of other machine parts.

The method of attaching the ball to the handle was selected with the view of eliminating any tendency toward distortion. It was, of course, necessary to find some means by which a hardened and ground ball could be attached to the handle, as the distortion produced by the hardening process would ruin the accuracy of the gage. After trying a number of methods, electric welding was found to give very satisfactory results, certain modifications of the customary method being applied to prevent drawing the temper of the ball. Fig. 2 shows the handle in position ready to be welded, and Fig. 3 shows a sectional view of the handle welded in place on the ball. Referring to these illustrations it will be seen that the central projection on the handle is melted away sufficiently so that the ball has an even bearing on the end of the handle.

Fig. 4 shows one of the Atlas ball gages being used as a limit gage. It will be seen from the illustration that in this case there are two balls, one attached to each end of the shank. The balls on this particular tool are 1.251 and 1.249 inch in diameter, these two sizes constituting the extreme limits between which the diameter of the hole in the cutter must lie. The shank which carries the larger ball is of greater diameter than that which carries the smaller ball, so that the workman is able to distinguish the two ends of the gage readily, without referring to the sizes which are stamped on the ends of the shank. Fig. 5 shows the application of the gage for gaging a hole which has been bored in the wheel shown mounted in a lathe chuck. This illustration shows the advantage of a spherical end over a cylindrical end for a gage of this type. Referring to the illustration, it will be seen that the gage can be placed in the hole at any angle without danger of jamming it, as would be the case with a cylindrical plug gage.

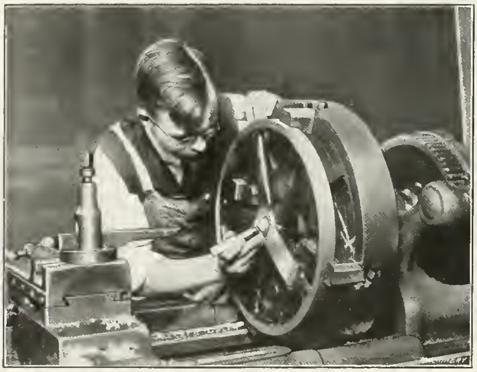


Fig. 5. Gaging the Bore of a Pulley with the Atlas Ball Gage

GARVIN DUPLEX HORIZONTAL DRILLS

The illustrations show a new line of duplex horizontal drills, recently brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. These machines are adapted to machine work from opposite ends simultaneously, using suitable fixtures for drilling, counterboring, turning or hollow-milling. Facing is done in practically one-half the time consumed in single spindle operations, and the machine provides for positive alignment, which is also an additional advantage. The rapidity of operation depends largely upon the style of fixture used.

With a view of entirely avoiding chip troubles, the machines were designed with large vee guides for the heads, leaving an open bed free from the accumulation of chips. The No. 00 machine is made with both screw and rack feed, having a capacity for ⅞-inch and ¾-inch drills, respectively. The rack feed machines, shown in Figs. 1 and 2, are made in four styles (A, B, C and D). The heads slide on generously proportioned vees, and are taper gibbed underneath to take care of lifting strains and wear. It will be noticed that there is a centrally located depressed surface, 12 by 12 inches in size, with a central T-slot planed out of the solid. This T-slot is square with the vees and provides a means for clamping fixtures and for changing them quickly. The thrust of the spindle is taken on ball races.

The heads of the No. 00-A duplex horizontal drill shown in Fig. 1 are controlled independently by hand capstan wheels, suitable micrometer stops being provided for accurate facing work. The capstan wheels have two working positions for long or short pieces. On the "B" style of drill the heads are moved simultaneously by hand through a centrally located capstan, operating through a rack and pinion feed. A friction clutch device provides for disengaging the left-hand head, allowing for a close adjustment to cover variation in the length of drills or turning tools. This also provides an adjustment for wear of the tools in sharpening. With this independent friction adjustment, various other operations, such as turning to exact shoulders, or facing to exact lengths are fully controlled.

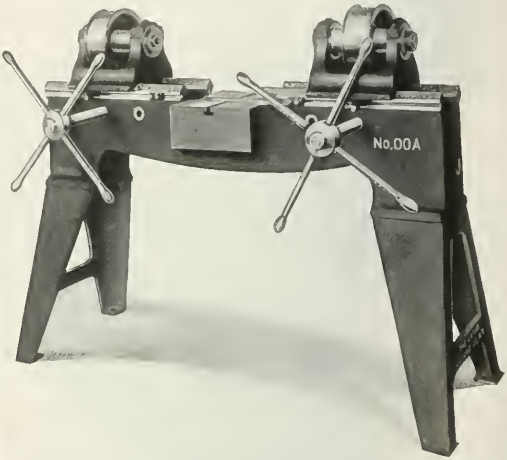


Fig. 1. Garvin No. 00-A Duplex Horizontal Drill

The "C" style drill, shown in Fig. 2, is the same as the "B" style, except that it is equipped with power feed, which feeds both heads simultaneously. There are three changes of feed, and automatic adjustable trip stops and micrometer stops are provided. A noteworthy feature of these drills is that on tripping the feed, the heads are returned immediately to their original positions through the unwinding of an adjustable barrel spring. The spindles are hardened and ground and run in bronze boxes. The "D" style of drill is made to cover numerous special requirements in duplex drilling, the sliding heads being replaced by sliding plates. Various single or multiple drilling heads can be mounted on these sliding plates and fed independently by hand, as in style "A"; simultaneously by hand, as in style "B"; or with automatic power feed, as in style "C" drills.

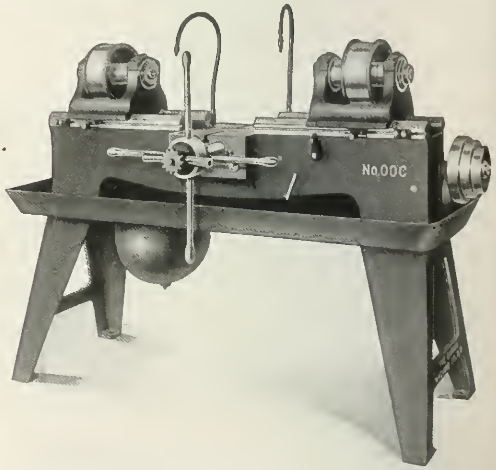


Fig. 2. Garvin No. 00-C Duplex Horizontal Drill equipped with Power Feed

AURORA DRILL WITH POSITIVE GEARED FEED

The 24-inch upright drill equipped with positive geared feed and shown in Fig. 1 is a new model which has been developed by the Aurora Tool Works, Aurora, Ind. It will be seen that this machine is equipped with positive geared feed, and Fig. 2 shows a detail view of the gear-box. The feed gears are covered by a solid case which is filled with heavy oil and the feed gears are of hardened steel.

The spindle is made of high-carbon steel and is provided with quick-return, the thrust being taken on roller bearings. The spindle has a feed of 11 inches and is bored for a No. 4 Morse taper. The positive geared feed is provided with automatic stops and gives six changes ranging from 0.006 inch to 0.039 inch per revolution of the spindle. The machine is driven by a four-step cone pulley and the back-gears have a ratio of 2½ to 1; they are engaged or disengaged by a lever which is conveniently situated for the operator. The diameters of the cone pulley steps range from 5½ to 11 inches by 3 inches face. The tight and loose pulleys are 12 inches in diameter by 3½ inches face and should run at from 400 to 600 revolutions per minute.

The high drilling capacity which this machine has shown in recent tests is due to the size and width of the belts and also to the fact that the power is applied to the drill in a simple and direct manner. The combination of the most advantageous gear ratios, pulley diameters, and belt speeds also adds to its efficiency.

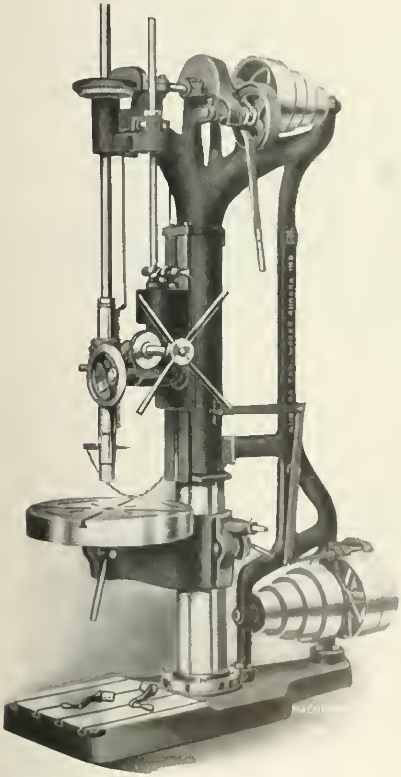


Fig. 1. Aurora Upright Drill equipped with Positive Geared Feed

The base is of massive construction and is provided with T-slots for holding large work which cannot be conveniently set up on the table. The maximum distance from the base to the end of the spindle is 46½ inches. The column is finished by grinding and the metal is well distributed to insure sufficient strength. The table is 22 inches in diameter and provided with bolt slots. The table arm has a long bearing on the column and a large circular bearing in which the table rests; the construction gives exceptional rigidity. The table is raised and lowered by means of a rack and pinion and is locked by clamping screws. The maximum distance from the table to the end of the spindle is 33½ inches. The height of the machine is 7 feet 6 inches and the floor space occupied 4 feet 7 inches by 1 foot 10 inches.

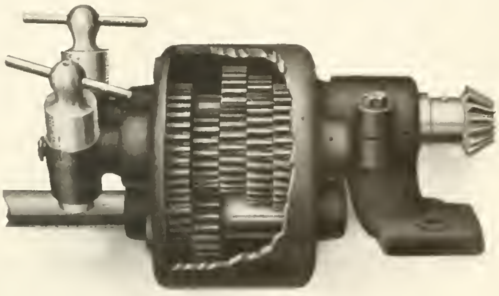


Fig. 2. Feed-box of the Aurora Upright Drill

TOLEDO DRAWING PRESS

The double-crank, double-action toggle drawing press illustrated herewith is a product of the Toledo Machine & Tool Co., Toledo, Ohio. The design of this machine includes an entirely new feature in the method of operating toggle drawing presses. Referring to the illustration, it will be seen that the rocker shafts run through the solid arch of the press from front to back, and, as a consequence, they are much more rigidly supported and the distance between the toggle joint supports is considerably reduced. This reduces the tor-

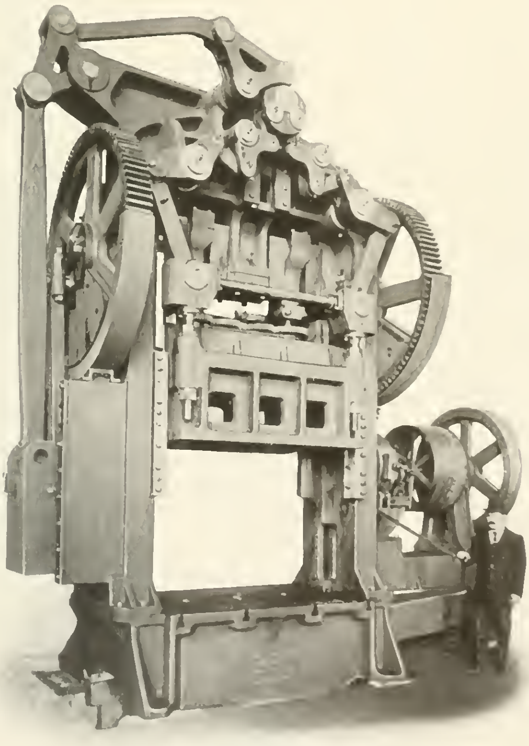


Fig. 1. Double-crank Double-action Toledo Toggle Drawing Press

sional strain to a minimum, especially on the wider patterns of double-crank machines. The mechanism used for transmitting power centrally to each of the two rocker shafts represents another new feature of this design. This also reduces the tendency toward torsional stresses between these shafts to a minimum, and simplifies the construction by only requiring power to be transmitted from the crankshaft on the left-hand side, thereby doing away with the additional driving mechanism required for transmitting power from both sides of the press.

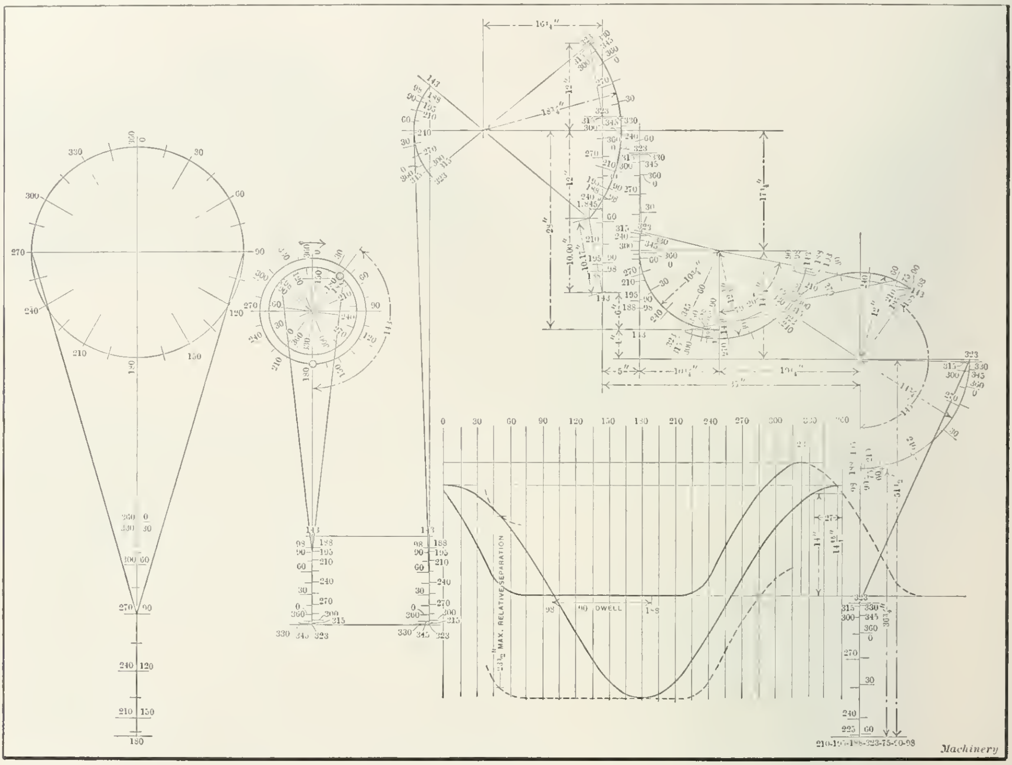


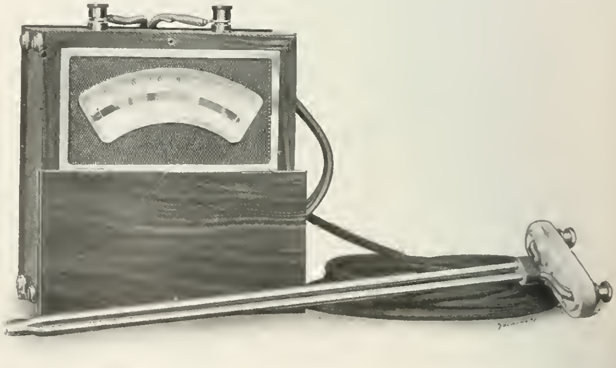
Fig. 2. Diagram showing Dwell of Blank-holder during the Drawing Operation

These new features, combined with the Toledo patented toggle movement—as used on the Toledo single-crank presses—give another advantage to this machine. The application of practically the same mechanical features on the double-crank machines that are used on the single-crank presses of this company's manufacture, provides for the absolute rest or dwell of the blank-holder during the drawing operation, through over 90 degrees of the plunger travel, as indicated by the diagram shown in Fig. 2. The advantages of this are twofold and may be briefly mentioned as follows: First, it facilitates drawing operations, especially on the finer gages of metal, and in such cases this feature is really essential to the attainment of satisfactory results. Second, any slight movement of the toggle arm and joint pin under the heavy pressures that are applied, not only caused a variation in the pressure applied during the dwell by the preceding forms of toggle movements which were used for this purpose, but also resulted in extreme wear on the pins. This difficulty has been entirely eliminated by the provision of the absolute rest or dwell which is obtained with the present type of machine.

This press is built in a variety of sizes and capacities and with any required width between housings. The machine illustrated in connection with this article has a width between housings of 84 inches; a plunger stroke of 29 inches; and a blank-holder stroke of 18 inches. The complete weight of the machine is 135,000 pounds.

BROWN MOLTEN METAL PYROMETER

The Brown Instrument Co., Philadelphia, Pa., has placed on the market an improved type of thermo-electric pyrometer which is intended for measuring the temperature of such metals as copper, brass, aluminum, bronze, etc., in the molten condition. This pyrometer represents the result of experiments which have been conducted with the view of producing a thermo-electric couple that is capable of withstanding the action of molten metals for a reasonable length of time. The couple finally adopted for this purpose is made of nickel-alloy



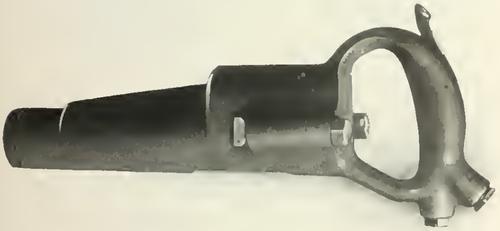
Brown Pyrometer for measuring Temperature of Molten Metal rods ¼ inch in diameter. The thermo-couple is plainly shown in the illustration, and on account of the large cross-section its life has been greatly increased.

A high-resistance portable indicating instrument is used in connection with this couple. The high resistance of the windings of this instrument makes its readings unaffected by changes in the length of the wire connecting it with the thermo-couple. In designing, the requirements of practical work have been borne in mind, and the construction has been worked out along lines which will enable it to be used in the foundry without danger of damage. The possible advantages of using a pyrometer in foundry work are quite generally recognized, but the delicacy of many forms of these instruments has been the cause of most practical foundrymen refusing to install them.

In using the present type of pyrometer, the thermo-couple is inserted in the molten metal before pouring. The temperature is obtained instantly in this way, and when it has once been definitely determined what constitutes the proper temperature of any metal for a particular class of work, the foundry can secure uniform castings of high quality by pouring them all at the proper temperature.

"LITTLE DAVID" RIVETING HAMMER

An improved pneumatic riveting hammer has recently been brought out by the Ingersoll-Rand Co., 11 Broadway, New York City, which has some novel features. The valve chamber is independent of the piston chamber which permits of the use of pistons of different lengths without the liability of valve breakages, so common in pneumatic hammers where the piston travels through the valve, or where the construction is such that the valve travels in line with the piston and is shifted by the piston compression. The grip-handle is of liberal size, and has a single lever throttle with a long bearing. The handle is attached to the cylinder by means of two bolts which are parallel to the cylinder on the sides. This insures perfect locking of the handle to the cylinder and precludes the necessity of using a vise or other mechanical device for holding the tool when taking it apart. This feature is especially convenient for structural iron workers who are not always equipped with the proper facilities for repairing tools. The hammer can be taken apart on the floor or the bench, and the only appliance necessary is a wrench for removing the nuts on the bolts. There is only one large port in the cylinder, which is equal in volume to the usual multiple port construction, but eliminates the liability of clogging.

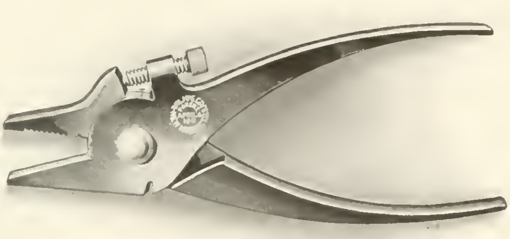

Ingersoll-Rand "Little David" Riveting Hammer

The hammer is shorter in length than other makes with a like stroke. It is light in weight, easy to handle, and has a very sensitive throttle control, making it specially suitable for drift pin work. The hammer is made in two sizes. The No. 60 has a 6-inch stroke and a capacity for driving rivets up to ⅞ inch in diameter. The No. 80 has an 8-inch stroke and is suitable for driving rivets up to 1¼ inch in diameter. The cylinder and handle are drop-forged, and all wearing parts are hardened. Another important feature is the sand blast finish on both the cylinder and handle which overcomes the hand slippages so frequent with hammers with a polished surface.

WEST HAVEN PLIER-WRENCH

The illustration shows a patented plier-wrench which has been placed on the market by the West Haven Mfg. Co., New Haven, Conn. This tool is made of drop-forged, tempered steel and has a set-screw on the arm by which the jaws may be set to any size within the range of the tool. By this means, all the back strain of the plier arms is taken by the set-screw. When used in this way, the tool constitutes a convenient form of wrench which will grip and release round material, working like a ratchet.

When it is required to use the tool as an ordinary pair of pliers, the set-screw is turned back where it is entirely out of the way. As part of the face of one jaw is milled crosswise, and the other is smooth with a groove milled lengthwise, this adapts the pliers for securing a firm grip on the end of a wire.


West Haven Plier-wrench for use as a Wrench or Pliers

This plier-wrench is especially useful in machine shops and garages, and it also constitutes an all-around handy tool for plumbers, electricians, and metal workers. It is made in two sizes, and either nickel-plated or finished black. The No. 8 tool is 6½ inches long and has jaws which open 1 inch. The No. 18 tool is 8½ inches long and the jaws open 1½ inch.

MUMMERT-DIXON OIL-STONE GRINDER

Mummert-Dixon Co., Hanover, Pa., has brought out an oil-stone grinder which is adapted for use in machine shops—particularly in the tool-room. Two oil-stone wheels are mounted on the front arbor of this machine, one wheel being coarse-grained and the other fine. There is a tool-rest at the front of each wheel, which can be easily adjusted to any desired angle and held in that position by a convenient locking device. The machine is particularly adapted for grinding lathe and planer tools and machine scrapers. For this purpose the coarse oil-stone wheel is used for the preliminary part of the grinding operation, and the fine wheel produces the final edge.

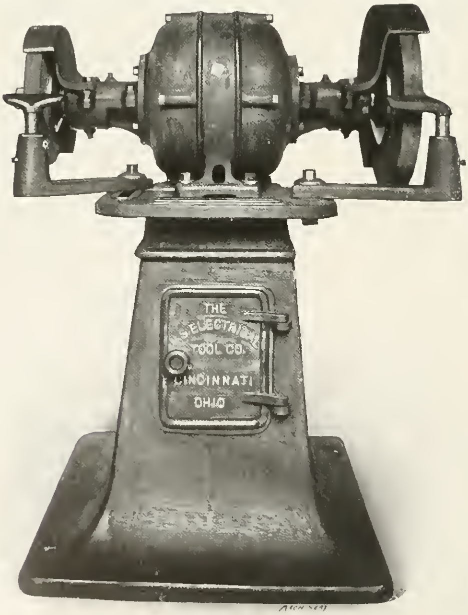
Mummert-Dixon Grinder with Oil-stone Wheels

Kerosene oil is used on these wheels, which prevents any tendency for them to "glaze," and also protects the tools from undue heating during the grinding operation. The oil is delivered to the stones by a small rotary pump which draws it from a reservoir in the base of the machine. The oil-stone wheels are cup-shaped and the oil is directed against the inside of the wheel; it then penetrates through the pores of the stone to the outside. When the wheels have become saturated they require very little oil to keep them in working order. Guards are used to prevent the oil from being thrown off the wheels and any surplus oil is caught in the pan and returned to the reservoir.

A ring emery wheel is carried by an arbor at the back of the grinder, and a slide table is provided at the side of this wheel for holding the work. The slide is provided with micrometer adjustments and the slide table may be adjusted to any angle. A great variety of work, such as hand filing operations, can be handled by this part of the machine much more quickly and accurately than they could by hand. A rest is provided so that the periphery of the wheel can also be used for grinding. This ring wheel runs at four times the speed of the oil-stone wheels. The machine may be adapted for motor drive, in which case a motor is placed in the base and connected to the pulley by a belt.

U. S. ELECTRIC GRINDER

The motor-driven grinding machine illustrated herewith is a product of the U. S. Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio. This tool is made with either direct- or alternating-current motor drive. The alternating-current grinder is driven by a motor adapted for operation on 220–440 volt circuits of twenty-five- or sixty-cycle, two- or three-phase. The machine driven by direct-current motor is adapted for 110–220 volt circuits.



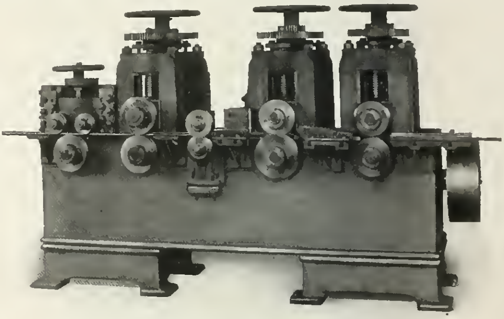
Electric Grinder made by the United States Electrical Tool Co.

The advantage of the direct motor drive on this tool lies in the fact that it is easily installed and may be located in any position in the shop, where it is most convenient. The absence of belts, shafts, and shaft-hangers provides clearance for overhead cranes, and also does away with the obstruction of light in the shop. The bearings of a direct-connected grinder are also relieved from the strain due to belt pull, which increases the efficiency of operation and reduces wear in the bearings.

Referring to the illustration it will be seen that the motor is completely enclosed and equipped with a heavy shaft and large dustproof bearings which insure reliable operation and minimum wear. The bearings are of the ring-oiled type. The design of the motor is such that no starting box is required. The machines are built with motors of three and five horsepower. The three-horsepower machine operates at 1800 revolutions per minute and is equipped with 12 by 2 inch emery wheels. This machine is 36 inches in height from the floor to the center of the arbor, and has a weight of 575 pounds. The 5-horsepower machine operates at 1120 revolutions per minute and is equipped with emery wheels 18 by 3 inches in size. The machine is 36 inches in height from the floor to the center of the arbor and has a weight of 875 pounds.

ETNA TUBE ROLLING MACHINE

The Etna Machine Co., Toledo, Ohio, has recently placed on the market a tube-forming machine which is used for rolling tubes into shape ready to have the joints brazed. The illustration shows the machine with a tube in course of production between the rolls. It will be seen that the ribbon stock, from which the tube is made, is fed between the forming rolls from right to left. In passing between the successive rolls, the stock is formed to the required shape, the ends abutting against one another. The machine is only intended for the production of butt-end tubing.



Etna Rolling Machine for forming Butt-end Tubing

NIAGARA CURVING AND FORMING MACHINE

The illustrations show a forming and curving machine for forming corrugated material, for culverts, sewers, etc., which was recently built by the Niagara Machine & Tool Works, Buffalo, N. Y. In designing this machine the intention was to produce a substantial and rigid construction, and at the same time provide all conveniences for adjusting and operating to obtain a maximum output. The machine will handle work as heavy as No. 10 gage standard galvanized sheets;

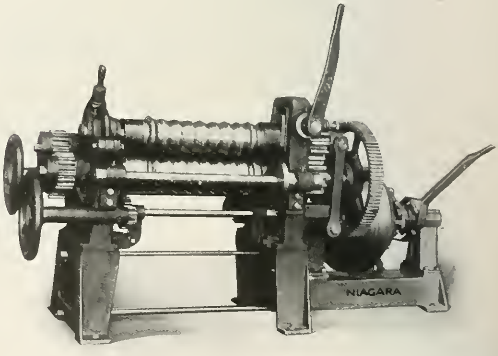


Fig. 1. Forming and Curving Machine for making Corrugated Cylinders

and it will not only curve them, but reshape the ends at the same time to make the different sections interlocking.

The arrangement of the rolls is shown in Fig. 2. They are forged from high-carbon steel, and made in one piece with the exception of the forming collars on the ends, which are removable. The two front rolls, as well as the rear roll, are driven by pinions and connecting gears made of steel, which have teeth cut from the solid. The lower and the rear roll can be raised and lowered by a handwheel on the left-hand side of the machine, and the upper roll can be raised by a lever on the right-hand side, to remove formed cylinders. The machine is double back-geared, the motion being controlled by a hand lever operating a powerful friction clutch. All bearings are bronze bushed. The outside diameter of the rolls is 7½ inches, and the diameter in the bearings 3½ inches. The machine weighs 4500 pounds.

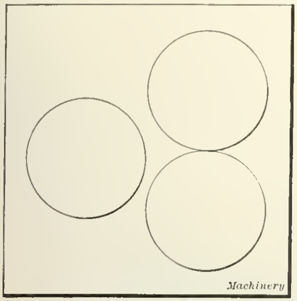
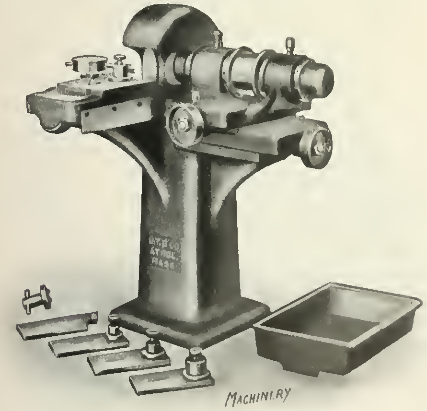


Fig. 2. Diagram showing Arrangement of the Rolls

UNION TWIST DRILL CO.'S FORMED CUTTER GRINDER

The machine shown in the accompanying illustration is a recent product of the Union Twist Drill Co., Athol, Mass., and is known as the No. 1 formed cutter grinder. This machine is designed for grinding formed cutters radially so that the cutter runs true and each tooth does its proper share of the work. Referring to the illustration, the cutter which is to be ground is mounted on the vertical arbor shown on the table of the machine adjacent to the wheel. To the left of the cutter there is an indicator which comes in contact with the relieved face of the tooth. When the radial face of one of the teeth has been ground, the reading of this indicator is noted. The work is then rotated to bring the next tooth into position for grinding, the cutter being adjusted to obtain a corresponding reading of the indicator to that at which the preceding tooth was ground. By this means the work is indexed to the required position. The successive teeth of the cutter are indexed and ground by this means. A small handwheel will be seen on the slide, upon which the work is mounted; this wheel provides for adjusting the slide in the desired position.



Machine for grinding Radial Faces of Cutter Teeth

It will be seen that two thumb-wheels are provided for securing longitudinal and transverse travel of the wheel. When the work has been indexed, the thumb-wheel for operating the transverse movement is brought into action and traverses the wheel up to the work. The longitudinal traverse wheel is used for truing the wheel. For this purpose, a diamond is mounted inside the wheel guard in line with the axis of the arbor upon which the work is mounted. When it is desired to true the wheel it is merely necessary to traverse it up against the diamond which trues the face that grinds the radial surface of the tooth.

The countershaft used with this machine has tight and loose pulleys six inches in diameter by 1½ inch face, and runs at a speed of 450 revolutions per minute. The grinding wheel used is 5 inches in diameter and a dust pan is provided for receiving the dust from the wheel when the machine is not connected to an exhaust fan. Work arbors are provided for carrying cutters having holes ⅜, ½ and ⅝ inch in diameter. The regular equipment of the machine includes a diamond for truing the wheel and a gage for setting the work in position for grinding. The net weight of the machine is 65 pounds.

S. K. F. BALL-BEARING HANGERS

The S. K. F. Ball Bearing Co., 50 Church St., New York City, is now placing on the market a new type of ball bearing line-shaft hanger of strong and simple design. The box containing the self-aligning ball bearing is suspended in the hanger frame on four adjusting screws, providing for lateral and vertical adjustments. The boxes are made in a single piece, accurately machined for the reception of the ball bearings and provided with a suitable face cap; the assembled box forms a large lubricant chamber with grooves adjacent to the shaft for the retention of the lubricant. The ball bearings themselves provide the alignment feature within the hanger box. The outer race is ground in the form of a sphere whose center is at the center of rotation of the bearing, and the inner race and double row of balls act within this spherical race in a manner similar to the familiar ball and socket joint.

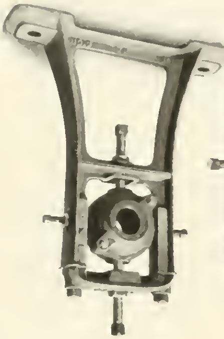


Fig. 1. Hanger designed for Attachment to Ceiling

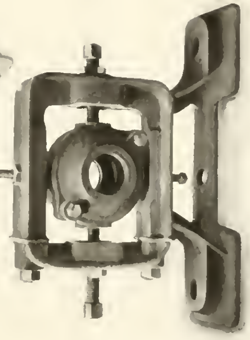


Fig. 2. Hanger for Attachment to Wall or a Post

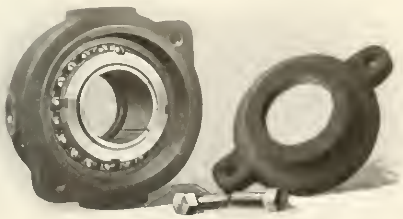
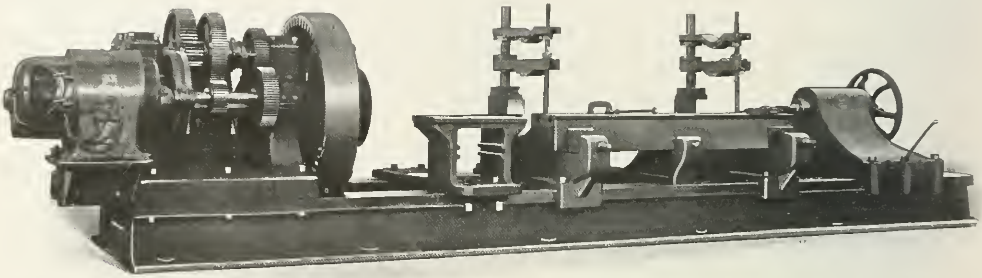


Fig. 3. S. K. F. Bearing used in Hangers

In case a shaft springs under load, the bearings adjust themselves to the deflection, at the same time maintaining a uniform circle of rotation for the balls. The bearing is of the familiar S. K. F. self-aligning type fitted with an adapter.

This consists of a taper sleeve and locking nut which secures the bearing rigidly in position on the shaft.

A series of careful experiments has established the fact that the amount of power that may be saved by operating lineshafts on ball bearings will range from sixty per cent to ninety per cent of the power required to drive the shafting alone. The various causes of friction in lineshafting are: misalignment, lack of proper lubrication, insufficient protection of the bearings against the intrusion of grit or shop dust and heavy belt tension on the driving or service pulleys. While ordinary lineshafts operate at speeds anywhere from 100 to 300 R. P. M. and are usually limited to these speeds, shafts running in ball bearing hangers may safely be run as high as 600 to 1000 R. P. M. without danger of heating, and with a considerable reduction of pulley sizes, shaft sizes and weights, and a consequent reduction of belt sizes and costs.

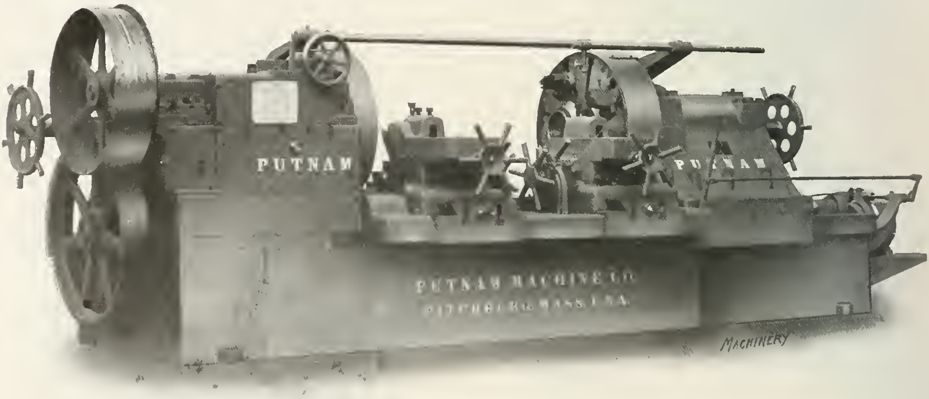


Garrison Lathe designed for Use in Steel Foundries and Roll Shops

Ball bearing hangers also reduce the lubrication required. The reason for this is that ball bearings require lubrication only at infrequent intervals, and the construction of the bearing boxes in the S. K. F. hanger frames is such that the leakage of lubricant is done away with. This factor, besides effecting a saving in the amount of lubrication used, introduces a large saving in the maintenance costs.

GARRISON LATHE FOR TURNING STEEL CASTINGS

The lathe shown in the accompanying illustration was designed for use in steel foundries and roll shops, where the greater part of the work consists of turning large steel rolls and pinions. This is a particularly severe class of service and the machine which can handle it satisfactorily must be of massive construction. With these requirements in view, the A. Garrison Foundry Co., Pittsburg, Pa., has brought out a lathe in which the bed is made of the double box type and strongly ribbed to secure the required rigidity. The machine swings 50 inches over the necking rest and 62 inches over the ways, and has a total weight of 84,000 pounds.



Putnam Lathe designed for turning Coach-wheels

The distinctive features of the design of this lathe may be briefly outlined as follows: There are no over-hanging gears, all of the wheels being between the two bearings on the headstock. All of the shafts can be lifted out independently without disturbing the others. The heavy driving gear for the faceplate pinion is located next to the front bearing of the headstock, and this design eliminates any spring which might be produced in this shaft. The main pinion is so located that the pressure on the shaft is down and not against the cap. All of the gears are of steel and have cut teeth, with the exception of the faceplate gear which is of air furnace iron. The motor gears are of the double spiral type. An iron gear guard, which is not shown in the illustration, completely covers all of the gears. This guard can be quickly removed when it is necessary.

The chief dimensions of this machine are as follows: Length of bed, 30 feet; maximum distance between centers, 21 feet; number of gear reductions from the motor to the faceplate, 5; total gear reduction (not including motor gears) 1 to 220; motor horsepower (continuous rating) 30 to 40; motor speed 550 to 1100 revolutions per minute.

PUTNAM FORTY-TWO INCH COACH-WHEEL LATHE

The 42-inch lathe illustrated in this connection is a recent product of the Putnam Machine Co., Fitchburg, Mass. This machine has been designed for turning coach-wheels, and with a view of adapting it to the severity of this class of service the construction has been made particularly massive. This fact will be readily appreciated when it is known that the weight of the machine is 80,000 pounds. Referring to the illustration it will be seen that the machine is equipped with a single-pulley drive, and six mechanical speed changes are provided. The lathe is adapted for either motor or belt drive.

Among the features of this lathe the following may be mentioned. The journal boxes supporting the main driving shaft are self-oiling. Flat chains are used to run over the shaft and the supply of lubricant which is carried up from the reservoir in this way insures keeping the bearings flooded. The journal boxes are piped on the outside of the machine for replenishing the oil supply. The Putnam patented non-slip equalizing driving dog is used on this machine, as well as on the double-headed driving wheel lathe of this company's manufacture. This dog is positive in action and each dog exerts the same driving force, thereby avoiding the danger of springing the tire more at one point than at another. This dog automatically adjusts itself to the load; and its driving force is not fixed but is always relative to and in excess of the resistance. The only adjustments which need to be made on this dog are to release it from the latched position after the wheels have been mounted in the lathe. The customary T-bolts and straps are furnished with the dogs, but the tires of many classes of wheels can be turned without them.

The Putnam combination tool-slide which is used on this lathe adds considerably to the efficiency of its operation. A tire may be finished in two operations and without requiring a change of tools except in cases where a tool-failure occurs. In such a case the damaged tool may usually be replaced while the other tool is working at its normal capacity. One roughing and one forming tool are mounted side by side in this carriage and either tool is readily detachable for the insertion of another tool in its place. The movement of the tailstock is provided for by a simple motor-driven mechanism. The tailstock is moved along the bed by a massive screw and nut and this movement is stopped when the wheels are in position, by an adjustable brake band which comes into action and allows the drum to slip.

LANGELIER SWAGING MACHINE FOR WIRE SPOKES

An improved type of automatic swaging machine designed and built by the Langelier Mfg. Co., Providence, R. I., for swaging wire automobile wheel spokes is shown in Fig. 1. It takes the wire from the coil, straightens it before entering the machine, swages the spokes between butts and cuts them off to length after swaging, all operations being entirely automatic and absolutely without waste or manual handling. The relative lengths of blank and finished spoke are shown in Fig. 2.

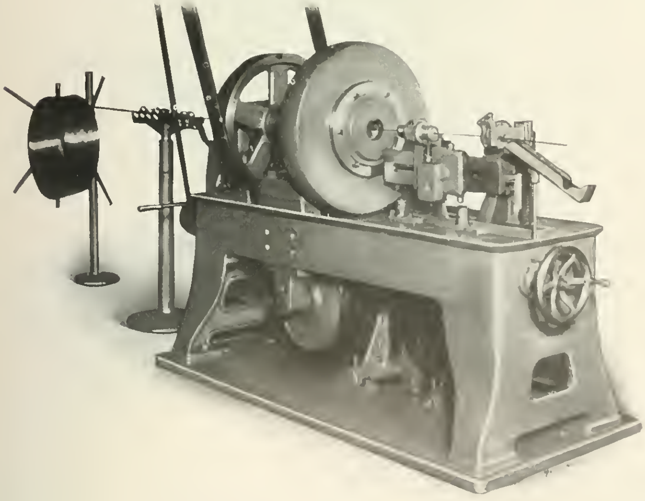


Fig. 1. Langelier Swaging Machine for making Wire Spokes for Automobile Wheels

This machine has a very high output. On ordinary automobile wire wheel spokes, the output is as high as three spokes a minute, all straightened, swaged and cut off. This is obtained by eliminating all time losses between operations. While one spoke is being swaged, a finished spoke is being cut off. The coil of wire is supported on a reel resting on the floor (shown at the extreme left in the illustration) from which it unwinds as the wire is drawn through the straightener on its way to the swaging machine. This straightener is an improved design of the rotary type of wire straighteners built by this company. It has off-set steel eyelets mounted on ball bearings in suitable holders, so designed that the off-set eyelets do not bear in an unyielding manner against the passing wire but revolve without marring its finish. Once properly adjusted to the correct off-set, these eyelets very seldom require adjustment, as no perceptible wear occurs until they have been long in use.

The wire enters the special swaging machine through the rear end of the hollow spindle carrying the dies, and as it is drawn through, these swaging dies close automatically over the wire, after allowing the portion forming the butt to pass out of them. A number of sharp blows are applied on the stock simultaneously from diametrically opposite directions, reducing it rapidly and giving it a sort of "hammer temper," for the distance between the butts. The dies then open automatically, allowing the portion of wire forming the opposite butt to pass out of the machine unswaged.

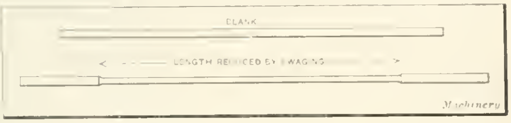


Fig. 2. Diagram showing Blank and Finished Spoke

The outward travel of a saddle with the chuck mounted on a horizontal slide in front of the machine head draws the wire through. This saddle is provided with a rack, seen projecting at the end of the slide in Fig. 1, in which an oscillating segment gear meshes. This gear is set in motion by a face cam and roller underneath the bed of the machine. The connection between the segment and the cam roll lever is obtained by means of a special form of link having a right- and left-hand nut (readily reached and locked from the rear), which upon being adjusted vertically, varies the centers of the link pins. This increases or decreases the arc of travel of the segment gear, and varies the travel of the saddle on the horizontal slide above the bed, thus producing spokes of different lengths and with different swaged portions between the butts. The wire-gripping chuck, carried by the saddle, closes on the wire for the outward or drawing stroke and releases it at the end of the stroke, the wire being entirely clear during the return of the chuck to its starting position for drawing out the next spoke. The automatic operation of the chuck is obtained through the up or down action of a wedge, actuated by the saddle as it reaches its extreme points of travel. At the end of this outward stroke, the wire is gripped firmly in the cutting-off attachment while the saddle returns rapidly to take the next spoke forward and the finished swaged spoke is cut off just before the next drawing stroke begins.

The cutting-off attachment consists of two hardened and ground steel bushings, whose two cutting faces are in close contact and slide past each other rapidly at the proper time. The swaged spoke is cut off with an almost perfect shear, and without any deformation of the wire, the ends being sharp and square with the wire. Forced oil lubrication to all running parts and to the dies is maintained by an automatic oil feed pump. Other types of wire feeds besides that described are also put on to suit different maker's spokes, and the machine is built for either belt or motor drive. The net weight is about 5500 pounds and the floor space occupied about 3 by 6 feet.

Have You a Job of Grinding

If you have, a suitable machine for the work is the

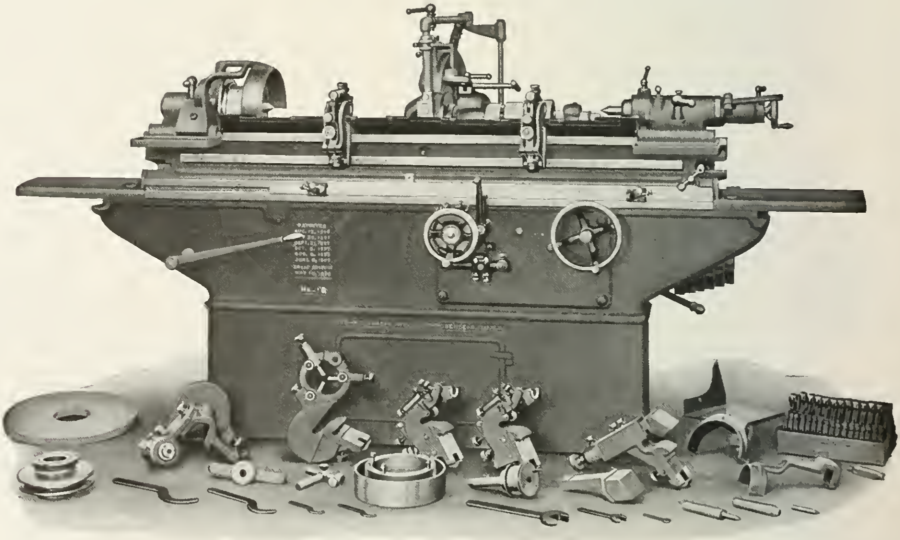
No. 14 Plain Grinding Machine

This machine swings 10″ diameter and takes 48″ length.

It is rigid in design and all alignments are correct—features that insure accurate work under heavy manufacturing cuts.

Rapid production is possible due to two important mechanisms—the automatic cross feed and universal back rests. By means of these work is quickly ground to accurate duplicate size with minimum attention from operator.

The machine is convenient for the operator. All levers and handwheels are within easy reach from the front. Work centers are at a convenient height.

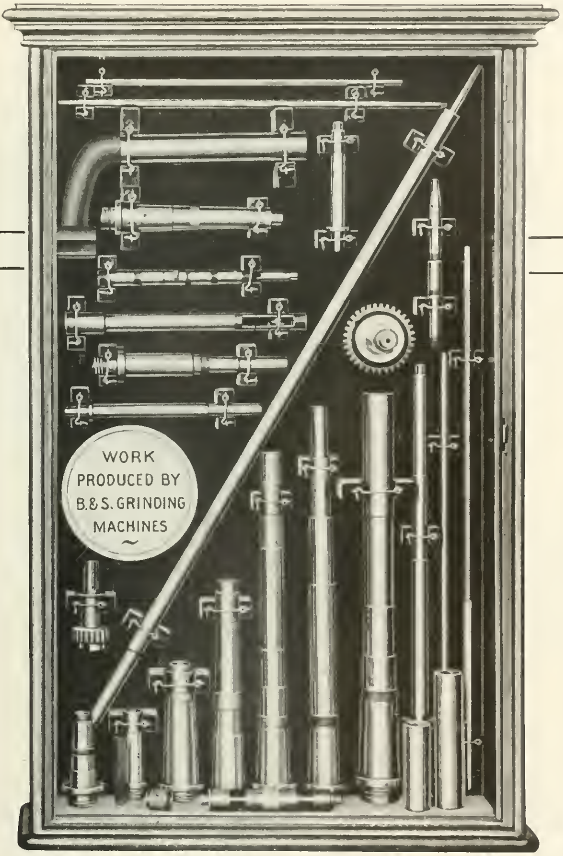


Brown & Sharpe Mfg. Co.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-30 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

Similar to Any in This Case?



Look over the pieces carefully. There are long slender shafts requiring careful support, long and short pieces of large diameter on which heavy cuts are taken, taper bearings on spindles, irregular shaped work such as shown near top of case, etc.

Note composite piece at bottom of case, consisting of hard steel, hard rubber, cast iron, aluminum, bronze, mica and soft steel. All ground equally well on the No. 14 machine.

Providence, R. I., U. S. A.

Canadian: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

Foreign: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain. F. W. Horne Co., Tokio, Japan, L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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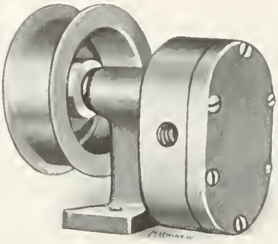
BICKFORD GEARED OIL PUMP

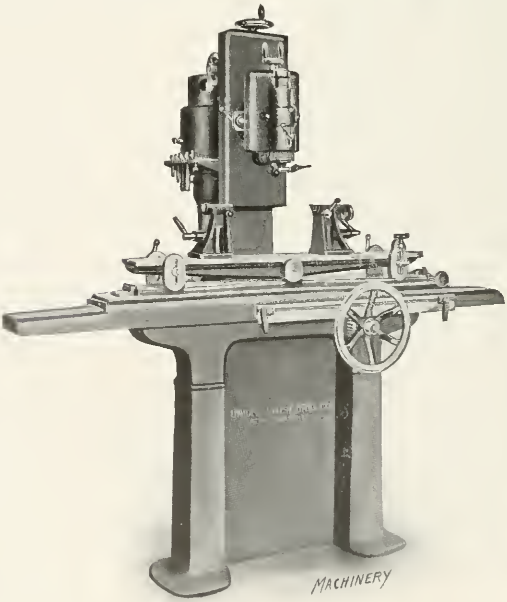
This pump has been brought out by the Bickford Machine Co., Greenfield, Mass., to meet the demand for an inexpensive device for supplying lubricant to cutting tools. The pump is of the regulation geared type, its main feature being the compactness of its design, together with the use of a special form of internal stuffing box which allows the main bearing to extend right through the pulley. It is tapped to receive a ⅜-inch pipe and will deliver oil or water at an equal rate, the capacity being 12 quarts per minute when the pump is running at 500 revolutions per minute.


Bickford Geared Oil Pump

CUTTER AND REAMER GRINDER

The Union Twist Drill Co., Athol, Mass., has recently placed on the market the cutter and reamer grinder shown in the accompanying illustration. This machine is designed for grinding straight or spiral milling cutters, face mills, end mills and straight or taper reamers. Suitable fixtures can be furnished for use in connection with this machine, which adapt it for sharpening face mills and side teeth of side mills; a fixture can also be supplied which enables the machine to grind end teeth of end mills.

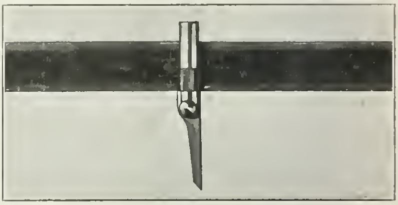
The machine has a capacity for grinding cutters up to 12 inches in diameter on centers, or reamers up to 24 inches in length. The cup form of wheel used on this machine is mounted on the vertical spindle shown in the illustration. This spindle is of hardened and ground steel, and runs in bronze boxes which are provided with means for making adjustment for wear. The cup form of wheel used gives a flat clearance and a stronger cutting edge than that resulting from the use of a disk wheel. The countershaft which is used in connection with this machine has tight and loose pulleys six inches in diameter by two inches face and is intended to be operated at 700 R. P. M. The machine occupies a floor space of 35 by 96½ inches. The regular equipment includes a countershaft, wrenches and an emery wheel. The net weight of the machine is about 1500 pounds.



Union Twist Drill Co.'s Cutter and Reamer Grinder

ALVAN HEIGHT GAGE

The illustration shows an attachment for a combination square which adapts this type of tool for use as a height gage. This attachment is a product of the Alvan Mfg. Co., 306 14th Ave., Newark, N. J. It consists of a hardened and ground jaw or blade which is secured to the scale of the combination square by an eccentrically located taper locking stud which is carried by a semicircular saddle piece. In adjusting the blade of the height gage attachment to any required position, the stud is partially loosened. When the saddle piece is secured in this way, a steady movement can be secured which enables the attachment to be brought to exactly the required position without delay. Ample compensation is provided for any variation in the width of the blade of the square on which the attachment is used.


Alvan Height Gage Attachment for a Combination Square

When this attachment is used as a height gage for testing and gaging surfaces or scribing lines, the stock of the combination square constitutes the base of the gage. Used in this way, the attachment adapts an ordinary combination square for such work as laying out, scribing lines, transferring dimensions, testing and gaging surfaces, etc., on pieces set on a surface plate, planer, shaper or milling machine. A pair of these attachments used in conjunction with the square stock still further increases the scope and usefulness of the tool.

Where two of these attachments are mounted on the blade of a combination square, they form a beam caliper and can be used for making either inside or outside measurements. In laying out from a given edge or shoulder on surface work, this attachment is of particular value.

BICKFORD BENCH GRINDER

This small combination disk and wheel bench grinder was designed by the Bickford Machine Co., Greenfield, Mass., to meet the requirements of small shops that could not afford a larger machine. It carries a 9-inch disk-wheel at one end of the spindle and any wheel at the opposite end having a ½-inch hole and a diameter up to 8 inches. A single flat rest is provided for the disk-wheel which is adjustable so that work may be ground either square or beveled. A plain rest is provided for the wheel, which is set ¼ inch below the center of the

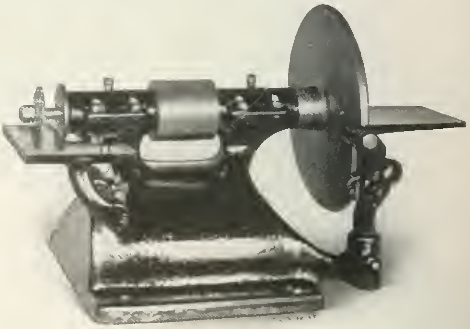
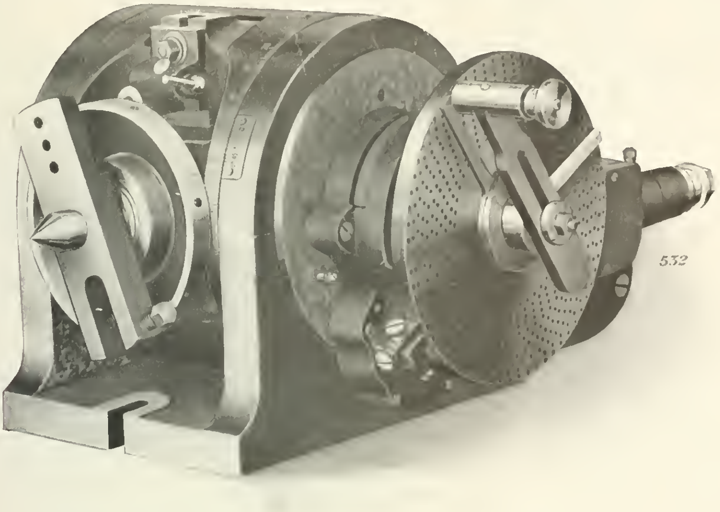


Fig. 1. Bickford Combination Disk and Wheel Bench Grinder

The Dividing Head is the Most Important Feature of a Universal Tool Room Milling Machine



All of our Universal Millers, both the Cone-driven type and the High Power Single Pulley Drive Machines are equipped with our Remarkably Rigid Universal Dividing Head.

Our design is simple and of proportions commensurate with the capacity of the High Power Machines.

For example—on a 12-inch Head the trunnions on which the spindle swings when setting for angular work, are 8½″ diameter; the spindle is 3½″ diameter in the front bearing.

There is a Front Index Plate for Direct Indexing any number that will divide evenly into 24, 30 or 36.

This is especially handy for indexing low numbers as when milling reamers, taps, etc.

The Direct Index is always ready for immediate use because the change from Universal Indexing to Direct and back again when the job is finished, is made in a few seconds without loosening anything or disturbing any adjustments.

The Side Index Plate is 8 13-16″ in diameter. It will index all numbers to 60, all even and those divisible by 5 to 120, and meets all usual requirements to 400.

And for the occasional job of Indexing High Odd Numbers, our High Number Indexing Attachment enables you to get the division you want, by Simple Indexing from plates without compounding or the use of special gearing.

This method of Indexing High Numbers has the further advantage of being applicable to angular work and such large work that can only be done with the Dividing Head Spindle in a vertical position.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

spindle and arranged to support work held on either side of the wheel. This arrangement makes a useful combination of disk and tool grinder for the tool-room or jobbing shop. The spindle is ¾ inch in diameter and runs in ring oiling adjustable bearings; it is driven by a 2½-inch belt.

A special countershaft has been designed for use with this machine, which is operated by a pull cord. A disk (not shown) is mounted beside the large disk on the countershaft and operates it by means of four teeth on each disk. The coil spring mounted on the rod carrying the belt loop keeps an arm on this rod in contact with a lug on the larger disk. The arrangement is such that ¼ revolution of the disk will shift the belt either off or on the driving pulley. A tension spring returns the smaller disk to the original position, so that continuous pulls of the cord shift the belt back and forth. The tight and loose pulleys are 5 inches and 4½ inches in diameter and the driving pulley is 13 inches in diameter; all of the pulleys have a face width of 2½ inches.

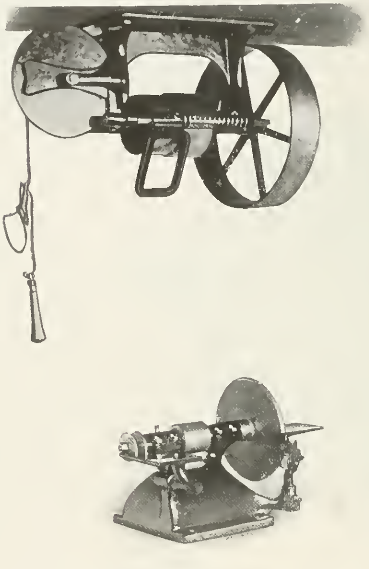


Fig. 2. Bickford Bench Grinder and Countershaft used to drive it

NEW MACHINERY AND TOOLS NOTES

Pliers: Utica Drop Forge & Tool Co., Utica, N. Y. These pliers are provided with a joint of the box type which affords support at each end of the hinge. One jaw is curved and the other flat and the pliers afford a parallel grip for all sizes of work within their range.

Hardness Testing Machine: Pittsburg Instrument & Machine Co., Pittsburg, Pa. A hardness testing machine which is based on the Brinell principle. The work is carried by a support, and a steel ball of 0.4 inch diameter is forced down upon it by a hydraulic press.

Power Hammer: Fairbanks Co., New York City. Leather straps have been eliminated from the design of this hammer, steel side arms and a spiral spring being employed to furnish the necessary elasticity. This hammer is built in two styles for either belt or direct-connected electric motor drive.

Tool-holder: Ready Tool Co., 654 Main St., Bridgeport, Conn. The important feature of the design of this tool-holder consists of a half round section of tool steel which is electrically welded to the body of the tool-holder and forms a bearing for the cutter. The body of the tool-holder is made of drop-forged chrome-nickel steel.

Small Grinding Machine: Ransom Mfg. Co., Oshkosh, Wis. Four sizes of small grinding machines which are made to carry wheels 8 by 1, 10 by 1½, 12 by 2, and 14 by 2½ inches in size. These machines can be equipped with wheel guards which may be removed when it is desired to use buffing wheels on the machines.

Hydraulic Pit Jack: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic pit jack having a capacity for lifting loads up to 10 tons and a rise of 103 inches. This jack is designed for such work as raising locomotive wheels and axles into position or lowering them when the axles are being removed from a locomotive.

Broaching Machine: J. N. Lapointe Co., New London, Conn. The machine is driven by a pulley 22 inches in diameter by 4½ inches face, and the driving screw is 3¾ inches in diameter by 1 inch pitch. Two geared speeds are provided by gears which run in an oil bath. Provision is made at the front end of the machine for attaching special fixtures.

Automatic Pinion Making Machine: Sloan & Chace Mfg. Co., Ltd., Newark, N. J. A machine designed for making pinions for watches, electric meters and similar mechanisms. The pinions are made direct from bar stock and the machine is able to make a complete pinion with a double cut, consisting of a roughing and a finishing cut across the teeth.

Hand Lathe: Grant Automatic Machine Co., Detroit, Mich. A hand lathe with the body and headstock cast in one piece and the spindle bearing lined with babbitt. The tailstock has both lever and screw feed, and the former may be instantly disconnected when it is required to use the handwheel or screw. The rest is clamped to the body by a single motion.

Keyless Drill Chuck: Gronkvist Drill Chuck Co., 20 Morris St., Jersey City, N. J. A chuck which consists of a knurled operating sleeve and a threaded shank which is slotted to receive three tapered jaws. The angle on the outside of the jaws and on the inside of a taper sleeve within the operating sleeve corresponds, and by turning the operating sleeve, the taper sleeve is forced in on the jaws, thus securing a firm grip on the work.

Three-spindle Cylinder Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. The machine is driven by a Westinghouse motor, providing spindle speeds of from 10.31 to 20.62 R. P. M. The drive to each spindle is through bronze spiral gears and a hardened steel worm. The main body of each spindle is 6 inches in diameter and the spindles run in bearings which are 29 inches in length.

Flexible Shaft: Plank Flexible Shaft Machine Co., Grand Rapids, Mich. A flexible shaft with a core made up of a number of small units. These units interlock in such a way that a continuous core can be assembled without the use of rivets or pins. This construction makes the units readily interchangeable for either varying the length of the shaft or for making repairs. The core is protected in the ordinary way by a spiral spring steel coil covered with leather.

Plain Milling Machine: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. This machine consists of a heavy-duty cone-type miller which has been manufactured by this company, in which an important improvement has been made by the application of quick traverse to the table. This effects a considerable reduction in the time ordinarily lost in non-productive motion. The quick traverse mechanism is an integral part of the machine and is built into the feed mechanism.

Fastening Bolt for Masonry: Paine Co., Corn Exchange Bldg., Chicago, Ill. A bolt adapted for fastening machinery to masonry or concrete. For this purpose a bolt of the usual style is provided with a split sleeve and a conical-ended sleeve between the nut and the head of the bolt. When the nut is screwed down it pushes the conical point of the upper sleeve into the split end of the lower sleeve, and in this way the split sleeve is expanded and secures a firm grip on the hole which has been drilled in the masonry.

Six-spindle Drilling Machine: Moline Tool Co., Moline, Ill. A six-spindle drilling machine driven by the spiral gear arrangement which has been applied on the machines of this company's manufacture. The heads are arranged for clamping in groups and means are provided for traversing the groups as required. This machine was especially designed for such operations as drilling railway frogs and switches, the work being clamped to T-slots in a vertical faceplate on the lower part of the column of the machine.

Large Compression Yoke Riveter: Hanna Engineering Works, Chicago, Ill. A large compression yoke riveter built for the General Electric Co., Pittsfield, Mass. This tool is to be used for riveting transformer cases. The riveter weighs 56,000 pounds, has a reach of 168 inches, a gap of 12 inches and exerts a pressure of 100 tons on the riveter for a pressure of 100 pounds in the cylinder. The Vulcan Engineering Sales Co., Chicago, Ill., is agent for this riveter, as well as the other products of the Hanna Engineering Works.

* * *

ANNUAL CONVENTION OF THE NATIONAL METAL TRADES ASSOCIATION

The fifteenth annual convention of the National Metal Trades Association was held in New York City, April 9-10 at the Hotel Astor, Mr. Henry D. Sharpe presiding. The program comprised the following reports and papers:

"Reports on Industrial Education," F. A. Geier, chairman;

"Apprenticeship," E. P. Bullard, Jr., chairman;

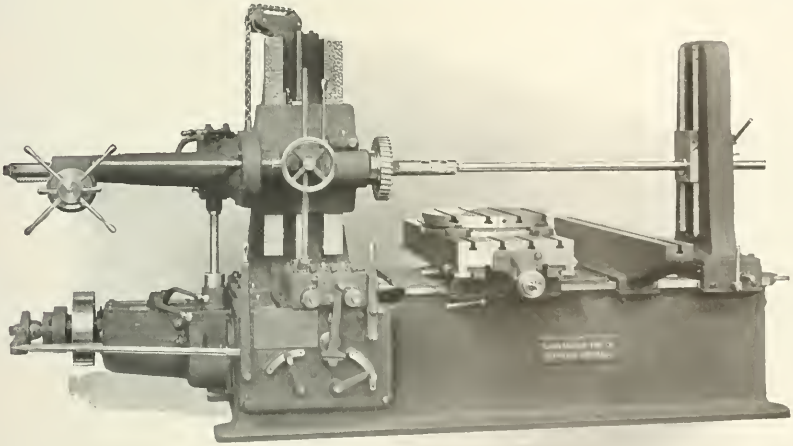
"Systematic Compensation for Industrial Accidents," Henry D. Sharpe, chairman;

We do not include a LIABILITY INSURANCE POLICY with the machine when we sell a

LUCAS "PRECISION"

BORING, DRILLING AND MILLING MACHINE

Because, WE DON'T HAVE TO



All the operating handles are so arranged with relation to each other that there is no probability of INJURY TO THE OPERATOR and he can't get in more than one feed at the same time, either.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst & Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

"Luck, Law and Industrial Accidents," by W. H. Doolittle, National Metal Trades Association's safety inspector;

"The Plea for Profit Sharing," by Maurice Barnett, of the Electro-Dynamic Co., New York City;

"Fire Prevention in Factories," by Lewis T. Bryant, Commissioner of Labor, State of New Jersey;

"Pension Plan for Employes," by William Lodge of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio;

"What's the Matter with the U. S. A.?," by Joseph W. Bryce of the *Square Deal Magazine*, Battle Creek, Mich.

The following officers were elected for the ensuing year: President W. A. Layman, Wagner Electric Mfg. Co., St. Louis, Mo. First vice-president, L. H. Kittredge, Peerless Motor Car Co., Cleveland, Ohio; Second vice-president, Herbert H. Rice, Waverly Co., Indianapolis, Ind.; Treasurer, F. C. Caldwell of H. W. Caldwell & Son Co., Chicago, Ill.

Mr. Robert Wuest, who has served the National Metal Trades Association so long and ably as its commissioner, has resigned on account of poor health and is succeeded by John D. Hibbard. The headquarters of the association will be removed from New England Building, Cleveland, Ohio, to the People's Gas Building, Michigan Ave., Chicago.

* * *

YALE & TOWNE NEW OFFICE BUILDING

Yale & Towne Mfg. Co. has removed its offices from 9 Murray St. to the new Yale & Towne building at 9 East 40th St., New York City, where a modern twelve-story building has been erected on a plot 50 by 100 feet. The company will occupy the entire building except three floors which will be rented. The new location was selected after a long and thorough investigation, as being the one best suited to meet the convenience of customers and to promote efficiency of management. It is in the center of the uptown section midway between the Grand Central and Pennsylvania railroad terminals in the heart of the hotel section and is easily accessible from all parts of the city.

New Yale & Towne Building.

The ground floor will be devoted to a series of exhibit rooms in which will be shown a large and effective display of locks and builders' hardware. The basement will contain the city salesroom, a large stock-room, and the repair department. The executive offices and directors' room will be on the twelfth floor, and the remaining floors will be devoted to the offices of department managers, treasurer and the large clerical force required for the business.

* * *

PERSONALS

Francis Auberty, of Paris, France, who has been in this country for over two years studying conditions and methods of manufacture in the machine tool business, sailed for home April 17.

Henry Jungerman has been appointed railway representative of Tate-Jones & Co., Inc., Pittsburg, Pa. Mr. Jungerman was formerly with the motive power and construction department of the Harriman Lines.

William J. Alles, night superintendent of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has resigned to take a position as assistant to Mr. J. S. Haynes, manager Dodge Bros., Detroit, Mich., beginning May 1.

Arthur S. Day, formerly manager of the Philadelphia office of Hill, Clarke & Co., Inc., has since April 1 been connected with the sales force of the Eveland Engineering & Mfg. Co., of Philadelphia, manufacturer of electric riveting machines.

Paul Lux of the Lux Model Works, Waterbury, Conn., has resigned his position as model maker of the Waterbury Clock Co. so that he may devote his entire time to the perfection of his line of special clock movements, spring motors, and other small gear mechanisms.

Oscar E. Perrigo, of Boston, Mass., delivered a lecture on the subject of rapid change gear devices before the Providence Mechanical Engineers' Association, Providence, R. I., March 25. As an introduction to the lecture, a brief history of the development of the lathe was given.

L. S. Starrett of the L. S. Starrett Co., Athol, Mass., received many congratulations April 25, which date was his seventy-seventh birthday. Mr. Starrett is the inventor of various machinists' tools, the first one being the combination square, now generally used by machinists, carpenters, etc.

A. L. Kern of the Studebaker Corporation, South Bend, Ind., who has been identified with that concern for a number of years in connection with the designing of dies and tools and the developing of a new steel frame dump wagon, has resigned his position. Mr. Kern has not as yet decided upon future plans.

George M. Harden, for a number of years treasurer of the Philadelphia Pipe Bending Co., Philadelphia, Pa., has resigned his position with that company, and will continue in the same line as district sales agent for the Whitlock Coil Pipe Co., Hartford, Conn. Mr. Harden has established offices at 518 Drexel Bldg., Philadelphia, for the sale of the various products of the company.

* * *

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WHICH IS STRONGER ?

A STAMPED OR A MILLED SCREW?

The H. S. & Co. Screws are made from sheet steel, stamped or "drawn up." Proper tests prove beyond a doubt that this method makes a stronger and tougher screw than one milled from the solid bar, owing to the position of the fibres of the steel. Well known proof of this is found in the comparative values of semi-finished nuts—those milled from solid rod not being as strong as the stamped goods.

In the solid bar screws, the surplus metal at the point at first appears to be advantageous, but in reality it is disadvantageous for the reason that the uniform thickness of our screws made from flat steel "died" out, permits a longer hold on the wrench and, therefore, a far better opportunity for tightening, while in the solid screw which is drilled and broached, it is necessary to turn in the surplus metal (resulting from the broaching) to the bottom of the hole, thereby partially filling the hole with nothing but waste material which has absolutely no holding power at all.

We invite comparative tests of the H. S. & Co. Hollow Set Screws with any other screws made having a hole or socket, and will supply FREE SAMPLES for this purpose, to reputable concerns.

Special Circular No. 3114 upon request.

HAMMACHER, SCHLEMMER & CO.
HARDWARE, TOOLS AND SUPPLIES
New York, Since 1848 4th Ave. and 13th St.

COMING EVENTS

May 15-16.—Semi-annual meeting of the National Machine Tool Builders' Association at the Hotel Astor, New York City. James H. Herron, secretary, 2041 East Third St., Cleveland, Ohio.

May 20-23.—Spring meeting of the American Society of Mechanical Engineers in Baltimore, Md. Hotel Belvedere, headquarters. Layton F. Smith, past president of the Baltimore Engineers' Club, chairman of the local committee. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

May 26-29.—Annual convention of the Master Boiler Makers' Association at Chicago. Harry D. Vought, secretary, 95 Liberty St., New York City.

May 26-31.—Convention of the Association Technique de Fonderie and foundry exhibition under its auspices in the premises of the Ecole Nationale d'Arts et Metiers, Paris, France. E. Ronceray, 9-11 rue des Envierges, Villa Faucheur, Paris.

June 10.—Departure from New York City, of American Society of Mechanical Engineers party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

September 17-23.—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, Mr. J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

October 10-17.—Eighth Annual Foundry and Machine Exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. Forty-five concerns were represented in the exhibition held in Buffalo last year. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago.

October 14-16.—Annual convention of the Allied Foundrymen's Associations. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

NEW BOOKS AND PAMPHLETS

Electrical Instruments and Meters in Europe. By H. B. Brooks. 88 pages, 6 by 9 inches. Published by U. S. Department of Commerce and Labor, Washington, D. C., as Special Agent Series No. 66.

Essentials of Electricity. By W. H. Timbie. 271 pages, 4¾ by 7 inches. 224 illustrations. Published by John Wiley & Sons, New York City. Price $1.25 instead of $1.50 as stated in the review notice in April.

Proceedings of the Twentieth Annual Convention of the International Railroad Master Blacksmiths Association. Edited by A. L. Woodworth, Lima, Ohio. 348 pages, 5½ by 8¼ inches. A. L. Woodworth, Lima, Ohio, secretary and treasurer.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson School of Technology, Potsdam, N. Y. Bulletin of information for 1913-14.

Syracuse University, Syracuse, N. Y. Bulletin of information for 1913 including the summer session from July 7 to August 15.

Armour Institute of Technology, Chicago, Ill. Bulletin of general information for 1912-13 on the courses in mechanical engineering, electrical engineering, civil engineering, chemical engineering, fire protection engineering, architecture, etc.

Columbia University, New York City. Bulletin of information on summer session for 1913 comprising courses in agriculture, architecture, metallurgy, chemistry, civil engineering, electrical engineering, mechanics, mechanical drawing, etc.

New Haven Manufacturers' Exhibit Association, New Haven, Conn. Souvenir book of New Haven Manufacturers' Exhibit Association illustrating booths and exhibits of goods shown in the association's permanent exhibit by the manufacturers of New Haven.

University of Wisconsin, Madison, Wis., announces that the thirteenth annual six weeks' summer school of the College of Engineering will open June 23. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying; other subjects may be taken in the College of Letters and Science. The university issues a bulletin on the summer school which may be obtained from F. E. Turneaure, dean of the university.

Buyer's Club of America, is an organization proposed by H. E. Gilman of the Marathon Motor Works, Nashville, Tenn., to bring closer together those connected with the purchasing end of various industrial and manufacturing organizations. The plan is to provide headquarters either in New York or Chicago, using preferably the top floor of some hotel, centrally located. Mr. Gilman points out that there is no such organization in existence to-day and if traffic men, engineers and men of other vocations of life can maintain a club, purchasing agents should also be able to maintain a club with resulting advantages to themselves and their concerns.

NEW CATALOGUES AND CIRCULARS

Utica Drop Forge & Tool Co., Utica, N. Y. Catalogue of "Utica" nippers and pliers, comprising a large line for all purposes.

Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3312 on "Imperial XB-2" two-stage air compressors with underneath intercooler.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 101 on "P & H" single line grab buckets for handling coal, ore, and other loose material.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 148, superseding Bulletin No. 104 on direct-current generators for railway service and other heavy duty, 150 to 1500 K. W. capacity.

Illinois Stoker Co., Alton, Ill. Catalogue of mechanical stokers of the moving chain grate type. The catalogue illustrates the construction of the furnace and grate, and shows a number of installations.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletins Nos. 201 and 901 on portable electric Scotch radial drills for direct and alternating currents, and portable electric reamers for direct current, respectively.

Firth-Sterling Steel Co., E. S. Jackman & Co., agents, 710 West Lake St., Chicago, Ill. Leaflet on Firth-Sterling special chisel steel for hand chipping chisels, blacksmiths' chisels and sets, pneumatic hammer chisels, etc.

Pawling & Harnischfeger Co., Milwaukee, Wis. Booklet entitled "Drilling and Boring Operations in Railway Shops," illustrating the use of Pawling & Harnischfeger horizontal drilling and boring machines on locomotive cylinders.

Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y. Catalogue No. 24-B on "Seneca Falls" quick-change-gear engine lathes, "Star" screw-cutting engine lathes, "Seneca Falls" speed and wood turning lathes, and attachments.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletins 137, 138 and 139 on Chicago "Giant" rock drill, tappet type; Chicago "Giant" rock drill mountings; and appurtenances for Chicago "Giant" rock drills, respectively.

Pennsylvania Pneumatic Co., Erie, Pa. Bulletin illustrating the Barr "unit-compound" air compressor in various types of steam, belt and electric drive. The air compressor is of the two-stage type, one piston acting for both stages.

Electric Controller & Mfg. Co., Cleveland, Ohio. Booklet entitled "Electrical Arithmetic," containing problems and answers which deal with the conditions in and around manufacturing plants and show advantages of electrically-operated machinery.

Ashcroft Mfg. Co., 85-89 Liberty St., New York City. Circular of paper testers and thickness gages for paper makers, containing valuable information on paper in general, standard sizes of paper, useful rules for paper box board buyers, envelope scale, etc.

Smith-Serrell Co., Inc., 90 West St., New York City. Bulletin No. 18 on the Francke flexible coupling for steam and gas engines, steam and water turbines, dynamos, motors, shafting, motor boat couplings, etc., made by the Francke Co., New Brunswick, N. J.

National Tube Co., Frick Bldg., Pittsburg, Pa. N. T. C. Bulletin No. 12, containing much "boiled down" information on pipe under the following heads: "Uniformity," "Chemical Composition," "Physical Properties," "Bursting Strength," "Thread," "Full Weight Pipe," "Spellerizing," "Cohesion," "Tests," "Specifications," etc.

Dodge Mfg. Co., Mishawaka, Ind. Booklet on the Dodge capillary self-lubricating bearing which describes the phenomenon of capillary attraction, illustrating it with a number of interesting views, and showing the construction of the new bearing which feeds oil to the shaft by means of a simple ingenious construction acting on the capillary principle.

Putnam Machine Co., Fitchburg, Mass. (Manning, Maxwell & Moore, Inc., 85 Liberty St., New York City, selling agents.) Bulletin on heavy pattern double-headed driving wheel lathes built in 79-inch, 85-inch, 90-inch and 100-inch sizes. The bulletin illustrates details of construction of the lathe and shows the forming tools used for roughing and finishing tires.

Pittsburg Emery Wheel Co., 603-604 Park Bldg., Pittsburg, Pa. Pamphlet entitled "Standard Tapers for Sides of Safety Shape Emery Wheels" by Charles G. Smith, president of the company, advocating the adoption by grinding wheel makers of one standard taper for the sides of wheels intended for use of safety collars. The taper recommended is ¾ inch per foot. See article in April MACHINERY.

Reliance Electric & Engineering Co., 1056 Ivanhoe Rd., Cleveland, Ohio. Bulletin No. 1010 on "Reliance" adjustable speed motor, Type AS, armature shifting design. This direct-current motor runs at any speed and develops a constant output over any range up to 1 to 10, with no electric controller. Applications of the motor to various types of machinery are shown, including many machine tools.

Bickford Machine Co., Greenfield, Mass. Booklet entitled, "Tap Making Simplified," by O. S. Bickford, illustrating and describing modern methods and machinery employed in the rapid and economical production of thread cutting taps. The matter is divided into two chapters on "Machine Screw Taps" and "Hand and Machine Taps," each illustrated with machines especially designed for tap manufacture.

Arguto Oilless Bearing Co., Wayne Junction, Philadelphia, Pa. Catalogue of "Arguto" oilless bearings printed in colors, illustrating cylindrical bushings and thrust washers, loose pulley equipment, clutch pulley equipment, countershaft equipment, special shapes of bearings, tension hooks for drawing rollers, etc. Claims made for these bearings are long life, permanent lubrication, elimination of repairs, reduced friction, etc.

Marvin & Casler Co., Canastota, N. Y. Catalogue of the Casler off-set boring head which is used both as a drill chuck and as a boring-tool holder, but especially for the latter. The catalogue illustrates uses of the boring head in the lathe, drilling and milling machine. A recent improvement is an adjustable boring-bar which is fixed to the boring head. This bar increases the stiffness of the tool and its capacity for deep holes.

Charles H. Besly & Co., 118-124 N. Clinton St., Chicago, Ill. Catalogue on Besly spiral disk grinders, band polishing machines, grinding fixtures, exhausters, accessories, pressed steel ring wheel chucks, spiral circles, cement, glue, oil and other supplies. The catalogue illustrates a large variety of disk grinding machines and gives the specifications for many more not illustrated which apply to the conditions found in a wide variety of metal manufacturing and wood-working.

A. E. Quint, Hartford, Conn. Illustrated catalogue No. 12 on Quint's vertical turret drilling, tapping and chucking machines. Light and heavy styles of multiple spindles with spindles ranging in number from four to twelve. These turret machines are so constructed that only the spindle in use is running, the others remaining stationary until indexed into the operating position. All spindles work to one center so that work may be fastened in a fixed position until finished.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 73 on Foxboro thermometers and thermographs, comprising three general classes, viz., 1. Depending on pressure caused by the expansion of a liquid and covering ranges from —60 to 200 degrees F; 2. Depending on the pressure of saturated vapor of a volatile liquid and having a working range of from —50 to 400 degrees F; 3. Depending on the expansion of an inert gas and covering ranges from —60 to 800 degrees F. The bulletin illustrates recording thermometers and various forms of charts used with them.

Cleveland Automatic Machine Co., Cleveland, Ohio. Catalogue of 184 pages on "Cleveland automatics," containing a fund of valuable information on the machines and attachments built by this company. Especial attention has been given to those features which would naturally interest the prospective purchaser. The Model "A" automatic machines, with capacities from ⅝ to 7¼ inches, are first illustrated, and opposite each illustration are given the important dimensions. Following are plan, end and rear views of the Model "A" and a description of some important operating features. The various attachments for this model are then illustrated and described. At the end of the Model "A" section, there is a two-page group of typical parts produced on the various sized machines of this model. Each piece is numbered for identification, so that anyone interested can readily obtain information regarding the method of machining rate of production, etc. The arrangement described in the foregoing has been followed for the other models. The latter part of the catalogue contains illustrated descriptions of certain important parts and attachments, many of which are applicable to more than one model. The simplicity of setting up a Cleveland automatic is illustrated by a view showing the operator in the four important positions relative to the machine. On the opposite page the adjustment for each position is explained. Some of the other features described are the double cross-slides; feed roll indicator and regulating wheel; third spindle-speed attachment; new positive-acting belt-shifter; new style chuck operating segment with adjustable cams; worm-gear and feed regulating disk; rotary oil pump; overhanging turning attachment with extra cutting head; independent cut-off and thread-rolling attachment; special box mill for taper or irregular forms; and various cross-slide and turret tools. The different methods of driving the spindle heads to obtain the best results under different conditions are clearly shown by line drawings, as well as the arrangement of the overhead drive for the various sizes and models.

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Supplement to

Tables for Article in this n

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—I

Letter	Name	Purposes for which suitable
B–c	Commercial brass........	Name and number plates; cases for instruments; oil cups; distributing boxes.
Cu–r	Copper..................	Copper pipe and tubing.
D–c	Muntz metal............	....
F	Brazing metal...........	Brazing metal, and all flanges and fittings that are to be brazed.
G	Gun bronze..............	All composition valves 4 inches in diameter and above; expansion joints, flanged pipe fittings, gear wheels, bolts and nuts, miscellaneous brass castings, all parts where strength is required of brass castings or where subjected to salt water, and for all purposes where no other alloy is specified. Composition valves: Safety and relief, feed check and stop, surface blow, drain, air, and water cocks, main stop, throttle, reducing, sea, safety sluice, and manifolds at pumps. Condenser, Distiller, Feed-water heater, Oil cooler. (Heads, shapes and water chests.) Pumps: Air-pump casing, valve seats, buckets, main circulating, water cylinders, valve boxes, water pistons, stuffing boxes, followers, glands, in general the water end of pumps complete except as specified. Stuffing boxes: Glands, bushings for iron or steel boxes. Blowers: Bearing boxes. Journal boxes: Distance pieces. Miscellaneous: Grease extractors; steam strainers, separators, casing for stern tube and propeller shafts, propeller hub caps. Bearings: Main, stern tube, strut and spring. Spring bearings: Glands and baffles.
G	Gun bronze..............	Reciprocating engine: Intermediate and low pressure relief valves and casings, crosshead brasses, crank-pin brasses, eccentric straps and distance pieces.
H	Journal bronze..........	Journal boxes, guide gibs, bushings, sleeves, slippers, etc. Reciprocating engine: Valve stem crosshead bottom brass; link block gibs, suspension link brasses.
M	Valve bronze............	All valves below 4 inches in diameter, for steam and general purposes, for which the material is not otherwise specified; hose couplings and fittings.
Mn–c	Manganese bronze.......	Propeller hubs, blades, engine framing, and composition castings requiring great strength.
Mo–c	Monel metal.............	Same as for Mn–c, and pumpliners, valve seats, and castings requiring great strength, hardness and incorrodibility; shaft nuts and caps.
N–c	Cast naval brass.........	Valve handwheels, hand-rail fittings, ornamental and miscellaneous castings, and valves in water chests of condensers.
P–c	Phosphor bronze.........	Castings where strength and incorrodibility are required.
S–c	Screw pipe fittings......	For composition screwed fittings.
Ni	Nickel..................	For valve seats.
A	Admiralty metal.........	Condenser, distiller, feed-water heater, and evaporator tubes.
B–n	Benedict metal..........	Condenser, distiller, feed-water heater, and evaporator tubes.
D–r	Muntz metal.............	Bolts and nuts not subject to action of salt water.
P–r	Phosphor bronze.........	Pump rods, valve stems, valve springs, etc., exposed to salt water.
Mn–r	Manganese bronze.......	Rolled rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility.
Mo–r	Monel metal.............	Rolled rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility, and pump rods.
N–r	Rolled naval brass......	Rolled rounds, used principally for propeller blade bolts, air pump condenser bolts, and parts requiring strength and incorrodibility, and pump rods, tube sheets, supporting plates, and shaft for valves in water heads for condensers.
B–r	Commercial rolled brass..	Sheet brass: For liners, trim, etc. Brass pipe: Boiler dry pipe, hand rails. Distributing oil tubes and water pipes. Commercial brass rod for trim, and purposes where strength and incorrodibility are not required.
W	Antifriction metal.......	Lining bearings.

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—II

Letter	Name	Composition by percentage					
		Copper	Tin	Zinc	Iron, Maximum	Lead, Maximum	Miscellaneous
B–c	Commercial brass	64–68	....	32–34	2.0	3.0	
D–c	Muntz metal.....	59–62	....	39–41	......	0.6	
F	Brazing metal ...	84–86	....	Remainder	0.06	0.3	
G	Gun bronze.......	87–89	9–11	1–3	0.06	0.2	
H	Journal bronze...	82–84	12.5–14.5	2.5–4.5	0.06	1.0	
M	Valve bronze	87	7	Remainder	0.06	1.0	
Mn–c	Manganese bronze*	57–60	0.75	37–40	1.0	......	Aluminum, 0.5; manganese, 0.3.
Mo–c	Monel metal.....	Remainder	....	....	6.5	......	Aluminum, 0.5; nickel, 60 (min.).
N–c	Cast naval brass..	59–63	0.5–1.5	Remainder	0.06	0.6	
P–c	Phosphor bronze*	80–90	6–8	Remainder	0.06	0.2	Phosphorus, 0.3.
S–c	Screw pipe fittings, brass....	77–80	4	13–19	0.1	3.0	
Ni	Nickel...........	....	....	....	......	......	Nickel, 97 (min.).
Cu	Copper	99.8 (Min.)	....			......	To be free from sulphur and other impurities and metals.
Zn	Zinc (rolled plates for boilers or slabs)	....	....	98½ (Min.)	0.08		
Sn	Tin..............	....	99.6 (Min.)				
Pb	Lead (1).........	....	....	....	......	Min. 99½	
	Lead (2).........	....	....	....	......	97½	
Mo–c	Monel metal (ingots or shot)	....	....	....	3.0	......	Nickel, 60 per cent (min.); manganese, 2 per cent (min.) balance copper, with amounts of other non-injurious ingredients

* The figures given are approximate and are a guide as to the proportions of the elements except those for lead, aluminum, and iron, which are maximum limits.

COMPOSITION OF MISCELLANEOUS ALLOYS

ALLOYS	Antimony	Bismuth	Copper	Gold	Iron	Lead	Nickel	Silver	Tin	Zinc	Cadmium
Brass, common yellow			61.6			2.9			0.2	35.3	
Brass, to be rolled			32						1.5	10	
Brass castings, common			20						2.5	1.25	
Brass castings, hard			25						4.5	2	
Brass propellers			8						1	0.5	
Gun metal			8						1		
Copper flanges			9						0.26	1	
Muntz metal			6							4	
Bronze statuary			91.4			1.37			1.7	5.53	
German silver			2		6.5		7.9			6.3	
Brittania metal	50	25							25		
Chinese silver			65.1		12		13.0	2.50		19.3	
Chinese white copper			20.2				15.8		1.3	12.7	
Medals			100							8	
Pattern letters	15	15				70					
Pinchbeck			5							1	
Babbitt metal	2		0.5						25		
Bell metal			4						1		
Chinese gongs			40.5						9.2		
White metal, ordinary	28.4		3.7						14.2	3.7	
White metal, hard			35						2.2	13	
Metal to expand in cooling	16.7	8.3				75					
Pewter	17								100		
Spelter			1							1	
Type metal	1					3–7					
Solders—											
Newton's, melts at 212 deg. F.		8				5			3		
Rose's, melts at 201 deg. F.		2				1			1		
Very fusible, melts at 155 deg. F.	50					25			12		13
Less fusible, melts at 199 deg. F.	5					3			2		
Tin solder, coarse, at 500 deg. F.						3			1		
Tin solder, ordinary, at 360 deg. F.						1			2		
Tin solder, melts at 225 deg. F.		50.8				27.8			21.4		
Brazing, hardest			3							1	
Brazing, hard			1							1	
Brazing, soft			4						1	3	
Brazing, softest	1								2		
Copper to copper			55						5	40	
Copper to iron			80						4	16	
Iron solder			2							1	
Steel solder			3					19		1	
Fine brass work			8					1		8	
Pewter solder, ordinary						1			2		
Pewter solder, soft		2				4			3		
Lead solder						83.0			16		
Aluminum solder, soft	45								25	30	
Aluminum solder, hard *										75	
Gold solder			1	24				2			
Silver solder, hard			1					4			
Silver solder, soft †								2			

* 25 parts aluminum. † 1 part brass wire.

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—III

Letter	Name	Composition by percentage					
		Copper	Tin	Zinc	Lead, Maximum	Iron, Maximum	Miscellaneous
A	Admiralty	70 (min)	1 (min.)	Remainder	0.075	0.06	
Be-r	Benedict nickel	84–86					Remainder nickel.
B-r	Sheet brass and piping	60–70		Remainder	0.5		
B-r	Commercial brass rod	60–63		Remainder	3.0		
Cu-r	Copper	99.5 (min.)					
D-r	Muntz metal	59–62		Remainder	0.6		
P-r	Phosphor bronze*	85–95	5–10	4 (max.)	0.2	0.06	Phosphorus, 0.15.
Mn-r	Manganese bronze*	57–60	0.5	37–40		1.0	Manganese, 0.30.
Mo-r	Monel metal	Remainder				3.5	Nickel, 60 (min ; aluminum, 0.5 (max.)
N-r	Rolled naval brass	59–63	0.5–1.5	Remainder	0.2	0.06	

* The figures given are approximate and are a guide as to the proportions of the elements, except those for lead, aluminum, and iron, which are maximum limits.

White Metal

Composition: 3.7 per cent of best refined copper, 88.8 per cent Banca tin, 7.5 per cent of regulus of antimony. (Well fluxed with borax and rosin in mixing.)

Turbine Materials

Blading and binding strips may be made of the following compositions:

1.—Monel metal.

2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.

3.—Cupro-nickel: 79-81 per cent copper; remainder nickel; iron not to exceed 0.75 per cent.

4.—Composition: 53-56 per cent copper; 1.5 per cent nickel alloy; remainder zinc; lead not to exceed 0.5 per cent.

5.—Phosphor bronze.

Calking Strips

Composition: 62-63 per cent copper; remainder zinc; lead not to exceed 0.6 per cent.

Dummy and Gland Strips

1.—Naval rolled brass.

2.—Composition: 71-73 per cent copper; remainder zinc; lead not to exceed 0.2 per cent.

Thrust Rings

Composition: 82-84 per cent copper; 12.5-14.5 per cent tin; 2.5-4.5 per cent lead.

MACHINERY

JUNE, 1913

A SCHOOL THAT TRAINS BOYS FOR SHOP WORK[*]

SHOP AND DRAFTING-ROOM METHODS OF A PROGRESSIVE TECHNICAL HIGH SCHOOL

BY EDWARD K. HAMMOND[†]

ONE of the most serious defects of the departmental method of factory administration is that it trains boys to be machine operators instead of mechanics. As this method enables a boy to obtain employment operating a milling machine, drill press or other tool and to receive fairly good wages for doing so—he naturally hesitates to sign a contract for four years' apprenticeship, during which time he will be working at a nominal rate of pay. The result is that there is a scarcity of mechanics who have a knowledge of all of the branches of their trade. The importance which machinery builders attach to this condition is emphasized by the fact that nearly every convention of such organizations as the National Machine Tool Builders Association and the National Metal Trades Association, brings forth discussions of ways and means of training boys so that they may develop into competent mechanics.

Fig. 1. The William L. Dickinson High School, Jersey City, N. J.

In such towns as Cincinnati, Ohio, where there are a large number of machinery building establishments, it is probable that the "part time" plan, where the boy spends one week in school and the next in the employ of a machinery building factory, offers the best solution of this problem which has yet been advanced. Such a plan is only feasible, however, where there are a sufficient number of factories adjacent to the school to make it possible to find shop work for the boys during the alternate weeks. Consequently, this is only a partial solution of the problem. It is felt that the method described in this article will be of interest to readers of MACHINERY, in that it is a plan which seems to possess more than the ordinary merit of systems of industrial education.

The William L. Dickinson High School was built in Jersey City, N. J., in 1905, and like the majority of such institutions, it had two purposes in view. One of these was to fit boys and girls for entrance into college, and the other to provide a general course of education for students who intended entering upon their life's work after completing the high school course. The work of the average high school course is generally recognized to be of little direct value to the boy who intends entering shop work. His training in mathematics and science may be of value to him, but only after he has passed through the preliminary period of his training in the shop.

For the purpose of providing a more practical form of education for this class of students, the technical and industrial department of the William L. Dickinson High School was established in 1912. This department is under the direction of Mr. Frank E. Mathewson, who has had a wide experience in shop work, and in the education of boys for shop work in several of the leading technical high schools of the country. Two courses of study are offered in the mechanical department. The first is a two-year course, which aims to give boys training in shop work, mechanical drawing, mathematics and applied science. The second is a four-year course. In the latter course, the first two years are devoted to training in mathematics, drawing and shop work. During the last two years, the students are allowed to specialize in the work which they intend to follow after leaving school.

The chief distinction between the equipment and work done in this school and that carried on in other manual training schools is that the conditions under which the boys work are as nearly as possible those which exist in modern manufacturing plants. All of the equipment consists of full-size machines which are capable of doing work on a manufacturing scale, and this equipment has been carefully laid out in the way it would be in a regular factory. Particular care is also taken on the part of the instructors to train the boys to use their tools as they will be required to do when working in a factory. Modern factory methods of management are also followed as closely as possible. The result is that the boys are familiar with factory routine before leaving school, and although there has not been sufficient time for a class to complete the prescribed course of study, it is felt that this training will enable the graduates to grasp the routine methods of a factory much more rapidly than would otherwise be possible.

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[*] For other articles on industrial education previously published in MACHINERY, see "State Trade School of Bridgeport," October, 1912, engineering edition; "Features of Apprenticeship System at the G. E. Co.'s Lynn Works," April, 1912, engineering edition; "The Cincinnati Method of Industrial Education—A Friendly Criticism," March, 1912, engineering edition; "The Wentworth Institute," October, 1911; "Training of Machinists in the Trade School," July, 1911, engineering edition; "The Development of Machinist Apprentices," October, 1910, engineering edition, and other articles there referred to. See also other articles dealing with this subject in the present number.

[†] Associate Editor of MACHINERY.

The distinctive feature of the shop work which is being done in this technical high school is that it consists of actual machine parts. Two important advantages are secured from the selection of such classes of work. First, they constitute the kind of work which the boys will be called upon to handle when they leave the school and go to work in a factory; and second, more care and interest will be taken when the work is to find some practical application. In this connection it may be mentioned that the students are at present working upon the construction of thirty speed lathes which are to be used in the vocational schools of Jersey City. The drawings for these lathes were obtained from a machine tool builder, and as the parts are comparatively simple, they afford excellent subjects to be handled in the pattern shop. When the patterns are made they are transferred to the foundry, where the castings are made, and these, in turn, go on to the machine shop and assembling shop. This is but one example, but it will serve to show the class of work which is being handled. The intention is to have the more advanced students handle such work as building small steam engines and similar units, when they have progressed far enough to be able to do this satisfactorily.

Fig. 2. View of One of the Drafting-rooms of the High School

In laying out the work for the different drafting-room and shop courses, an effort has been made to interlock these departments as closely as possible. This article has particular reference to the methods followed in the machine shop. However, the work of the drawing-room, pattern shop, forge shop and foundry are all supplementary to the work of the machine shop, and the methods followed in these departments will be briefly outlined in order to lead up to the work done in the machine shop.

Drafting-room

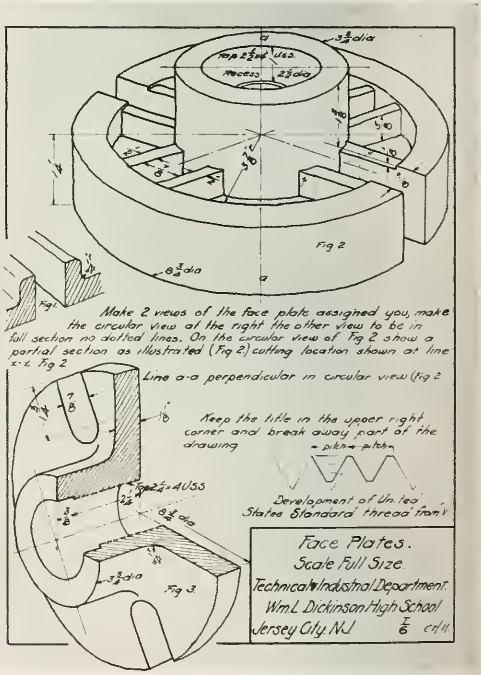
The most important feature of the work of the drafting-room is the way in which its relation to the work of the pattern shop and machine shop is emphasized. After the boys have been given sufficient training to familiarize them with the use of drawing instruments and methods of mechanical drawing, the work assumes a practical nature. Two opportunities for working out this feature are afforded. The first consists of making drawings from which patterns are made in the pattern shop and pieces finished in the machine shop. The second is sending the boys down to the different shops to make free-hand sketches of parts which are being handled in those departments, and then having them come back to the drafting-room and make complete working drawings from these sketches. It will be obvious that this is the sort of work which the regular draftsman is called upon to handle. The boys are not only required to do this work neatly and accurately, but their ranking is also based upon the length of time which they require to make a complete drawing. If it is necessary for any of the boys to go back to the shop for additional information, after the first trip has been made for the purpose of making a free-hand sketch, the fact is taken into consideration and their ranking is correspondingly reduced.

Pattern Shop

The pattern shop is equipped with standard pattern making lathes made by the American Wood Working Machinery Co., and the necessary equipment of band saws, circular saws, trimmers, and other machines required for performing operations on rough stock. Most of the work in the pattern shop is done from drawings which the students have made in the different drawing-room courses. The idea of this is to give them a clear understanding of the relation existing between the drafting-room and the shop, and to cause them to acquire interest in the work. The patterns made in this shop are sent on to the foundry, where castings are made from them by the same students who have taken part in making the patterns. This is of particular value in giving the boys a thorough understanding of the reasons for the different principles of pattern making. By using the same patterns in the foundry, the students see just why the parting lines were arranged in a certain way, why fillets are necessary and the reasons for the other principles they have followed in the pattern shop.

Foundry and Forge Shop

The foundry is arranged for both floor and bench molding and is equipped with a Whiting No. 1 cupola furnace. A mezzanine floor is on two sides of the room; the charging door of the cupola is located on this floor and the remaining space is taken up by core-making benches, etc. The brass furnace is also located on the mezzanine floor and a jib crane is provided for swinging the crucibles down to the main floor ready for pouring. The space for floor molding occupies the middle of the room and the benches for bench molding are arranged around three sides.



Make 2 views of the face plate assigned you, make the circular view at the right the other view to be in full section no dotted lines. On the circular view of Fig 2 show a partial section as illustrated (Fig 2.) cutting location shown at line x-x Fig 2

Line a-a perpendicular in circular view (Fig 2

Keep the title in the upper right corner and break away part of the drawing

Development of United States Standard thread from V

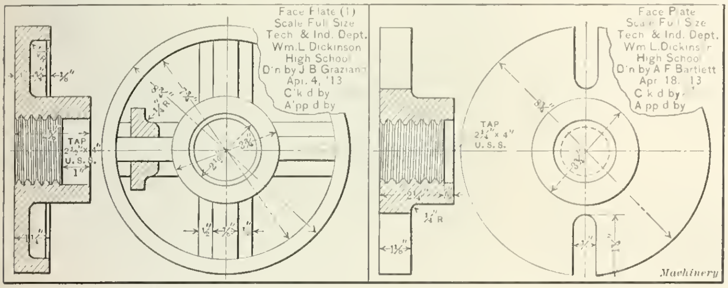
Face Plates.
Scale Full Size.
Technical Industrial Department.
Wm. L. Dickinson High School
Jersey City. N.J. $\frac{I}{6}$ cr/11.

Fig. 3. Free-hand Sketches from which Working Drawings are made

It has been the policy, as far as possible, to have the students make such parts of the equipment as they could handle satisfactorily. In the foundry, the bases for the molding benches were purchased, while the wooden tops of the benches were made in the wood-working shop. Similarly, the iron brackets supporting the small shelves that carry the molding tools were made in the forge shop, and the wooden tops for these shelves were made in the wood-working shop. The equipment which has been provided in the foundry is believed to be sufficient to produce all the castings which can be handled in the machine shop.

The forge shop occupies a room adjacent to the machine shop and is arranged with the usual equipment of forges and anvils for handling smaller classes of work.

Machine Shop



Figs. 4 and 5. Working Drawings of Faceplates shown in Fig. 3

A review of the usual methods of instruction in the machine shops of different manual training and technical schools has shown that the first work handled consists of such operations as hand filing and chipping. This may constitute good practice but the pieces upon which the boys are put to work would never be handled in this way in a factory. It was felt that many boys are discouraged by being put through these "paces" before being allowed to start machine operations, particularly when they see the facility with which the work that they are doing by hand can be performed on a shaper or milling machine. In the machine shop of the technical high school, this method of instruction has been departed from in many essentials. In the first place, the boys are put to work on the machine as soon as they come into the shop. The preliminary instruction consists of a complete explanation of the design and construction of the lathes upon which the first work is done. Thus the principles of back-gearing, gearing a lathe for cutting different screw pitches, the method by which the machine is lubricated and kindred subjects are explained. As a result, the boys have a fairly accurate conception of the "why and wherefore" of the operations which they are performing when they start work.

Fig. 6. One Corner of the Pattern Making Shop

The first actual experience on the machine consists of oiling and cleaning, after which simple exercises in turning, screw cutting, etc., are taken up and the individual students are allowed to progress as their proficiency warrants. In going through the shop it is evident that not only is the standard of accuracy high, but the methods in use correspond closely with those of the regular machine shop. During a recent visit which the writer made to the school, he stopped in front of one of the lathes upon which a little red-haired fellow had just finished turning a mandrel. The working drawing showing the required dimensions was tacked up on the wall before him, and upon asking how close his work came to the required dimensions, this young mechanic slipped his third finger through the frame of his micrometer and adjusted it to the work in the most approved fashion. He then handed the micrometer over with a smile which indicated that he was thoroughly satisfied that its reading would agree with that called for on the drawing.

Contrast of School and Apprenticeship Training

Whenever a new kind of work is taken up, the class is assembled in the lecture room at the corner of the shop and all of the operations connected with it are explained. After this explanation has been given by the instructor, he distributes a set of mimeograph forms which give a general outline of the ground covered in his lecture. This constitutes the second opportunity the boys have to gain the necessary information, and if anyone is still in doubt about certain points, he is at liberty to apply to the instructor for additional information.

Now let us trace the relationship between this sort of training and that which the average apprentices receive in a factory. In the latter case, the boys usually sign a contract for four years work and it may be safely said that very little progress is made during the first two or three years. A large part of the time is taken up in doing inferior classes of work such as cleaning machines, oiling lineshafts and running errands. When the boy is given an opportunity to run a machine, it is set up for him and he merely has to put successive pieces of work in place and start it. The foreman of the average shop is too busy to spend time explaining mechanical principles or operating methods to the apprentices, so that the boys have to "dig out" such information for themselves or pick it up little by little from obliging men in the shop who are willing to help them along. The boys in the high school, on the contrary, have all of the processes connected with their work explained to them, so that they have a firm foundation for the more advanced work that they will come to in later years of their school course and when they get out into factory work.

Fig. 7. High School Boys at Work in the Foundry

A good example of the difficulties encountered by the average apprentice is illustrated by a story which was recently told one of the instructors in the machine shop by a night school student. This boy showed more than usual aptitude in the manner in which he handled lathe operations and became so efficient that the instructor asked him what class of work he was engaged in during the day. The boy answered that he ran a lathe. The instructor then asked him what benefit he expected to derive from devoting his time to work in the lathe department of the machine shop, when he already possessed sufficient knowledge of such work. The answer was that the explanation of the basic principles of lathe work given in connection with the shop instruction made it well worth his while to attend the night school. He then went on to explain to the instructor that his requests for explanations of such matters in the shop had led to his becoming sort of a "fag," the different mechanics trading off information in return for having their tools cleaned, having errands run and for other services of a similar nature.

Management of the High School Shop

The work is issued to the school shops on orders, in the same way that it would in a manufacturing establishment. Each order has an order number, etc., and a careful account is kept of the amount of time which the boy spends upon it. He is not only required to do a good job, as regards finish and accuracy, but he must also finish his work in a reasonable time. The marks given on each job are dependent on these three factors, and it is quite possible for the boy who takes the greatest length of time to secure the highest mark, as those who rush through their work with haste are likely to produce work deficient in accuracy and finish. The time taken on each job is recorded by one of the students who acts in the capacity of time-keeper, and another student serves as the shop foreman. This boy is given power to issue orders in the shop and the other boys are expected to follow his instructions. This practice is followed to develop executive ability in boys who show any capacity in that direction.

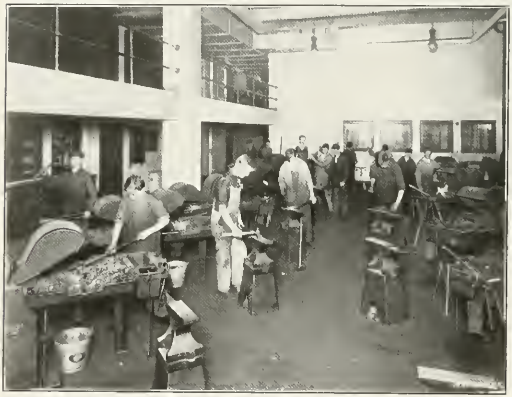


Fig. 8. The Forge Shop—Everybody is Busy

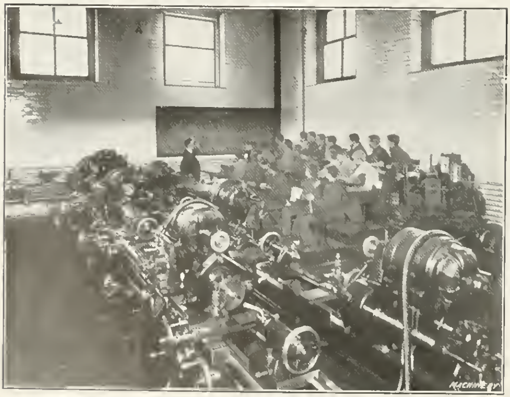


Fig. 9. Teaching Principles of Gearing in the Machine Shop

All of the boys at present enrolled in the machine shop are first-year students and are engaged on such operations as turning, facing, centering, screw cutting, etc. Most of the pieces upon which they are working are parts of the thirty speed lathes for the vocational schools, referred to in a preceding paragraph. In machining these parts it was deemed advisable to finish them 1/16 inch over size, in order to avoid the loss of material that might result from inaccurate work. The boys are not told, however, that such is the case, and they think that they are machining the work to the finish dimensions. The boys naturally take more pride in turning out good jobs when they feel that they are doing some useful work, than if they know that the product of their labor will be sent back to the cupola to be remelted and made into another rough casting, upon which the same useless expenditure of work is to take place.

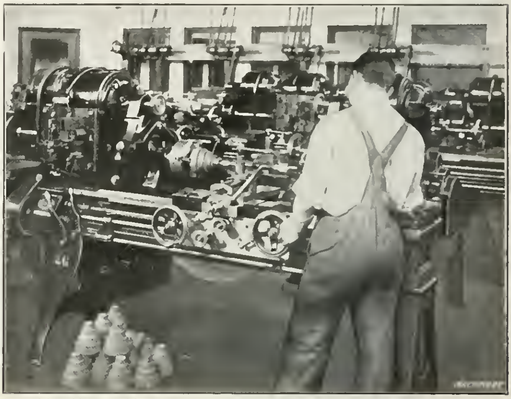


Fig. 10. Machining Speed Lathe Cone Pulleys on a Flather Lathe

The equipment of the shop in which the first-year students are employed consists of thirty fourteen-inch Flather engine lathes driven by direct-connected motors. There are also four Rivett bench lathes, one B. & S. miller, one American shaper, one J. E. Snyder drill, one Henry & Wright drill and the necessary tool grinders, centering machines, hacksaws, etc., for handling the classes of work for which such machines are required. A well supplied tool-room has also been provided, which contains an exceptionally complete equipment of tools suitable for the work handled in this shop.

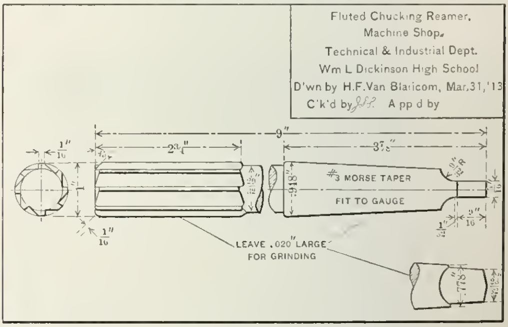


Fig. 11. Working Drawing for a Chucking Reamer to be made in the Machine Shop

The more advanced students will handle such work as fitting, assembling and other classes of machine shop work for which a higher degree of skill is required. The shop which has been equipped for this purpose contains a complete assortment of tools adapted for such classes of work. These include a Cincinnati surface grinder, Cincinnati and Brown & Sharpe milling machines, Whitcomb-Blaisdell planers, and a complete equipment of the American Gas Furnace Co.'s furnaces for the heat-treatment of tools. This shop is also provided with an excellent tool-room equipment, which has been carefully selected to meet the requirements of the work which will be handled in this shop.

A particularly valuable feature of the work of the technical and industrial department of the Dickinson High School lies in helping each student to decide what trade he is best suited for. At intervals of six months, each instructor sends in a report of every student in his class. Special forms are provided for this purpose on which the instructor reports not only the quality of work that the boy has done, but any particular ability that he has shown in a given direction. At the end of the first two years it is proposed to hold a conference between the student, his parents and the director of the technical and industrial department. At this conference, the work done by the boy during the past two years will be discussed and the ability he has shown in any given direction will be pointed out to him. Of course, the ultimate selection of his trade will be left to the boy, but he will be recommended to enter the trade for which the instructors believe he shows the greatest aptitude. As previously stated, his last two years in school will be devoted largely to shop work, special class room work being given in different subjects that are allied to the trades that are taught. After completing such a course of training, it appears evident that a boy should be much more competent to take up the routine of factory work than he would be after completing an ordinary high school or manual training school course. There has not been sufficient time to graduate a class from the technical and industrial department of this school, so that experience has not shown just how the ability of the boys will compare with that of apprentices who have been trained in a factory by following the usual routine. It appears evident, however, that at the completion of such a course of training, a boy should be able to enter upon his factory work as an advanced apprentice, and that he ought to have a much more specific knowledge of the underlying principles of his trade than he could possibly obtain by the usual methods of apprenticeship.

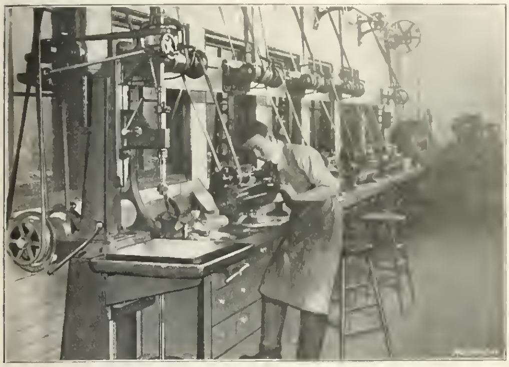


Fig. 12. Upright Drill, Bench Lathes, Centering Machine and Arbor Press

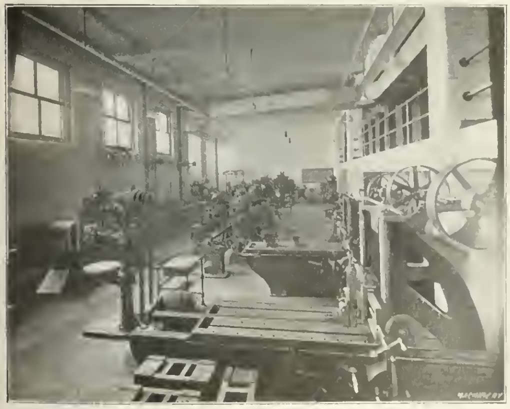


Fig. 13. General View in Shop for Advanced Machine Work

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Of 4234 known causes of fire in Chicago during 1911, 1121 were due to carelessness in the use of matches.

PROGRESS IN AEROPLANE DESIGN AND AERONAUTICAL MOTORS*

One of the first impressions of the aeronautical show at Olympia, London, early this year, was that the aeroplanes exhibited were workmanlike machines which could be trusted to fly. The show was confined to English and French machines, and neither the United States, Germany nor Austria were represented. A study of the aeroplanes exhibited left one with the conclusion that the greatest part of recent progress in flying machines is due to improvements of the engine. No matter what improvements are made in wing and propeller construction, without a light, powerful and reliable engine these improvements come to naught. Three years ago, there were practically no engines on the market which could be relied on to produce more than forty brake horsepower with a moderate weight per horsepower. At the present time, engines giving 100 to 150 brake horsepower are often used in aeroplanes, and there are some makes of engines available at even greater powers.

The improvement in the engines, however, has not been accompanied by any radical alteration in their general outlines. All the types now in use were developed several years ago, and the improvements have been in detail and in better proportions of the parts, as well as in the kinds of materials used. Possibly the greatest development has been in connection with the radial type with fixed cylinders. There is, of course, nothing new in this type, but little attention was paid to it until recently, one cause for this neglect undoubtedly being due to imaginary lubrication difficulties. It is obvious that this type requires the least length of crankshaft and crankcase for a given cylinder capacity, and therefore it should theoretically, at least, be the lightest per horsepower. It needs somewhat heavy piping arrangements, however, and it is possible that the more ordinary types of engines may in the end give equally good results.

The vertical type has the longest shaft and crankcase, and therefore should be theoretically the heaviest, the diagonal coming between the vertical and radial types. Nevertheless, the vertical type was more represented at Olympia than any other, and its practical advantages in construction may enable it to be made so nearly the weight of the other types that it may survive.

The radial type is made with any number of cylinders from three upward, ten being the usual limit. The vertical engines had either four or six cylinders, while the diagonal engines had eight or twelve cylinders. It is rather curious that the six-cylinder diagonal engine is never used.

The accompanying table gives general particulars as far as they are obtainable from the makers of various types of engines exhibited. The data are based on statements by the manufacturers. In some instances, the engines will give somewhat greater powers than stated if run at higher speed, while independent tests of other engines have shown that they will barely give the rated power. The weights in some cases include radiators, reducing gear for propeller, etc., which is indicated in a note to that effect. It will be seen that there is considerable variation in the proportions adopted by various makers for producing the same result. The weight per brake horsepower varies from less than two pounds to over six pounds, these extremes being both met with in engines which give very good results in practical flight. The cylinder capacity per brake horsepower varies from less than six cubic inches to nearly ten cubic inches, while the weight per cubic inch of cylinder capacity varies from 0.21 pound to 1.07 pound. It is clear from these figures that there are still two ways of making a light engine—the one to make it very light for its cylinder capacity and the other to get a great deal of power out of cylinders of a given size. Which principle will survive remains to be seen, and it is possible that success may best be obtainable by not going to the extreme in either direction. It is quite clear, however, that there is no tendency whatever to follow the practice used in the racing motor-car engines, tending to an extreme high-speed high-compression type.

The last column in the table is of some interest, showing as it does the mean pressure aimed at. This is calculated from the given brake horsepower and the number of revolutions per minute, and is the mean pressure corresponding to the brake horsepower, no allowance having been made for engine friction. This latter, therefore, must be added to obtain the actual mean pressure in the cylinder. This, it will be seen, is in many cases so high that it appears as if the number of revolutions at which the power is obtained must be understated.

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*Abstract of article in Engineering (London), February 28, 1913.

The Renault engine has been found extremely satisfactory by the British military authorities. It will be noted that this type of engine is one of the heaviest per horsepower in the list. The fact that such a heavy engine should be preferred by the military authorities to the lighter forms would indicate that the latter are not always as reliable as could be desired. The weights given, of course, in the case of the Renault engine include the reducing gear for the propeller, so that the weight is not fully comparable with the weights given in most of the other cases.

TABLE SHOWING CHIEF DIMENSIONS, ETC., OF AEROPLANE ENGINES

Name	Brake Horsepower	Type	Cooling	Cylinders							Weight	Revolutions per Minute	Weight per Brake Horsepower	Cylinder Capacity per Brake Horsepower	Weight per Cubic Inch, Cylinder Capacity	Mean Cylinder Pressure Corresponding to B.H.P.
				Diameter		Stroke		Number	Ratio of Stroke to Diameter	Total Capacity						
				mm.	in.	mm.	in.			cub. in.	lb.		lb.	cub. in.	lb.	lb. p.sq.in.
Anzani	30	Radial	Air	105	4⅛	120	4¾	3	1.14	190	121	1300	4.0	6.3	0.64	97
	45	Radial	Air	90	3½	120	4¾	6	1.33	280	154	1300	3.4	6.2	0.55	98
	60	Radial	Air	105	4⅛	120	4¾	6	1.14	380	200	1300	3.3	6.3	0.53	97
	80	Radial	Air	90	3½	130	5⅛	10	1.45	505	238	1250	3.0	6 3	0.47	101
	110	Radial	Air	105	4⅛	140	5½	10	1.31	740	308	1200	2.8	6.7	0.42	99
Austrian Daimler*	40	Vertical	Water	100	4	120	4¾	4	1.20	230	180	1450	4.5	5.8	0.78	94
	65	Vertical	Water	120	4¾	140	5½	4	1.17	387	250	1350	3.8	6.0	0.65	98
	90	Vertical	Water	120	4¾	140	5½	6	1.17	581	360	1300	4.0	6.5	0.62	96
	120	Vertical	Water	130	5⅛	175	6⅞	6	1.35	848	450	1200	3.7	7.1	0.53	94
Benz	100	Vertical	Water	130	5⅛	180	7⅛	4	1.38	585	......	......	......	5.8	....	....
Clerget	60	Revolving	Air	120	4¾	120	4¾	7	1.00	580	200	......	3.4	9.7	0.35	....
Gnome	50	Revolving	Air	110	4⅜	120	4¾	7	1.09	487	168	1200	3.4	9.7	0.34	68
	80	Revolving	Air	124	4⅞	140	5½	7	1.13	720	192	1200	2.4	9.0	0.27	76
	160	Revolving	Air	124	4⅞	140	5½	14	1.13	1440	307	1200	1.9	9.0	0.21	76
Green	35	Vertical	Water	105	5⅛	120	4¾	4	1.14	253	177	......	5.0	7.2	0.70	....
	65	Vertical	Water	140	5½	146	5¾	4	1.02	550	317	......	4.9	8.4	0.57	....
	100	Vertical	Water	140	5½	152	6	6	1.08	860	471	......	4.7	8.6	0.55	....
Laviator	80	Diagonal	Water	100	4	130	5⅛	8	1.30	498	276	1200	3.4	5.3	0.59	125
	120	Diagonal	Water	114	4½	160	6⅝	8	1.40	796	419	1200	3.5	6.7	0.53	107
	250	Vertical	Water	180	7⅛	200	7⅞	6	1.11	1860	1215	1050	4.9	7.5	0.65	101
Mercédès	70	Vertical	Water	120	4¾	140	5½	4	1.17	387	308	1400	4.4	5.5	0.80	103
	90	Vertical	Water	140	5½	150	5⅞	4	1.07	564	400	1300	4.5	6.3	0.71	97
	100	Vertical	Water	120	4¾	140	5½	6	1.17	581	444	1300	4.4	5.8	0.77	105
N. A. G.	55	Vertical	Water	118	4⅝	100	4	4	0.85	314	......	......	......	5.7	....	....
	150	Vertical	Water	135	5⅝	160	6⅝	6	1.18	840	......	......	......	5.6	....	....
Renault†	40	Diagonal	Air	70	2¾	120	4¾	8	1.71	225	242	1800	6.0	5.6	1.07	74
	70	Diagonal	Air	96	3½	140	5½	8	1.46	494	397	1800	5.7	7.0	0.80	77
	100	Diagonal	Air	96	3½	140	5½	12	1.46	740	639	1800	6.4	7.4	0.86	69
Salmson	80	Radial	Water	120	4¾	140	5½	7	1.17	675	286	1250	3.6	8.4	0.42	76
	110	Radial	Water	120	4¾	140	5½	9	1.17	870	305	1250	2.8	7.9	0.35	80
Wolseley†	60	Diagonal	Water	95	3¾	140	5½	8	1.46	486	410	1200	6.8	8.1	0.85	98
	80	Diagonal	Air	95	3¾	140	5½	8	1.46	486	370	1600	4.6	6.1	0.76	82
	120	Diagonal	Water	127	5	178	7	8	1.40	1100	630	1050	5.3	9.2	0.57	82

In all engines except the Wolseley, dimensions of cylinders are given by the makers in millimeters, and the inch dimensions are approximate equivalents.

*Weight includes radiator. †Weight includes reducing gear for propellers.

In comparing aeroplane engines, it must be remembered that lightness of the engine itself, even if combined with reliability, is not the only important point. In some cases very light engines are inconvenient to attach to the machine, and, therefore, require heavy base or foundation plates. In addition to this, economy of fuel is of considerable importance, because when long flights are made, an engine, no matter how light in itself, if it be extravagant in fuel consumption, may have no advantages as regards the total working weight of the aeroplane. If it consumes more fuel, there is the weight of the fuel, and the larger tanks and their support to be taken into account. Assuming a difference of one-quarter pound per horsepower-hour of fuel consumption, this would mean 2½ pounds per horsepower in a ten-hour run. For a 100-horsepower engine, this would mean 250 pounds exclusive of the additional weight of the tank.

Although the majority of the aeroplanes exhibited at Olympia were of British make, all of these except one were equipped with foreign engines. There were, however, some promising British engines exhibited in the section for aeroplane motors.

As an indication of what may be expected of a good aeronautical engine, it may be mentioned that it is considered that the weight of an aeronautical motor should not exceed four or five pounds per average brake horsepower developed in a five-hours' run, and that, if possible, the engine should run twenty-four hours without compulsory stopping, and that the propeller speed should be between 900 and 1200 revolutions per minute.

With regard to the aeroplanes themselves there was a general tendency in those exhibited at Olympia to make the construction more substantial than formerly. This is probably largely due to the fact that more power is now available in the modern engines and therefore extreme lightness is not so necessary as formerly. It will, therefore, be seen that the improvements in the engine are largely responsible for such improvements as may be met with in the construction of the aeroplane itself.

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SPECIAL MACHINERY MAKERS

Many inquiries come to MACHINERY in the course of a year for the names of concerns engaged in the business of developing inventions, building special machinery, making metal and wooden models, and manufacturing mechanical novelties on a contract basis. All concerns prepared to do work to order will confer a favor by sending a statement to the editor of the classes of work for which they are best equipped.

THE DEVELOPMENT OF SKILLED MECHANICS

THE NECESSITY OF TRAINING WORKMEN—ORGANIZATION OF APPRENTICESHIP COURSES

BY C. J. MORRISON*

A difficulty which seems to be always present, and about which we are continually learning, is that of the scarcity of skilled mechanics. Nearly all manufacturing concerns experience this difficulty, more or less, according to the general conditions of business. Various excuses are given for the scarcity of good mechanics, but the fundamental trouble is seldom mentioned. In this, as in many other instances, people like to be deceived. The real trouble is that good mechanics are the product of a natural inclination toward the trade selected, an adequate education, and a careful training, and these conditions are not being met. In other words, a good mechanic must be made by proper methods of apprenticeship and these methods are found in very few plants. Not only is this the case, but even where the proper methods are used there are, in many cases, only a few apprentices. An extreme example of this condition is seen in a plant which employs 2000 men, and claims to have the most up-to-date and approved methods of apprenticeship, but is applying them on only two apprentices. The other extreme is to be found in a plant where there is no regular method of apprenticeship, and where the ratio of apprentices to mechanics is ten to one. Neither plant is turning out a supply of good mechanics. The various trade unions have recognized the evil of the second condition and have provided a maximum ratio of apprentices to mechanics, but they do not seem to have realized the danger arising from a condition where there are too few apprentices. It is perfectly practical to work out maximum and minimum ratios for various industries and different localities.

After the question as to the number of apprentices has been decided, the methods of instruction and the grades of apprenticeship should be determined. A longer time is required to learn trades requiring considerable skill, and a longer preliminary education is required in preparation for apprenticeship in some trades than in others. All of these factors must be carefully considered and provided for. As too much education is not likely to be attained, every encouragement and inducement possible should be given toward a liberal education. In order to be successful, any method of apprenticeship must endeavor to develop body, mind, character, and skill. The selection of material for apprentices is of great importance, and the employer should carefully investigate the suitability of a candidate for the trade that he wishes to learn. The investigation should take into consideration parentage, character, education and physical condition. In case a candidate appears favorable in the light of this investigation, he should be taken on trial and given every opportunity to demonstrate his fitness for the trade he has chosen, and also to determine for himself if the trade is to his liking. A trial period of three months would probably suffice in most cases. The importance of this trial period should not be overlooked, as it is important for the employer to secure apprentices who will eventually make good mechanics and also for the apprentices to be in the trade to which they are adapted. One does not have to look far to find numerous instances of "round pegs in square holes"—of good farmers being turned into poor mechanics.

During the trial period a record should be kept of the work performed and the candidates for apprenticeship should be under the direction of a shop instructor as much as possible. The various methods of hazing the new arrivals, in which even the foremen frequently take part, should be vigorously discouraged. An opportunity should be given each candidate to observe various phases of the work in order that he may be able to determine his ability for the trade he has chosen. This method at the same time enables the employer to determine the desirability of the candidate.

After the apprentice is chosen, his education and training should begin at once. As to the methods to be pursued, one can scarcely do better than to quote from Mr. G. M. Basford: "Another principle is mental training which, to insure complete success, must be parallel and simultaneous with the manual training in order that the boy may understand his work, know his materials, understand his methods, and know the reasons for what he does. For this, night schools will not suffice, and it seems fair to say that no recruiting system can approach the ideal which does not provide this mental training by taking the school to the boy; taking it in working hours and compelling his attention to it being as vital a part of his apprenticeship as the trade itself. This requires a substitute for the master of years ago in the form of a shop instructor who is capable of teaching the apprentice the theoretical and practical parts of his trade. It is important that the apprentice should come into contact with the real problems of the shop and that he should work as nearly as possible upon the same basis as the workmen, knowing that the product which he contributes is part of the general product of the plant. He should be taught to consider the commercial question of cost and the problem of management in the organization, so that he may see where the workman and employer fit into the general scheme. In mental training the same idea appears. This offers no field for the lover of 'pure mathematics,' but it offers a wonderful field for the man with practical ideas who understands the apprentice mind and knows the questions which are constantly arising with respect to the work of the shop. Mechanical drawing offers the readiest educational medium, and the development of this subject will lead to a clear view of the entire educational scheme. The brain and the hand must be trained simultaneously."

Mr. E. P. Bullard, Jr., who is considered an authority on this subject, speaks of the situation as follows: "The apprentice school is a necessary adjunct to any well organized apprentice system. Few concerns are large enough to support a school of their own, as is done at Lynn and Schenectady, and not every community is prepared to establish a technical school such as Winona or Cincinnati University. Fortunately, however, like industries usually locate in the same neighborhood, so that it is possible for manufacturers employing a similar class of labor to cooperate in the establishment and maintenance of apprenticeship schools. In Bridgeport, Conn., this has been done very successfully. The members of the local manufacturers' association, working in conjunction with the Y. M. C. A., have established a school for apprentices, who attend class two hours per day for five days a week. The boys are paid regular wages for the time they spend in the class room, and the entire expense of the instructor, who is especially employed for this purpose, is borne by the manufacturers who have boys in the school."

Too much emphasis cannot be laid upon the necessity of education in connection with shop training. This education must be of a practical nature and particularly adapted to each trade. Moreover, special provision should be made to accommodate the exceptional apprentices who are capable of rising above their fellows. These are the "cream" and are the future foremen, superintendents, and managers. In the shop, regular courses must be laid out and rigidly adhered to. The shop instructor should make up a regular schedule so that shifts can be made without delaying work or demoralizing the shop. Provisions should be made in the schedules so that apprentices showing a special aptitude for some particular branch of their trade can spend more than the regular allotted time on that branch.

So far only regular apprentice courses have been considered, but special courses intended for the instruction of grown men in specialized work are also important. The National Machine Tool Builders' Association has recognized the necessity of special apprenticeships and has laid out the following courses of instruction:

Turning: Two years.
Boring, Vertical and Horizontal: One and one-half year.
Planing: One and one-half year.
Milling: One and one-half year.

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* Chief Engineer, Froggatt, Morrison & Co., 149 Broadway, New York City.

Drilling: One year.
Grinding: One year.
Erecting: One and one-half year.
Turret: One year.
Vise Work: One and one-half year.
Scraping: One and one-half year.

Shops that have tried these special courses are highly enthusiastic over their success. As it is hardly practical to send these men to school during working hours, a night school giving short courses of instruction on practical subjects should be established. The development of character in both the regular and special apprentices is largely in the hands of the shop instructor who, of necessity, must be a man whose character is beyond reproach. It is first necessary to gain the confidence of an apprentice, and then to try to correct any evil influences by bringing better ones to bear upon him and talking things over with him in a quiet way. While the moral development is exceedingly important, it will make no difference in the immediate shop output, but ten years from now it will bring results in plenty. The development of loyalty to themselves, their employers, and their country in the future generation of mechanics is worth more in dollars and cents than most of us realize. What can be better for everyone concerned than an earnest, loyal corps of employes, sober and industrious, wide awake and ambitious? Apprentice clubs are of great assistance in the development of character and are also of much help in an educational way. They may also be easily extended to assist in the physical development of the members. Wherever practical such clubs should be formed.

The work of organizing the courses of apprenticeship, selecting the lines of education, conducting the clubs and securing the instructors and teachers should come under the direct supervision of some high official of a concern, but the details should not be undertaken by him unless he gives up his other duties; this for the simple reason that he will not have the time to devote to the duties, and the subject is important enough to require the entire time of the best man obtainable. In the case of small shops, several could combine and place all of their apprentice problems in the hands of one man. There are those who will say, "All this sounds very fine, but it costs too much money." Here is the crux of the whole matter; these methods are not money wasters, but money earners. To quote again from Mr. Bullard: "Many large and successful concerns which have had apprenticeship systems in operation for a period of years are unanimous in their statements that apprenticeship systems do pay. If properly instructed and intelligently directed, their employment is more profitable than the employment of the so-called skilled workman who has been available in the past. Apprentices pay as producers during their term of service, as competent skilled journeymen when they have completed their course, and as industrially intelligent foremen and executives later on. Those boys who leave at the termination of their apprenticeship become staunch supporters of the mother-shop, always ready to say a good word for it."

In a concern which the writer recently visited, where very complete machine records are kept, forty per cent of the machines were operating at an average efficiency of forty-seven and a half per cent. This efficiency is not a comparison with an arbitrary standard, but with schedules that have been maintained and upon which other workmen have earned a substantial bonus. It would certainly pay this concern to have mechanics who would operate these machines at a rate nearer their normal capacity, for under the present condition there is not only a great loss in output, but a heavy increase in the unit cost. To make the matter perfectly clear, consider as a concrete example; standard time 8 hours, wage rate $0.30, and burden rate $0.24.

COST AT STANDARD TIME

Wages 8 hours at 30 cents	$2.40
Bonus	.48
Burden 8 hours at 24 cents	1.92
Total cost	$4.80

COST AT 47 1-2 PER CENT EFFICIENCY

Wages 16.8 hours at 30 cents	$5.04
Bonus	0.00
Burden 16.8 hours at 24 cents	4.03
Total cost	$9.07

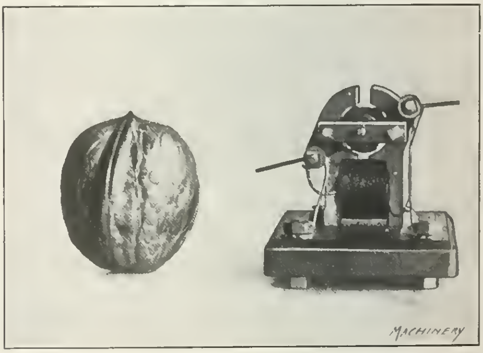
Here we have less than half the normal product at nearly double the cost, which is an average figure and must be multiplied by fifty to get the total for all the machines in the department. This, of course, only illustrates the loss due to lack of skilled mechanics, and there may still be a fear that the apprentices do not pay during the course of apprenticeship. The experience of one large concern that has very extensive courses of apprenticeship should allay this fear. In computing the cost of work by apprentices, they add to the wages all the expenses of conducting the courses, and to determine the rate per hour divide by the hours spent in the shop thus also placing on the work the wages for the hours spent in school. This concern has excellent records of the work of all employes and a consideration of these records shows that on the average the work done by the apprentices costs 36 per cent less than the same work done by mechanics. In other words, a job costing $10.00 when performed by a mechanic would cost $6.40 when done by apprentices. As apprentices pay both during the period of apprenticeship and afterward, it seems strange that the opportunity for such a profitable investment should be neglected. Let the manufacturers consider this question seriously and there will soon be less complaint about the scarcity of skilled mechanics.

* * *

SMALL ELECTRIC MOTOR

BY CHARLES L. WAGNER*

The accompanying illustration shows an electric motor which is so small that a five cent piece would afford more than enough space for it to rest upon. A fair idea of its size will be obtained from the illustration, where it is shown beside an ordinary English walnut. The idea of building this motor occurred to the writer from reading descriptions of various mechanical curiosities which appear from time to time in the different technical journals. In setting about this task, the idea was to determine just how little material it would require to construct a motor that would run as dependably as those of larger sizes. The base of the motor shown in the illustration is made of wood and plays no mechanical part in its operation.



An Unusually Small Motor

The motor is of the under-wound type and contains only 25 feet of wire in its windings, 9 feet of which is on the armature. The motor is 1 inch high, 5/8 inch wide and 1/2 inch thick, and the armature is 5/16 inch in diameter. The armature shaft is 1/16 inch in diameter and the commutator, which is made in three segments, is 3/16 inch in diameter. This motor constitutes a perfect miniature of larger machines of the under-wound type and runs at 3000 R. P. M. It weighs 12 pennyweight, and when operating hums like the buzz of a bee.

* * *

There is such a wide margin between extreme tinkering with a machine and neglecting to keep it in order that there is but little excuse for indulging in the extremes.

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* Address: 1002 Fourth St., Warren, Pa.

THE HEAT-TREATMENT OF GEARS AT THE BOSTON GEAR WORKS[*]

APPARATUS AND TREATMENT DEVELOPED WITH SPECIAL REFERENCE TO GEAR REQUIREMENTS

BY GEORGE L. COLBURN[†]

The heat-treating equipment of the Boston Gear Works, Norfolk Downs, Mass., is located in a separate fireproof building 26 feet by 45 feet, which consists of a steel framework covered with asbestos protected metal. Fig. 1 shows the arrangement of the equipment which comprises two carbonizing furnaces using coal as a fuel and having heating chambers 24 inches by 60 inches and also the following oil furnaces: Rockwell, 24 inches by 36 inches; American gas, 20 inches by 60 inches; Westmacott, 10 inches by 12 inches; Stewart, crucible and lead reheating. The temperatures are indicated by a Bristol thermo-electric pyrometer. A steel jib crane allows heavy work to be easily placed in or removed from the furnaces and cooling tanks.

Kinds of Heat-treatment

All the work usually carried on in an up-to-date hardening plant is handled at the Boston Gear Works, such as carbonizing and hardening low carbon and alloy steels, oil tempering the higher carbon and alloy steels, treating high carbon and tungsten tool steels, pack-hardening, annealing and drawing. The heat-treatments in use are mainly those recommended by the Iron and Steel Division of the Society of Automobile Engineers, known as the "S. A. E." treatments. These treatments cover carbon steels with 0.10 to 0.95 per cent carbon; carbon steel screw stock; 3½ per cent nickel steel with 0.15 to 0.50 per cent carbon; low, medium and high nickel chrome-nickel steel with 0.15 to 0.50 per cent carbon; low and medium nickel chrome-nickel vanadium steel; 1.0 and 1.20 per cent chrome steels with 0.95 and 1.20 per cent carbon; chrome-vanadium steel with 0.15 to 0.95 per cent carbon; and silico-manganese steel with 0.50 per cent carbon.

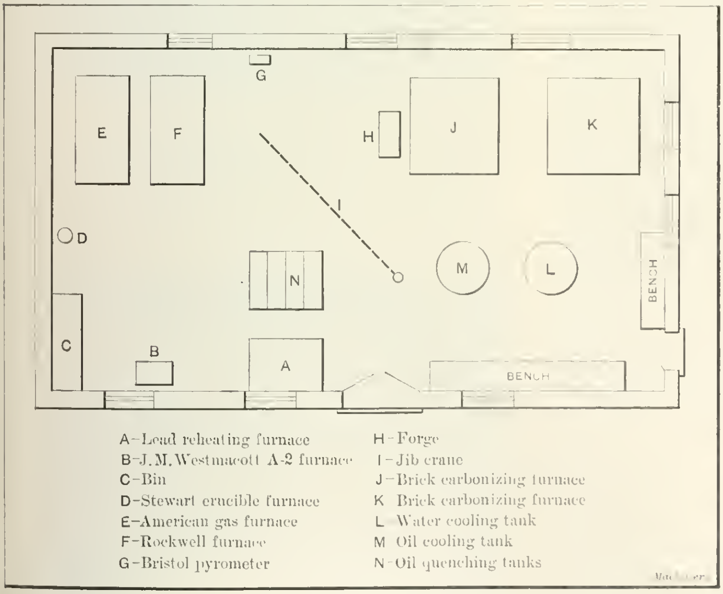

Fig. 1. Plan View of Heat-treating Plant showing Arrangement of Equipment

For special gear steels, referred to in the following list, special treatments are used which have been largely developed in the plant.

For 0.08 to 0.15 per cent carbon No. 1 machinery steel. Treatment *Z*.

For 0.15 to 0.25 per cent carbon No. 2 machinery steel. Treatment *I*.

For 0.35 to 0.40 per cent carbon No. 3 machinery steel. Treatment *E*.

For 0.40 to 0.50 per cent carbon oil tempering No. 4 machinery steel. Treatment *J*.

For 0.15 to 0.25 per cent carbon 3½ per cent nickel steel. Treatment *G*.

For 0.15 to 0.25 per cent carbon chrome-vanadium steel. Treatment *S*.

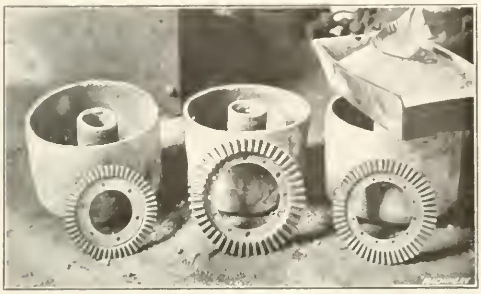

Fig. 2. Pots for casehardening Automobile Bevel Drive Gears

Treatment G

1. Carbonize between 1600 and 1750 degrees F. (1650–1700 degrees F. desired).
2. Cool slowly in the carbonizing material.
3. Reheat to 1450 1525 degrees F.
4. Quench.
5. Reheat to 1300–1400 degrees F.
6. Quench.
7. Reheat from 250 500 degrees F. (in accordance with the necessities of the case) and cool slowly.

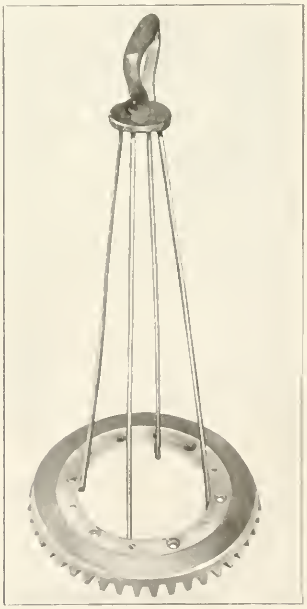

Fig. 3. Holder for dipping Ring Gears

Treatment S

1. Carbonize at a temperature between 1600 and 1750 degrees F. (1650-1700 degrees F. desired).
2. Cool slowly in the carbonizing mixture.
3. Reheat to 1600 1700 degrees F.
4. Quench.
5. Reheat to 1475 1550 degrees F.
6. Quench.
7. Reheat to 250-550 degrees F., and cool slowly.

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[*] For further information on the heat treatment of steel, see "The Pyrometer and Time Study in Steel Treatment," December, 1912; "Analysis and Heat-treatment of Low-carbon and Alloy Steels," August, 1912, and the articles there referred to.

[†] Address: Care of Boston Gear Works, Norfolk Downs, Mass.

Treatment E

1. Heat to 1500 to 1550 degrees F.
2. Cool slowly.
3. Reheat to 1400 to 1450 degrees F.
4. Quench.
5. Reheat to 600 to 1200 degrees F. and cool slowly.

Treatment Z

1. Carbonize at 1600 to 1650 degrees F.
2. Quench direct in oil.
3. Draw in oil 400 to 450 degrees F.

Treatment I

1. Carbonize at 1600 to 1650 degrees F.
2. Cool in pot.
3. Reheat from 1550 to 1600 degrees F. (1575 degrees preferred).
4. Quench in oil.
5. Reheat from 1350 to 1400 degrees F. (1375 degrees preferred).
6. Quench in oil.
7. Draw from 300 to 400 degrees F.

Treatment J

1. Heat from 1450 to 1500 degrees F. (1480 degrees F. preferred).
2. Quench in oil.
3. Reheat to 800 to 900 degrees F. (Sometimes drawn as low as 600 degrees F. or as high as 1100 degrees F., according to requirements).
4. Cool slowly in the air.

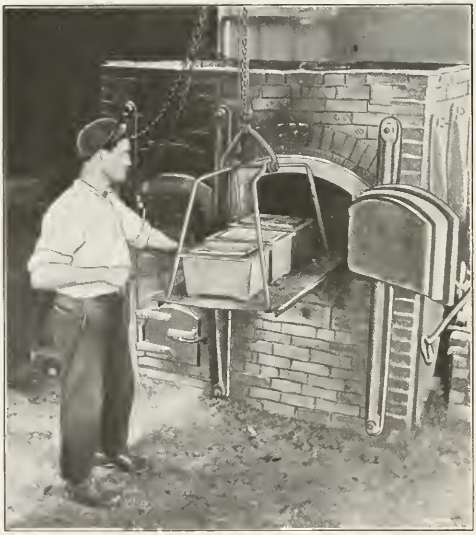

Fig. 4. Method of placing Carbonizing Boxes in Furnace

There is considerable doubt relative to the proper heat-treatment for 0.35 to 0.40 per cent carbon machinery steel, as it is neither a casehardening nor oil tempering steel. This steel is largely used in its natural state. Treatment *E* is the one recommended by the S. A. E. for the treatment of 0.40 per cent carbon steel. Treatments *G* and *S* are also standard treatments of the S. A. E.

The method used by the Boston Gear Works for testing steel for heat-treating is to cut off ¼-inch disks from both ends of a bar after the rough ends have been cut off. The bar is stamped with a number and the disks with the same number. The disks are then heat-treated and broken by a ten-pound drop hammer, the height of drop and number of blows being recorded. Gear teeth are also tested by a Burgess drop hammer testing machine, the standard being a 15-tooth, 6-pitch 14½-degree involute gear of one-inch face. The average of a number of tests on casehardened standard test gears of No. 2 machinery steel required 31 blows with a ten-pound hammer dropped thirty inches to fracture a tooth.

Carbonizing Methods

The depth and quality of the case that is produced depends upon the duration of the heat-treatment, the temperature, the kind of carbonizing material used, the cooling process, and the temperature at which reheating and quenching operations are carried on. For casehardened gears, the best results are obtained with a refined case and fibrous core. Great care is required in packing gears in the pots with the carbonizing material. The pot covers are luted or sealed with fireclay and it is important that no gas escapes. More heats are obtained with malleable iron pots than those of ordinary cast iron, as the latter burn out more rapidly. Granulated bone, charcoal and commercial carbonizing compounds are used for carbonizing.

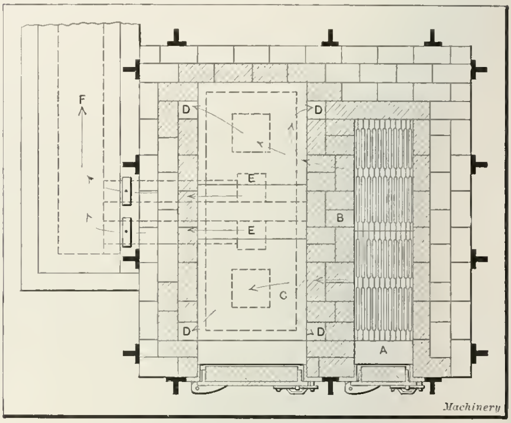

Fig. 5. Plan View of Carbonizing Furnace

Fig. 2 illustrates three casehardening pots for carbonizing automobile main-drive ring bevel gears. These pots have cored centers and lugs on the bottom to allow a more uniform circulation of heat than is secured with the use of ordinary cylindrical pots. The carbonizing material in the pan at the right is packed around the ring gears in the pots, after which the covers are sealed on with fireclay.

Fig. 4 shows the method of placing carbonizing boxes in one of the coal furnaces. The three rectangular boxes on the platform are suspended from an overhead jib crane in front of the open furnace door, ready to be pushed into the furnace. Fig. 5 is a sectional plan of the brick carbonizing furnace and Fig. 6 a cross-sectional elevation. This furnace is of the reverberatory type, the heat being deflected from the firebox *A* over a bridge *B* and down upon the work, the firebox *A* and furnace chamber *C* being arched over. The gases from the furnace chamber *C* descend through four flues *D*. These flues unite in two ducts *E* which lead to the chimney flue *F*.

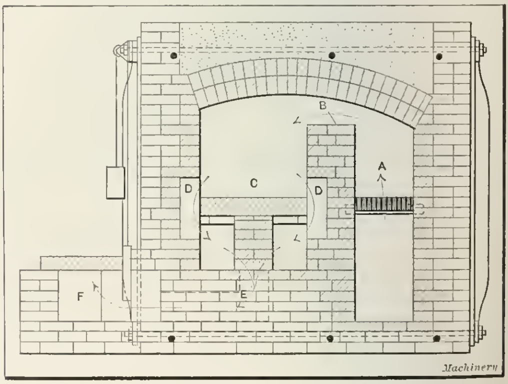

Fig. 6. Sectional Elevation of Carbonizing Furnace

Casehardening

After carbonizing, the work is carefully reheated and treated according to one of the preceding methods. The quenching equipment includes a cylindrical steel water cooling-tank, three feet diameter by six feet deep, with a water inlet and outlet. The tank is placed vertically, with half of its depth below the floor level. A similar oil cooling-tank, thirty inches diameter by six feet deep, is placed in an outer water tank, three feet diameter by six feet deep, which acts as a water jacket. This outer tank has a water inlet and outlet which provides circulation that keeps the oil at a low temperature.

Fig. 3 shows a special fixture for holding ring bevel gears for quenching which has given very satisfactory results, reducing the warpage to a minimum. Fig. 7 shows this fixture ready for use in the oil quenching tank.

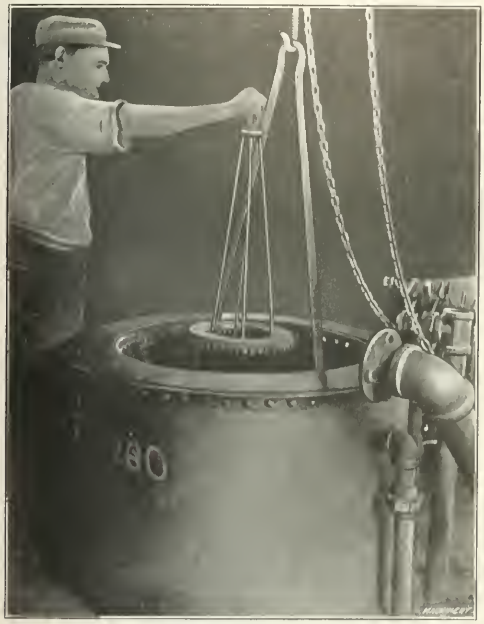

Fig. 7. Gear on Holder ready to dip in Oil

Reheating and Oil Tempering

Fig. 8 shows a gear which has been reheated in the Rockwell oil furnace, and is about to be quenched for hardening. This picture also shows the Bristol pyrometer mounted on a post at the right, and an American gas furnace at the left equipped for burning 34 distillate fuel oil. The four rectangular oil tanks at the front are used for quenching. A special grade of light oil is used for oil-hardening on most classes of work. Fig. 9 illustrates the reheating furnaces equipped with two lead baths, one bath taking work up to sixteen inches diameter and the other up to seven inches. This lead bath furnace, of the company's own design and construction, uses oil as a fuel, and is equipped with a pyrometer so that the temperatures are carefully indicated. The special tools for gripping and handling the various types of automobile gears in a scientific manner are a part of the outfit of the reheating process. An oil tempering bath, with a range up to 800 degrees F., is used for "drawing back" or tempering gears to the required degree of hardness. A special tempering oil is used, having a high flash point. Special thermometers are used in the tempering baths and all degrees of temperature up to 2300 degrees F. are under control. As the work passing through the heat-treating department requires this range of temperatures, it is necessary to have proper heating facilities and equipment that will retain fixed temperatures accurately.

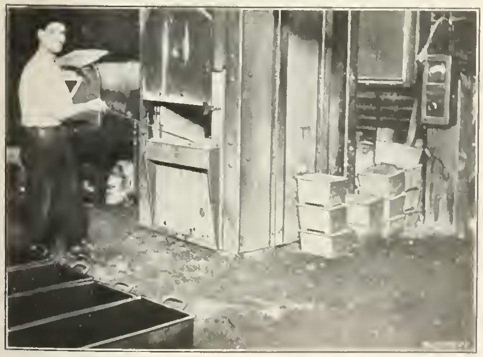

Fig. 8. Removing Small Gear from Heating Furnace

Each particular grade of steel used in the manufacture of gears is stamped with a symbol and these symbols are charted in the hardening room so the hardener knows at a glance what kind of steel he is treating. Carefully written hardening orders, designating the required treatment that the material is to receive, are sent to the hardener with each lot of gears, so that the chances of error in this most important operation are reduced to a minimum. Cleaning baths and wire brush wheels are used to clean the gears after receiving the heat-treatments.

* * *

The popular conception of what constitutes a fireproof building material is somewhat vague, and often buildings are assumed to be fireproof that are nothing of the kind. For example, many people look upon steel construction as a fireproof construction because "steel cannot burn." Steel columns and girders, however, are anything but fireproof in the strict meaning of the word, when in the presence of inflammable materials. When heated, they will bend or buckle, thereby causing the collapse of a whole structure. The collapse of the Chamber of Commerce in Cincinnati a couple of years ago, due to a small fire that was soon put out, was an example of this. A peculiar experience with fireproof electric cables which also shows the difficulty of constructing anything that will, under all circumstances, be proof against fire or heat, is reported from England. In a generating station, certain cables covered on the outside with fireproof braid were destroyed in a remarkable way. The fire itself was a comparatively small blaze started by an accidental short circuit and was promptly extinguished. It appears, however, that the short circuit had enormously overloaded the cables so that the stranded copper cores were heated to a red heat. The expansion of the cores rent the fireproof braid and exposed the rubber insulation underneath to the air so that it caught fire and was destroyed by the flames.

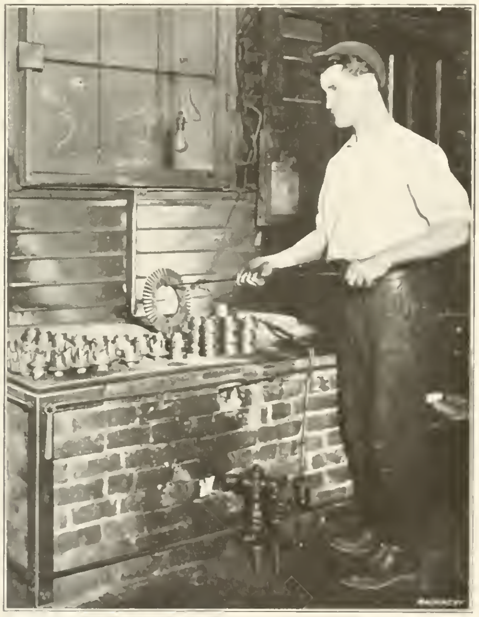

Fig. 9. Reheating Furnace equipped with Lead Baths

HARDENING HAMMER DIES*

HEATING AND PACKING—QUENCHING AND QUENCHING BATHS—TEMPERING

BY WILLIAM E. SNOW†

The hardening of large die-blocks, for either hot or cold work, is a serious problem to most manufacturing concerns, because, in addition to the cost of the steel, a very heavy expense for the labor of die-cutting is involved. The total cost of a pair of dies frequently ranges from one hundred to three hundred dollars or more, so that the loss of a single die in hardening is a serious item of expense, aside from the long time required to replace it. Furthermore, a hammer die that is subjected to the blows of a drop weighing from twelve hundred to eighteen hundred pounds, must be very skillfully heat-treated in order to stand up under the repeated heavy shocks without breaking. For this reason, many concerns send their expensive dies away to be hardened, but as this is not always convenient, a description of the methods and equipment of the expert die hardener may be of benefit to those who wish to do their own hardening.

The requisites for a properly hardened hammer die are: a perfectly hard face, with a sufficient depth of hardening to prevent the surface from sinking; sharp, clean edges and corners; a soft, tough body to insure against breakage; freedom from warping or change of size, due to shrinkage of the steel in cooling. The face of the die should be not only file hard, but should stand a smart blow, of a hardened steel hammer without perceptible dent. With any good uniform die steel these qualities may be readily obtained by the following treatment.

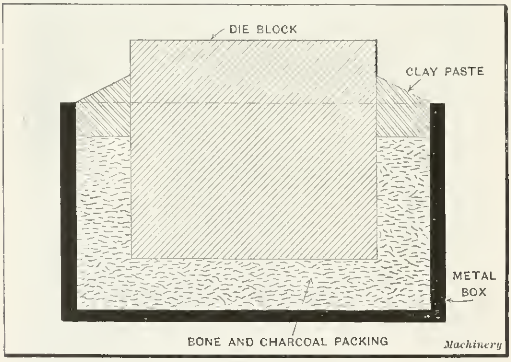

Fig. 1. Packing a Die-block for heating

Heating and Packing for Heating

For heating the dies, an oil or gas furnace is the ideal equipment, but a coal or coke-fired muffle capable of maintaining a temperature of at least 1600 degrees F., will answer the purpose, provided the temperature can be held constant. The great advantage of the gas or oil furnace over the coal or coke-fired muffle is the greater rapidity with which the temperature can be raised or lowered, and the ease with which it can be held constant.

A temperature-indicating device, either pyrometer or pyroscope, is an absolute necessity if good results are to be obtained, as it is impossible to judge the temperature by the eye with sufficient accuracy for hardening this class of dies. A temperature difference of twenty-five degrees has a very noticeable effect upon the die, while a fifty-degree variation may spoil it entirely, particularly if at the critical high heat demanded with some of the best alloy steels. Under certain conditions, a temperature difference of even seventy-five degrees cannot be detected by the eye with certainty. No guesswork should be permitted to enter into the hardening of dies, as a few failures cost many times the price of a good pyrometer or pyroscope.

Dies should always be packed for hardening. To pack a die properly, mix a thick paste of linseed or cottonseed oil and powdered bone-black. Paint the face of the die with a thick coat of this paste, which will bake on under the action of the heat and protect the delicate edges from oxidation through contact with the air.

Next, take a shallow sheet-iron or cast-iron box, an inch or so wider than the die all around, and fill the bottom to the depth of an inch with fresh bone and powdered charcoal, mixed half-and-half. Place the die, face down, in the center of the box, taking care not to displace the paste on the face. Now fill in between the sides of the box and the die with more bone and charcoal, mixed half-and-half, right up to the top of the box. The die should set in the box only deep enough to allow its top edge or back to project about an inch above the top of the box, for convenience in handling with the tongs when removing from the box to quench. Now cover the space between the upper edge of the box and the sides of the die with a thick layer of wet clay paste, which will bake on and keep the charcoal from burning out, and the die is ready for the furnace. Fig. 1 shows the arrangement of the die and packing in the box.

Die steels in general give the best results when quenched at the temperature which produces the densest, finest-grained fracture. Unless you know exactly what this temperature is for the steel you are using, first ascertain it by placing a number of small pieces of the steel in the furnace (they do not need to be packed for this purpose) and hardening and fracturing them at different heats, starting at a low heat and gradually working up until you obtain the greatest refinement of the grain of the steel. Note the temperature at which it is obtained, as that will be the correct quenching heat. Do not assume, because you may be getting good results from your dies, that your heat is correct. Make certain, and you may get even better results.

The dies should be put into the furnace as soon as it is lighted and allowed to "come up" with it. If the correct quenching temperature for the steel is, say, 1500 degrees F., then the furnace should be checked when the pyrometer indicates 1400 degrees, and the dies allowed to soak at that even heat for three or four hours. Then the heat should be slowly raised to the final 1500 degrees, and held at that point for one or two hours longer, according to the size of the die, large blocks requiring a longer time to attain an even temperature throughout than small ones. Then the die is ready for quenching.

Do not attempt to hurry the heating of dies, as it takes several hours for the heat to penetrate the packing and thoroughly soak into the die-block, until the outside and the center are the same temperature. More dies crack in cooling, or afterward, from insufficient heating than from any other one cause. With this in mind, five hours is the least permissible total time in the furnace, and seven to eight hours is much safer. Most expert die hardeners put their dies into the furnace in the early morning, and take them out in the late afternoon.

Care must also be taken that the dies get an even heat in the furnace. As may readily be proved by manipulation of the pyrometer rod, some parts of a furnace are frequently much hotter than others; so, to avoid getting one end of the die hotter than the other, it should be occasionally reversed, end for end, while heating.

Cooling and Cooling Baths

The proper cooling of dies is as essential to good results as the heating itself. Even when a die has been correctly heated, improper cooling may make it too soft, or warp it, or even cause it to crack, rendering it totally unfit for use. The requisites for properly cooling a die are: a sufficient flow of cold water to cause it to harden to the necessary degree of surface hardness to withstand wear, and to a sufficient depth to prevent the surface from sinking under heavy blows of the hammer; and means for applying the water in such a manner as to cause the least possible warping. The rate of cooling has an appreciable effect upon the initial heat required to make a die hard enough. If the water equipment permits of very quick cooling, a somewhat lower heat may be used, and the lower the heat, the less trouble from warping. It is useless to attempt to cool a die-block of any appreciable size in a tank of still water, as the heat in the large body of metal draws the surface faster than the water can harden it. It will harden upon the immediate surface, under such treatment, if heated enough, but there will be no depth to the hardening, and the face will soon sink in use, causing cracks to form. A properly hardened die should have a depth of hardening of from ¼ to ¾ of an inch, according to the steel used. Oil should not be used to harden hammer dies, as its cooling action is not sharp enough to produce a sufficient depth of hardening.

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* For further information on hardening hammer dies see "Drop-Forge Die-Sinking—2," August, 1912.
†Address: 24 Milk St., Boston, Mass.

In cooling, the face of the die should receive a sufficient flow of cold water to cause it to harden to the greatest possible depth. The back of the die should at the same time receive a similar treatment, to make the shrinkage of face and back equal, thereby preventing warping. The sides of the die may be left to take care of themselves. Dies may be hardened either face up or face down, according to the equipment used. Fig. 2 shows a most desirable arrangement for hardening dies face down. *A* is the cooling tank; *B*, the die; *C*, a six-inch water pipe; *D*, an eight-inch overflow pipe; *E*, an inch-and-a-half water pipe; *F*, a quick-opening valve; *K*, a flattened nozzle with a long, narrow opening; *G*, a quick-opening valve; and *J*, adjustable rods for supporting the die at the two ends.

To harden a die, the water level is lowered to the line *H*, by means of the two-inch drain *I*. The packing box containing the die is then removed from the furnace and set upon the floor. The back of the die, which protrudes an inch or more above the packing, is grasped firmly with a pair of tongs and lifted from the box. If the bone paste, which has baked on in a hard crust, sticks to the face of the die, no attempt is made to remove it, as it serves to keep the air from the face of the die until it is under the water, at which time the paste will crack and fly off. The die is immediately placed in the tank, face down under the elongated nozzle *K*, the two ends resting upon the adjustable supports *J*. When in this position, the die should be central over the pipe *C*, as well as central under the nozzle *K*. As soon as the die is in place, the valve *G* is turned on, which permits a large volume of water under pressure to flow out of the pipe *C* up against the face of the die. This flow of water rapidly raises the level in the tank from the line *H*, so that in the course of a few seconds the whole die-block is immersed. Just before the water level reaches the top of the die-block, the valve *F* should be quickly opened, permitting a small stream of water at high pressure to strike the back of the die, thus equalizing the cooling strains. When the water reaches the level *L*, an inch or two above the top of the die, the overflow pipe *D* takes care of it and prevents it from rising further. The flow from pipes *C* and *E* is allowed to continue until the die-block is cool enough to handle, which requires only about two minutes from the time the water is turned on, for a medium-sized die. This is very rapid cooling, as this same die-block, if put in a tank of still water to cool, would retain a visible red for five or six minutes. The application of the water to both face and back of the die, equally, balances the cooling strains and does away with warping.

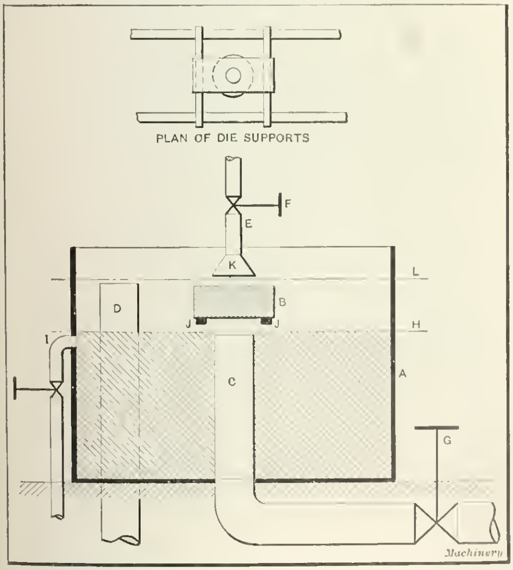


Fig. 2. Cooling Bath arranged to throw Water against Both Faces of the Die

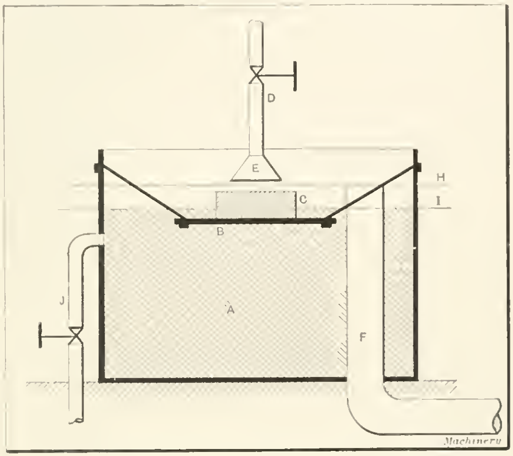


Fig. 3. Cooling Bath arranged to partially immerse the Die and to throw Water against the Top Face of the Die

As it is not always convenient or possible to get a six-inch water supply even at low pressure into the hardening room, an alternative scheme is shown in Fig. 3. This is a method for hardening the die face up, and requires only a small water supply, an inch-and-a-half pipe at forty to fifty pounds pressure, such as is obtainable in most towns. With this arrangement we have the tank *A*, the iron plate *B*, supporting the die-block *C*, the inlet pipe *D*, fitted with the nozzle *E*, and the overflow pipe *F*.

In operation, the water is lowered by means of the drain *J*, to the level *I*, which covers the plate *B* about an inch deep. The die is removed from the furnace as before, and placed upon the plate *B*, centered under the nozzle *E*. The water that covers the plate, and the cold iron itself, rapidly cools the back of the die. As soon as the die is in place, the valve *D* is opened, and the water from the nozzle *E* strikes the face of the die. The water level in the tank rises rapidly to the level *H*, completely immersing the die, and the overflow pipe *F* holds it there. The water from the pipe *D* is permitted to flow upon the face of the die until cool enough to handle.

With this last arrangement, the flow of the water from the pipe *D* must be so regulated as not to cool the face faster than the back of the die; otherwise warping will occur. With a little practice this method will produce nearly as good results as the double pipe arrangement, except that the dies will have a little greater tendency to warp. Either method, though, is far ahead of the common tank in this respect.

Tempering in Oil

Dies should be tempered, or drawn, as soon as they are cool enough to remove from the tank. If not drawn at once, they are liable to develop cracks. For tempering, the proper equipment consists of a small tank of oil, a suitable burner underneath for heating it, and a high-temperature thremometer. Any high-grade cylinder oil of high flash point is suitable for the work. Low-grade oils smoke unpleasantly at moderate heats, and will not stand high temperatures. The drawing temperatures of die steels range from 350 to 480 degrees F. The color barely starts at 350, while 480 produces a very full straw.

Heat the oil bath to the temperature corresponding to the desired color, immerse the die-block completely in the oil, and let it soak for an hour or more. Remove from the oil, quench in water or cool oil, and place in a warm, even temperature over night, or until ready to use. A lead bath should not be used for dies, as the lead will stick to the intricate corners and angles and cause trouble. Oil is the only proper medium for this purpose.

Do not attempt to draw die-blocks by simply starting the surface color on a hot plate or in a furnace, as is common practice in many shops. This heats only the immediate surface, without relieving the greater cooling strains that are locked into the body of the metal. For hammer dies under heavy service it is most important that these strains be thoroughly released; otherwise the dies are apt to crack or break down prematurely. Surface-drawn die-blocks should be classified with the methods of the old-fashioned spring maker who tempered his springs by rubbing them with a charred pine stick, the sparks given off by the burning wood presumably indicating the degree of heat.

Points to Remember

1. Fresh bone has a decided carbonizing (surface hardening) effect upon the steel. The ordinary mixture is half bone and half charcoal. More bone gives greater hardness, more charcoal less hardness, for a given heat. The proportions of bone and charcoal should be varied to suit the work in hand. Increase of hardness means increase of brittleness.

2. Unless the face of the die is treated with a jet of water under pressure, the sunken parts of the pattern will not harden equally with the face. When dipped into still water to harden, steam forms in the die cavity, which keeps the water from entering to properly harden these parts of the die. To overcome this, the water must be forced into the sunken parts of the die by pressure sufficient to overcome the resistance of the steam that is formed by the heat.

3. The most skillfully hardened dies will not give good service unless set absolutely parallel as to their surfaces under the hammer. In a block that is set in the hammer or anvil a little "off" the strains created are enormous, and breakage is sure to result speedily.

4. Hammer dies must have *depth* of hardening, as well as surface hardness, to withstand the heavy blows to which they are subjected. Other kinds of dies do not need this, because the work is light, and service is merely a matter of wear of their edges. Sinking of the face of a hammer die means the development of cracks every time, so the steels used should be selected for their deep-hardening qualities. This means alloy steels, generally, as few carbon steels will harden to a depth of more than 1/16 inch, which is entirely inadequate for this service.

* * *

The rigid accuracy of tooth form and spacing required of gears for high-grade automobiles has made many changes in gear cutting practice. Hardened gears are desirable but very expensive and difficult to produce when the teeth are hardened after they are cut. Unless extraordinary care is taken, the teeth and spacing will be perceptibly distorted. Grinding the teeth may be accomplished and is being done with satisfaction, except on the score of cost. To avoid the troubles incident to hardening after the teeth are cut, some automobile makers are cutting their gears by the planing process after hardening. This also is a slow and costly process but is simple and reliable in results. The planing cuts are taken at slow speed and turpentine is used instead of soda water or lard oil. The work produced is beautiful in finish and, of course, as accurate as the general limitations of the cutting process permit. The hardness of these gears as shown by the scleroscope test is 75 to 80.

* * *

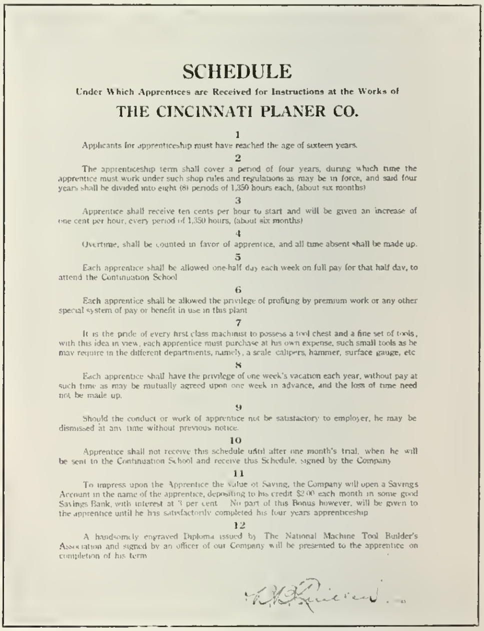
The Bullard Machine Tool Co. is cutting large bevel wheels for boring mills from heat-treated chrome-nickel steel, having a hardness of 35 to 40 scleroscope test. The gears are not heat-treated after cutting, thus changes of tooth shapes and spacing incident to heating and quenching are avoided.

A MODERN APPRENTICESHIP SYSTEM

BY A. J. SCHNEIDER*

The necessity of training apprentices is just as much of a "live question" to-day as it has been at any time during the history of the metal trades, and the purpose of this article is to show the advantages of the "Apprentice Schedule" developed and used by the Cincinnati Planer Co., Cincinnati, Ohio, over the old contract system which was recently discarded. Having seen both systems in use, the writer is in a position to discuss the advantages and disadvantages of each.

To begin this discussion let us make a study of the contract system by supposing that the factory has an opening for a machinist apprentice. Such being the case, the employment department will either send for a boy who has already made application or else take steps toward securing new applicants. A study has been made of methods of advertising for boys and a standard advertisement has been developed that is placed in the newspapers which find their way to the homes of the working people. When an applicant calls and is interviewed, he is told that it takes four years to learn the trade, that he will be sent to school a half day each week with pay, what the rates of payment are and other details; and finally he is told that he *must sign a contract*. This is where the mistake is made. The boy frowns and becomes confused. He doesn't want to sign that contract and although he may not say so, you can see it. There may be no very good reason, but the boy simply doesn't want to bind himself in such a way. Perhaps he feels that he is being forced to do something. He is. You ordinarily go against a boy's nature when you try to force him. If you ask this one why he doesn't want to sign the coutract, he will tell you that he doesn't know that he will like the work, or that if he signs a contract for four years he might want to make a change after having worked for two or three years. Say what you will, most boys prefer to work as apprentices without siguing a contract. The employer is not protected or benefited in any way by the contract, so what is the use of making a boy sign it if he doesn't wish to? The chances of employing the boy are diminished if such a course is followed, and the signing of the contract by him, his father and witnesses, is but an imaginary protection to the employer. In the first place it is not legal, and a boy cannot be compelled to work under the contract if he doesn't want



SCHEDULE

Under Which Apprentices are Received for Instructions at the Works of

THE CINCINNATI PLANER CO.

1

Applicants for apprenticeship must have reached the age of sixteen years.

2

The apprenticeship term shall cover a period of four years, during which time the apprentice must work under such shop rules and regulations as may be in force, and said four years shall be divided into eight (8) periods of 1,350 hours each, (about six months)

3

Apprentice shall receive ten cents per hour to start and will be given an increase of one cent per hour, every period of 1,350 hours, (about six months)

4

Overtime, shall be counted in favor of apprentice, and all time absent shall be made up.

5

Each apprentice shall be allowed one-half day each week on full pay for that half day, to attend the Continuation School

6

Each apprentice shall be allowed the privilege of profiting by premium work or any other special system of pay or benefit in use in this plant

7

It is the pride of every first class machinist to possess a tool chest and a fine set of tools, with this idea in view, each apprentice must purchase at his own expense, such small tools as he may require in the different departments, namely, a scale calipers, hammer, surface gauge, etc

8

Each apprentice shall have the privilege of one week's vacation each year, without pay at such time as may be mutually agreed upon one week in advance, and the loss of time need not be made up.

9

Should the conduct or work of apprentice not be satisfactory to employer, he may be dismissed at any time without previous notice.

10

Apprentice shall not receive this schedule until after one month's trial, when he will be sent to the Continuation School and receive this Schedule, signed by the Company

11

To impress upon the Apprentice the value of Saving, the Company will open a Savings Account in the name of the apprentice, depositing to his credit $2.00 each month in some good Savings Bank, with interest at 3 per cent No part of this Bonus however, will be given to the apprentice until he has satisfactorily completed his four years apprenticeship

12

A handsomely engraved Diploma issued by The National Machine Tool Builder's Association and signed by an officer of our Company will be presented to the apprentice on completion of his term

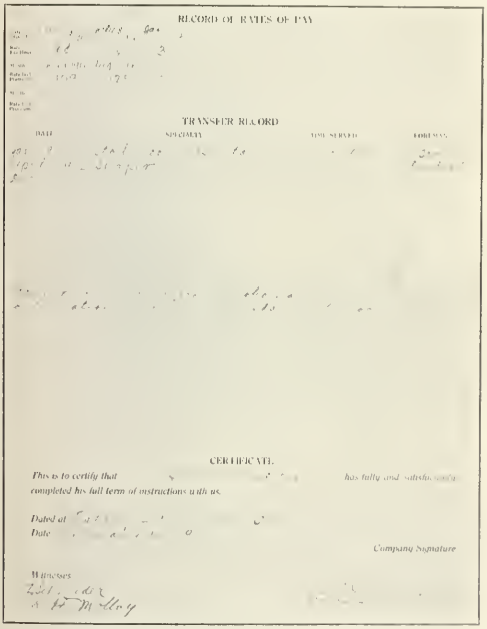
Fig. 1. Rules and Regulations under which Apprentice is employed

to. If he is compelled to work, it is exceedingly doubtful if satisfactory results will be obtained. Don't be selfish; look at the subject from both sides; he may do very well with some other employer or in some other line of work, and he may have very good reasons for not being satisfied. There are probably boys in your own shop who received part of their training in other factories and they are probably good boys at that.

---

* Cost Accountant, Cincinnati Planer Co., Cincinnati, Ohio.

The accompanying illustrations show the apprentice schedule which has been adopted by the Cincinnati Planer Co. This schedule is printed on the four pages of a double sheet 8½ by 11 inches in size. Fig. 1 shows the first sheet which contains the rules under which the apprentice is employed. Figs. 2 and 3 show the two inside sheets of the schedule which is used by both the company and the boy to keep a record of changes, rates, time served, etc. The form shown in the illustrations is a sample of one of the schedules now in use, and the following is a brief outline of the method followed in employing apprentices. Boys are not accepted unless they are over 16 years of age and, as previously stated, the period of apprenticeship is four years. A record of the time served is kept and the apprentice is given an increase in pay of at least one cent per hour about every six months, the increase depending upon his advancement and ability. Credit is given for exactly the amount of time which the apprentice puts in in the shop, plus school and vacation time. He is sent to a continuation school half a day each week, where he learns how to make and read drawings and blueprints and other things that will help him to become more efficient in his work. A method of rewarding him for rapid advancement is provided by allowing him to benefit by any premium or other system of pay which is used in the plant.


RECORD OF RATES OF PAY

TRANSFER RECORD

DATE	SPECIALTY	TIME SERVED	FOREMAN

CERTIFICATE.

This is to certify that [illegible] has fully and satisfactorily completed his full term of instructions with us.

Dated at

Date

Company Signature

Witnesses

Fig. 2. Inside of Schedule used for keeping Record of Rates of Pay

It has been recognized that a boy will naturally take more interest in his work if he owns a complete set of tools, and consequently each apprentice is asked to provide himself with a good tool box and a set of tools. It is felt that a boy who works faithfully during the year is entitled to a vacation and, therefore, each apprentice is offered one week's vacation. Paragraph 11 of the schedule shown in Fig. 1 represents a change from the old idea of paying the apprentice a bonus of $100 on the completion of his term. This method has been modified by opening a bank account for each boy at the end of his first month's employment. A bank book is issued in his name and he is credited with $2 for every month's work, the deposits so made drawing 3 per cent compound interest. It is believed that this course offers an inducement for the boy to save money. Another advantage is that a boy can see his bonus increasing every month, and knowing that he cannot use it until the expiration of his term, he is more anxious to remain until its completion. The bank book is given to the boy twice a year (at the time of interest payment) and he is told to take it home, show it to his people and then return it before the first of the following month. Close cooperation of parents is invited and they are welcome to call upon the management at any time. In case of trouble of any kind, the parent is sent for and it has been found that a discussion of the difficulty between the parent and management will improve the boy's future conduct. The best apprentice is usually the one whose parents take an active interest in his work and advancement.

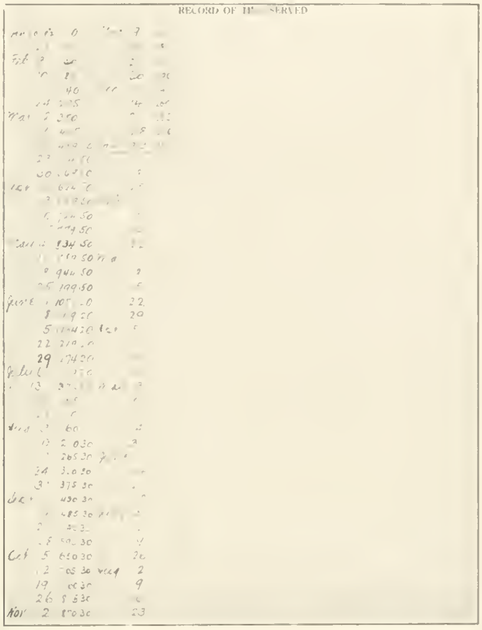
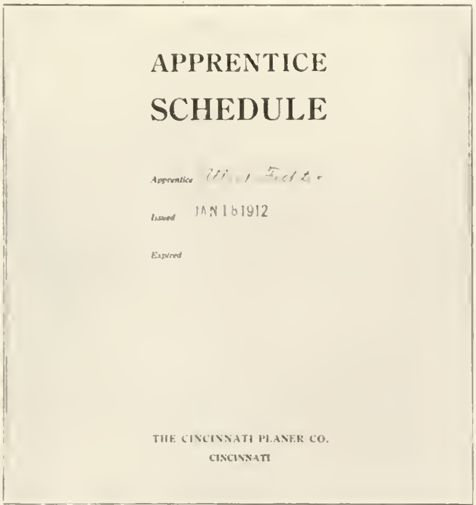

RECORD OF TIME SERVED

Fig. 3. Inside Sheet used for keeping a Record of Time served by Apprentices


APPRENTICE SCHEDULE

Apprentice

Issued JAN 16 1912

Expired

THE CINCINNATI PLANER CO.
CINCINNATI

Fig. 4. Outside Sheet of Folder showing Data used for Filing Purposes

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

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UNNECESSARY EYE-STRAIN IN THE DRAFTING-ROOM

The weakening of the eyesight of draftsmen and the various nervous ailments, headaches, etc., that often follow, are frequently due to wholly unnecessary eye-strain. The eyesight is not weakened by continuous use entirely, but rather by use under improper conditions. Adequate lighting, both natural and artificial, is a primary requirement, but there are other causes of eye-strain in the drafting-room that are perhaps just as important. The making and reading of drawings with lines of inadequate thickness put the eyes to a test that is far more injurious than is their continuous use. The making of tracings from pencil drawings where the lines are so fine that they are barely distinguishable through the cloth, puts an extreme strain on the eyes.

With many draftsmen it seems to be a hobby to use pencils entirely too hard to produce a line of adequate thickness. Many draftsmen will say that if they use a softer pencil, which will produce a strong, easily distinguished line, it will smudge on a drawing upon which they may have to work for a considerable length of time, and that in drawings with fine detail, it is absolutely necessary to use a hard pencil so as to be able to draw very fine lines. This may be true in extreme instances, but as a rule it is possible to make such drawings to a larger scale so as to avoid the necessity for such lines. At any rate, drawings in which extremely fine lines are necessary are not made constantly, and softer pencils than, for example, 6-H could be used to advantage for everyday work.

A drawing with very fine lines may look neat to the casual observer, but the man who must work from it will appreciate bold, distinct lines, and as drawings are made for *use* and not for *appearance*, why not make them so as to best meet all practical requirements, and at the same time save the draftsman's eyesight? The latter incidental result is well worth accomplishing.

* * *

THE ENGINEERING OF ACCIDENT PREVENTION

Considerable misunderstanding seems to prevail on the question of accident prevention. It is looked upon by many as a purely humanitarian matter, and the general public appears to have the opinion that whenever an employer becomes imbued with the humanitarian spirit he merely has to spend a few dollars, or at least not an excessive sum of money, and say: "Henceforth we are going to prevent accidents in this factory." There is no question but that the initiative rests with the employer, and without his good-will and cooperation accident prevention is a difficult task; but apart from the efforts of the individual employer, the problem has vast ramifications. The prevention of accidents includes the solution of many difficult engineering problems. The designer both of machinery and of plant and general shop equipment needs training in order to understand the problems connected with accident prevention and to be able to guard against accidents in an effective manner. It seems safe to say that many accidents due to inherent dangers in machinery could be prevented *before* the machines are built. The time when they can be best guarded against—as has been repeatedly emphasized in MACHINERY—is when the design is on the drawing-board. The designer, the mechanical engineer, the superintendent of the plant—anyone responsible for the conditions under which men will operate machines or perform their duties—have a difficult task, and one that requires as careful attention as that of the purely operative features. The problem of accident prevention is essentially an engineering problem, and every machine designer should realize that the machine which is unsafe to operate is a failure, even if it should have 100 per cent efficiency. The plant in which men risk life and limb or health is not a well-designed plant, no matter how expeditiously the work passes through it.

* * *

THE PRINCIPLES OF GAGING

A common idea of a gage is that it is and should be an exact complement of the part to be produced in all essential details. A thread plug gage, for instance, is regarded as being properly a steel plug threaded and hardened, the thread shape being exactly that of a standard thread. A U. S. standard thread gage will be made with a thread section of sixty degrees included angle and with the top and bottom flattened one-eighth the pitch; a Whitworth gage with fifty-five degrees included angle and the top and bottom rounded.

The makers furnish gages in these forms in response to common demands, although they know well that a gage so made is not a properly designed testing instrument. It is true that the ordinary thread plug gage may answer for the purpose designed with general satisfaction and it is also true that it is hardly practicable to devise a low-priced gage in which the faults of the plug gage are eliminated. The plug gage satisfies the common demand for a standard form that can be referred to for all dimensions, angles and shapes. The mechanical public should recognize the fact, however, that a gage which measures all the dimensions of even a simple part, is likely to be a very poor instrument for testing its accuracy.

As a general principle, a plug should never be required to measure more than one diameter except in the case of tapers, and not even then where close limits are established. A solid gage should not be required to verify concentricity of more than two bored diameters simultaneously, nor should it be required to establish the truth of a tapered part with the axis of a bored hole by reference to any other part than the hole itself. Take the cartridge chamber of a rifle as an illustration. In this example, a chamber of peculiar shape is required to agree with master plugs and to be concentric in all cross-sections with the axis of the barrel. An amateur's idea of a proper gage would perhaps be a hardened steel plug fitting the chamber at all points and extending some distance into the barrel. Practically, such a gage is useless, for it covers so much that nothing is definitely determined within the limits prescribed by gun-makers.

The best type of gage and the one that is being adopted by progressive concerns whose work permits, is that in which fixed gage points are replaced by adjustable gage points fitted with micrometer dials so that the plus or minus readings can be taken. Gages of this style have been used for some time in the manufacture of sewing machines and guns. While costly to equip, they are correct in principle, and when intelligently used insure exact measurements and interchangeability.

MATHEMATICS FOR ENGINEERS

Engineering practice, both in design and operation, is based on our knowledge of physics and mathematics. The more exact and complete that knowledge, the less uncertain engineering results become, and hence the less the factor of safety or "factor of ignorance" as, aptly enough, it has been called. Too implicit a reliance on the conclusions of purely mathematical investigation has been a frequent fault in the past. The reams of baseless theory written on the gyroscope, the fall of the Quebec Bridge because a mathematical formula was stretched beyond its rightful limits, and the fact that, after more than seventy years of mathematical and physical theorizing, marine engineers are still unable to design a screw propeller which shall be fully efficient under novel conditions —all these are cases in point. While mathematical processes are essentially methods of precision, they give trustworthy results only when the basic assumptions from which they proceed are correct. Otherwise, like the house built on the sand, they fall before the winds and waves of practical experience.

In addressing the Mathematical Congress at Cambridge, England, in August, 1912, the late Sir William H. White, the foremost naval architect of his time, said:

> Purely mathematical theories have served, and still serve, a useful purpose in engineering; but it is now universally agreed that the chief services of mathematics in engineering are rendered in framing schemes for experimental research, in analyzing results, in directing the conduct of observations on the behavior of existing engineering works, and in the establishment of general principles and practical rules which engineers can utilize in their daily professional employment. * * * The mission of engineers as a class is to produce results, "to do things" which shall be of practical service to humanity and shall insure the safety of life and property. Complete solutions of problems, in the mathematical sense, are not usually to be found by engineers. They have to be content, in many cases, with partial solutions and fair approximations.

No argument is needed to prove that every young engineer—in college, in practice, or in the shops should endeavor to acquire an adequate knowledge of mathematics. It is a mental tool which is in constant use in much of his daily work. Without it, even the approximate solution of difficult problems in untried fields would be impossible; and, in training the mind in logical and precise methods, it is invaluable. He finds, however, two obstacles to overcome: First, to decide just what, in his own case, this "adequate" knowledge comprises; and, second, how to gather this special knowledge, owing to the very general manner in which the whole subject is usually presented to him. Almost universally, engineering students are taught mathematics by mathematicians, and this practice has wide approval in that it gives a broader and more comprehensive view of the subject. There is, however, a marked difference between the engineer skilled in mathematics and the mathematician who has a general acquaintance with engineering work. In important respects, the two differ radically in their habit of thought. Mathematical methods are essentially rigid and precise; while, on the other hand, the determination of a stress to the nth place of decimals does not concern the engineer. In fact, any expenditure to obtain accuracy which is beyond "good enough" engineering requirements is a waste of time and money.

Hence, there seems much to support the argument often advanced that our technical schools should give supplementary courses in applied mathematics conducted by, and for, engineers. It is one thing to teach a student the general uses and handling of a file or a chisel, and quite another to show him, by concrete examples, the many things which can be accomplished with these tools. Such a course should exclude everything which is purely academic or is not required to meet the student's special needs, and it should show him, by varied and abundant examples from practice, the definite applications of mathematics in his special branch of engineering. Prof. John Perry, in his admirable work, "Calculus for Engineers," obviously had this need in view. A series of such books, covering the whole field of mathematics, would be of much service, not only to college students, but to practicing engineers and to that far greater body of eager and ambitious young men whose circumstances forbid technical training and enforce self-instruction.

THE 1912 U. S. STANDARD FOR FLANGED FITTINGS AND FLANGES*

The dimensions of the standard fittings and flanges adopted by the National Association of Master Steam and Hot Water Fitters and the American Society of Mechanical Engineers, are given, in part, in the Data Sheet Supplement accompanying this number. The tables in the Data Sheet cover the standard weight fittings from the 1-inch to the 26-inch size, whereas the 1912 U. S. standard includes standard weight fittings varying from 1 inch to 30 inches and extra-heavy fittings varying from 1 inch to 24 inches. The adoption of these schedules was the result of a long and careful investigation by the National Association of Master Steam and Hot Water Fitters' committee on standardization and a similar committee of the American Society of Mechanical Engineers.

The special feature of the 1912 U. S. standard is the interchangeability of fittings. For example, the face-to-face dimensions on the "run" of, say, 12-inch tees is the same whether the size be 12 by 2 or 12 by 12 inches. Crosses of corresponding diameter will also interchange with tees, the face-to-face dimension being standard. A cross or tee will also interchange with an elbow of the same nominal size. The advantages of this feature of interchangeability are obvious. In determining the dimensions and sizes, the aim of the committees was to provide for adequate strength, with the lowest cost consistent with uniformity. The various makes of flanges and fittings used heretofore have had such a low factor of safety as compared with the pipe itself, that it was deemed advisable to adopt a standard giving a higher factor of safety in the bolts, flanges and fittings.

The 1912 U. S. standard-weight flanges are identical with the alternative standard flanges submitted by the sub-committee of manufacturers with respect to diameter of bolt circle, number of bolts and diameter of bolt holes, with the exception that the U. S. standard gives ⅞ inch instead of ¾ inch for diameter of bolt hole for 4-inch pipe. The standard of the Engineering Standards Committee of Great Britain, and the standard of the *Verein deutscher Ingenieure*, do not have sizes exactly corresponding to the standard weight and extra-heavy weight of the 1912 U. S. standard, but have the most important dimensions the same for all pressures.

For extra-heavy flanges up to 9 inches inclusive, the 1912 U. S. standard and the standards of most manufacturers are identical. Above 9 inches the U. S. standard is somewhat larger than the present standards. With the British standard, the diameter of bolt circle and number of bolts are the same for pipes corresponding to the 1912 U. S. standard, or the proposed Manufacturers' standard weight and extra-heavy weight, but for sizes above 10 inches, the diameter of the bolt circle is from ¼ to ½ inch less than the proposed Manufacturers' standard and ¾ inch less than the U. S. standard. The number of bolts, in most cases, for pipes above 10 inches, in the U. S. 1912 and Manufacturers' is from two to four bolts greater than in the British standard. As far as size of bolts is concerned, the British standard makes a distinction between pipes for pressures up to 225 pounds and up to 325 pounds. The bolts for pipes up to 225 pounds, are below the Manufacturers' standard ⅛ inch in nearly every case, and below the U. S. standard from ⅛ to ⅜ inch. In pipes for a pressure of 325 pounds, the British standard is the same as the proposed Manufacturers' schedule in all cases except 14- and 18-inch sizes, in which cases the British standard is ⅛ inch larger than the Manufacturers' standard, but is from ⅛ to ¼ inch smaller than the U. S. standard.

It is thus seen that wherever there is a distinction between the 1912 U. S. and proposed Manufacturers' standard, the 1912 U. S. standard is invariably on the side of greater safety and strength and has the added feature of interchangeability, whereas the proposed Manufacturers' schedule has different face-to-face dimensions. As to the comparison with the British and German standards, it must be remembered that they cover, by one standard, both weights of the American specifications, and naturally, as would be expected with compromises, must have higher values for standard-weight pipes and lower values for extra-heavy weight pipes.

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* With Data Sheet Supplement.

DESIGNING FACEPLATE JAWS AND SCREWS FOR A HEAVY LATHE

AN ANALYSIS OF STRESSES AND DETERMINATION OF DIMENSIONS TO RESIST THEM

BY W. G. DUNKLEY*

There are some cases in the design of machine tools where the determination of the strength of different parts by rigid calculations is practically impossible, owing to the uncertain nature of the stresses involved. In other cases, such calculations would probably be unnecessary, because the designer might safely rely upon his experience to guide him in proportioning the parts correctly. In designing the jaws and screws for the faceplate of a heavy lathe, however, it is both possible and necessary to determine the limiting sizes by direct calculation. A lathe which is required for heavy faceplate operations may be severely handicapped, simply because its faceplate cannot carry work which might otherwise be handled in the lathe. The greatest difficulty which confronts the designer in work of this kind is that he does not always know the actual load that the machine members may be called upon to carry; in such cases, the approximate load can only be determined by supposition.

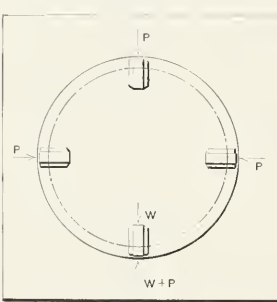

Fig. 1. Pressure on Jaws with Screws Vertical and Horizontal

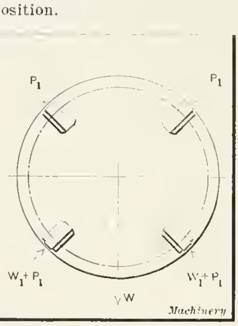

Fig. 2. Pressure on Jaws with Screws inclined 45 Degrees

In the design of the jaws and screws for the lathe faceplate dealt with in the present article, the writer has selected a case in which the work is 12 feet in diameter by 3½ feet long and weighs 80 tons. The first point to be considered is the equilibrium of the load when held stationary in the position shown in Fig. 1. There is obviously a tendency for the load to rotate about the point *O*, Fig. 3. In order to fall from the faceplate, it would be necessary for the work to shear off the corner of the top jaw at *N*; but since the distance O-N_1 is very little greater than the distance *O*-*N*, this will not be necessary if the jaw does not fit well on the work, as indicated by the dotted lines. On this account, it is safer for purposes of calculation to consider that the work is prevented from falling over by the frictional resistance due to the pressure of the three upper jaws. The two side jaws may possibly relieve the lower jaw of a part of the load, but here again it is safer to assume that the lower jaw takes the total downward force due to the weight of the work. If the work is of the shape indicated by the dotted line at the lower jaw, the pressure on this jaw will be concentrated at the point *O*, and we will consider that this is the case, in order that the extreme condition of stress may be dealt with.

The Maximum Pressure on the Lower Jaw

Referring to Fig. 3, let *P* be the necessary pressure on each jaw to give the required frictional resistance to prevent the work from falling over. If μ is the coefficient of friction, μP is the frictional resistance offered by each jaw to prevent the work from falling over. Taking moments about *O* we get:

$$144\,\mu P + 2 \times 72\,\mu P = 80 \times 16 \text{ inch-tons.}$$

$$288\,\mu P = 80 \times 16 \text{ inch-tons.}$$

Assuming $\mu = 0.2$, we get

$$P = \frac{80 \times 16}{288 \times 0.2} = 22 \text{ tons (approximately.)}$$

Perhaps it should be mentioned at this point that the pressure of the jaws on the work would really be somewhat greater than the result obtained by the preceding calculation, in order to hold the work when the faceplate is in the position shown in Fig. 2. The value of *P*, however, is undoubtedly greater than it actually needs to be, because the fact that the jaws are serrated has been neglected. This serration of the jaws will enable them to bite into the work to some extent, the result being more than sufficient to adequately insure the ability of the faceplate to hold the work.

Referring to Figs. 1 and 3, it will be seen that allowance must be made for a total vertical pressure of $W + P$ tons on the lower jaw. We have assumed that this pressure is concentrated at the point *O*, its amount being given by the following equation:

$$W + P = 80 + 22 = 102 \text{ tons.}$$

Determining the Depth of the Lip

The lip of the jaw $AOBA_2$ in Fig. 4 is a cantilever loaded with $W + P = 102$ tons at the end, and having a length of 5 inches. Therefore, the stresses across the section A-A_2 consist of a shearing stress varying from zero at *A* and A_2 to a maximum at A_1,* and also of tensile and compressive stresses of varying intensity, the latter being due to the bending moment of the load which is:

$$M = 102 \times 5 \text{ inch-tons.}$$

It will be evident that the stresses across this section are of variable intensity. Without entering into a complete discussion of this matter, we will deal with the tensile stress at the point *A*; this is the point of maximum tensile stress in the section and so may safely be used as a basis of calculation.

Let f_t = safe tensile stress = 6 tons per square inch;

$$Z = \text{modulus of section} = \frac{b \times H^2}{6};$$

M = maximum bending moment in inch-tons.

Then $f_t Z = M$ inch-tons.

Substituting known values in this equation, we have:

$$\frac{6 \times 8H^2}{6} = M = 102 \times 5 \text{ inch-tons.}$$

$$H^2 = \frac{102 \times 5 \times 6}{6 \times 8} = 63.7.$$

$$H = \sqrt{63.7} = 8 \text{ inches (approximately.)}$$

If we consider that the load is not concentrated at *O*, but that it is equally distributed along *A*-*O*, the value of the bending moment will be:

$$M = 102 \times \frac{5}{2}$$

$$H^2 = \frac{102 \times 5 \times 6}{2 \times 6 \times 8} = 31.8$$

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* Address: 25 Rothwell St., Manchester, England.

[* The common theory of flexure is a convenient assumption for practical purposes, and assumes that the internal stresses at any transverse section of a loaded beam are resolved into horizontal components producing longitudinal tension or compression, and vertical components producing vertical shear. The stress due to this shear is assumed to be of uniform intensity over the transverse section of the beam. This common theory of flexure, therefore, disregards the horizontal shear in the beam due to bending. Assume, for example, that a wooden beam 12 by 12 inches and of any convenient length is supported at both ends with a load in the middle; it will then bend a certain amount. Then take a pile of boards, each board being 12 by 1 inch and of the same length as the beam. Stack these boards to form a beam 12 by 12 inches and support and load them in the same way the beam was loaded. According to the common theory of flexure, both these beams have equal resistance to bending, but it will be found that the composite beam will bend considerably more than the solid beam. The reason is that in the solid beam there is a resisting horizontal shearing stress which opposes bending. This is absent in the composite beam, because the boards are free to slide on each other. The true shearing stress, therefore, is different from that assumed by the common theory of flexure. When the horizontal shearing stress is considered, the intensity of the resulting shearing stress varies from zero at the lower and upper surfaces of the beam to a maximum at the neutral surface. The common theory of flexure, however, in neglecting the horizontal shear generally errs on the side of safety. It is, in general, unnecessary to consider the horizontal shear, but the author of the present article has undoubtedly called attention to the varying stresses due to shearing, in order to make clear the difficulty of an exact theoretical analysis and to show how the calculations can be carried out to satisfaction, even when the complex nature of the stresses is disregarded.—EDITOR.]

$H = \sqrt{31.8} = 5.65$ inches

An approximate value of H lying between the two values determined by the preceding calculations is 7 inches, and this would probably represent a safe figure for practical purposes. Considering the fairly high safe stress of six tons per square inch that was assumed, however, it will probably be wiser to accept the first value of $H = 8$ inches in order to make allowance for heavier work that may be set up in the lathe. It is important to note that if the value of H had been determined by simply considering the shearing stress on the section A-A_2—a shearing stress of 5 tons per square inch being used—the value of H would have been as follows:

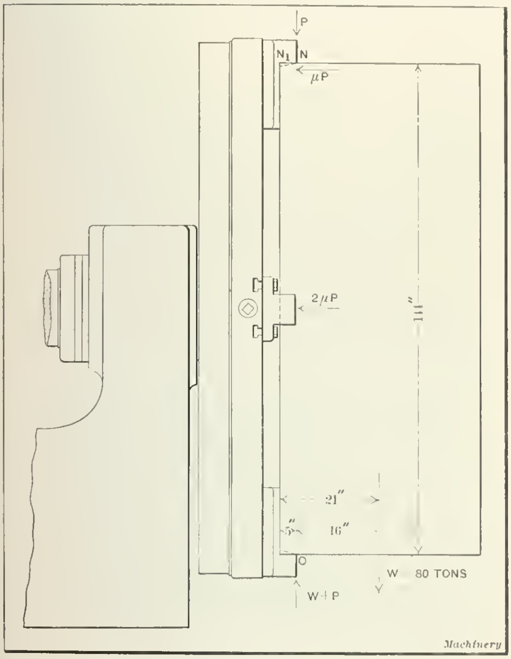

Fig. 3. Stresses produced by Weight of Work on Faceplate Jaws

$5 \times \text{area} = \text{total shearing stress} = 102$ tons

$5 \times 8H = 102$ tons

$$H = \frac{102}{40} = 2.55 \text{ inches}$$

It will be obvious from a comparison of this value with the values obtained in the preceding calculations, that the result obtained from a simple consideration of shearing stresses is entirely inadequate; and that it is essential to consider both the bending and shearing stresses in designing this member.

The Size of the Bolts in the Jaws

The forces which hold the lower jaw in equilibrium are shown in Fig. 4, where the vertical downward pressure on the jaw of $W + P$ tons is balanced by the vertical reaction R of the screw, by the friction between the jaw and faceplate, and by the friction between the T-nuts and T-grooves. If T is the tension in tons per bolt, the frictional resistance caused by the eight bolts will be as follows:

$8\mu T$ = frictional resistance between jaws and faceplate.

$8\mu T$ = frictional resistance between T-nuts and T-grooves.

Assuming a value of 0.2 for the coefficient of friction μ, we have the total of the frictional resistances as follows:

Total frictional resistance $= 16 \times 0.2\,T = 3.2\,T$ tons. To preserve equilibrium, the total upward forces must balance the total downward forces and so we have:

$$R + 3.2\,T = 102 \text{ tons} \qquad (1)$$

Taking moments about C, we get

$RX + 102\,Y = 2 \times 4\,T + 2 \times 10\,T + 2 \times 16\,T + 2 \times 22\,T$

$RX + 102\,Y = 104\,T$

In the preceding calculations, the value of the frictional resistances between the T-nuts and T-grooves of the jaws have been neglected as their value is relatively small. Giving X a value of 4 inches and Y a value of 10 inches, we get

$$4R + 1020 = 104\,T \qquad (2)$$

In order to solve these two equations to determine the values of R and T, we multiply Equation (1) by 4 which gives

$4R - 408 = -12.8\,T$

Subtracting this result from Equation (2) gives

$1428 = 116.8\,T$

$$T = \frac{1428}{116.8} = 12.2 \text{ tons per bolt}$$

Substituting this value of T in Equation (1) we get

$R = 102 - 3.2 \times 12.2 = 63$ tons.

We see from this result that when bolts are tightened up sufficiently to prevent the work from slipping, the frictional resistance will take 39 tons of the vertical downward load of 102 tons, leaving the screw to carry the remaining 63 tons. Assuming the safe stress on the bolts to be 3 tons per square inch, we have

$3A$ = tension per bolt $= 12.2$ tons.

This gives the value of A—the cross-sectional area of the bolts—as follows:

$$A = \frac{12.2}{3} = 4.06 \text{ square inches}$$

$$D^2 = 4 \times \frac{4.06}{\pi}$$

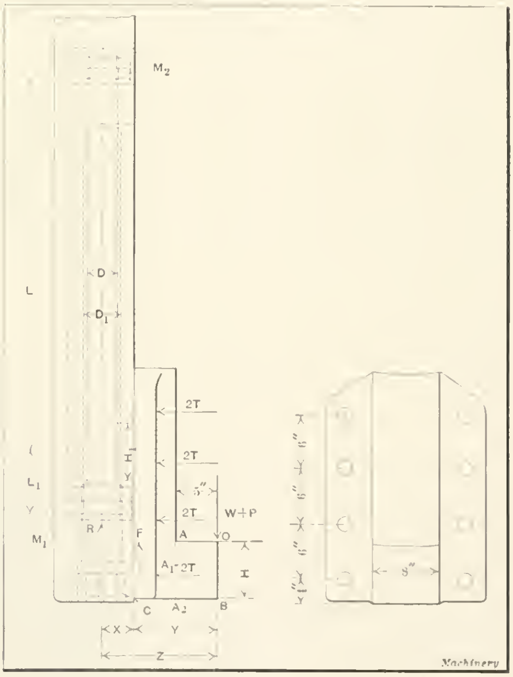

Fig. 4. Analysis of Stresses in Lower Jaw and Screw

$$D = \sqrt{4 \times \frac{4.06}{\pi}} = 2.25 \text{ inches (approximately)}$$

It is, of course, impossible to know with what intensity the bolts will be tightened up, and for this reason the safe tensile stress has been taken at the very low figure of 3 tons per square inch, in order to allow for excessive tightening.

The Adjusting Screws

The design of the adjusting screws is an extremely important part of the faceplate design, as it is evident that these screws are called upon to carry a very considerable load. We have already seen that the maximum load on each screw is 63 tons. Assuming a safe stress of 5 tons per square inch, we have:

$$5A = 63 \text{ tons}$$

$$A = \frac{63}{5} = 12.6 \text{ square inches}$$

$$D^2 = 4 \times \frac{12.6}{\pi}$$

$$D = \sqrt{4 \times \frac{12.6}{\pi}} = 4.0 \text{ inches.}$$

We come now to the question of whether the lock-nuts should be put at M_1 or M_2 in Fig. 4. If the lock-nuts are placed at M_2, the screw is in tension while if they are placed at M_1, the screw is under compression. It is one of the universally accepted maxims of good designing that screws should always be put under tension if possible and at first sight this would appear to decide the question at once. It is undesirable for long screws to be put in compression, owing to the tendency which exists for them to give way laterally; we must not forget, however, that this rule does not hold for short screw lengths in compression. We already know that the adjusting screws of the lathe faceplate under consideration, may be stressed to 5 tons per square inch, and in deciding the correct position of the lock-nuts, the fundamental relations between stress and strain must be borne in mind. These relations may be briefly outlined as follows:

Stress per square inch = strain × modulus of elasticity.

$$\text{Strain} = \frac{\text{Extension (or compression)}}{\text{Original length under stress}}$$

$$\text{Stress per square inch} = \frac{\text{Extension (or compression)}}{\text{Length under stress}} \times E$$

Extension (or compression) = (Stress per square inch × Length under stress) ÷ E

In the preceding relations, E is the modulus of elasticity = 13,000 tons. We see that although the strain depends entirely upon the stress, the actual extension or compression due to this stress, is proportional to the length of the screw under stress. This holds good for both tension and compression. If the lock-nuts are placed at M_2, $L = 50$ inches = length of screw and this gives:

$$\frac{5L}{E} = \text{extension of screw} = \frac{5 \times 50}{13{,}000} = 0.019 \text{ inch.}$$

If the lock-nuts are placed at M_1, the length of screw under stress is $L_1 = 7$ inches, which gives the amount of compression as

$$\frac{5L_1}{E} = \frac{5 \times 7}{13{,}000} = 0.003 \text{ inch.}$$

The results of the preceding calculations show that the best design is that in which the lock-nuts are placed at M_1, because the change of length in the screw in this case is only about one-seventh of what it would be if the lock-nuts were placed at M_2. If the screws had been made smaller, the stress would probably be considerably greater than 5 tons per square inch and with the lock-nuts placed at M_2, the extension of the screw would become very appreciable. Now let us consider what this might mean. With the load as shown in Fig. 3, the stress in the lower screw is considerably greater than in the upper screws. The extension of the lower screw, due to this stress, will reduce the grip of the upper jaw so that the grip of the two side jaws is largely responsible for holding the work in position. The reduction of the grip of the upper jaw produced in this way, may be sufficient to allow the work to fall from the chuck in extreme cases, where the size of the screws has been reduced—with a false view to economy—so that they are too small to carry the load without undue elongation. This point has been mentioned to emphasize the importance of designing the screws in such a way that the elongation will be reduced to a minimum. When the lock-nuts are placed at M_1, and the jaws are moved nearly to the center, there will necessarily be a greater length of screw under compression; but as the jaws are moved toward the center of the chuck, the size and weight of the work which they carry is reduced, the tendency toward increased compression being limited in this way.

The Length of the Nut

In determining the proper length H_1 for the nut, a width of seven inches will be assumed. The value of the bending moments taken about the point C is given by the following equation:

$$f_t\, Z = \text{Bending moments} = R\, X = 63 \times 4 \text{ inch-tons.}$$

$$Z = \frac{63 \times 4}{f_t} = \frac{63 \times 4}{6} = 42.$$

For the rectangular section in question,

$$Z = \frac{b\, H_1^2}{6} = \frac{7\, H_1^2}{6}$$

Substituting known values in this equation, we have

$$H_1^2 = \frac{6 \times 42}{7} = 36$$

$$H_1 = 6 \text{ inches}$$

which is the required length of the nut.

* * *

OPTICAL ILLUSIONS

The accompanying illustrations show some optical illusions of a very interesting character. The illustrations and the captions beneath them are self-explanatory. Those shown in Figs. 1 and 2 are of exceptional interest. It is almost impossible to convince oneself that the lines drawn around the center in Fig. 1 are concentric circles. Try with a compass, however, and the lines that look like hoops sadly bent into all kinds of shapes will be found to be "round circles."

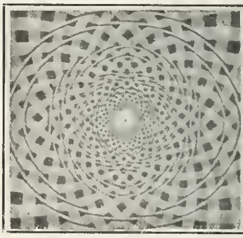

Fig. 1. A Pattern made up of Oblongs? No; Concentric Circles!

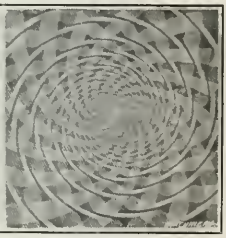

Fig. 2. A Spiral which is not a Spiral. What is it?

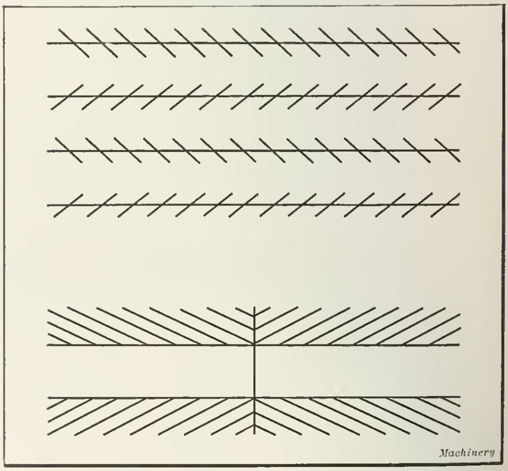

Fig. 3. Parallel Lines

* * *

During 1912, 3000 miles of new line was added to the railroads of the United States.

POWER REQUIREMENTS FOR MACHINE TOOLS

SUMMARY OF TESTS MADE TO DETERMINE POWER CONSUMPTION OF MACHINE TOOLS

BY HARRY C. SPILLMAN*

A few years ago the electric motor drive began to take a prominent place in manufacturing plants. At that time many factories changed from the old method of belting the engine to a large drive shaft, which was connected by belts to long lines of shafting throughout the plant, to the individual motor drive having a separate motor attached to each machine. The owners soon discovered that this made a very expensive installation, and this form of drive, although the most flexible, is gradually giving way to the group drive for light machine shop work. In the group drive a motor drives a short length of lineshafting which, in turn, drives the machine tools. This arrangement makes the first cost considerably less than that of the individual motor drive, and if planned systematically it is almost as flexible as the latter method.

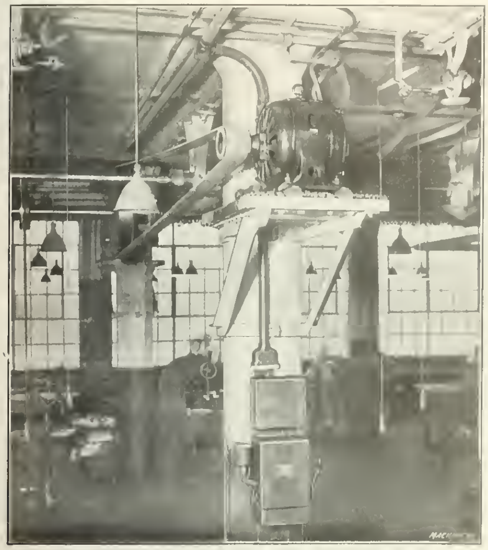

Fig. 1. View of Motor and Bracket Mounted on Concrete Column

The best arrangement for the group drive is to divide the machine shop into small units, having a motor for each department or each kind of machines. The lineshafting should be as short as possible and the motors placed in accessible positions, so that they can be watched and easily replaced in case of a breakdown. A small platform makes an excellent mounting for a motor, as it can be easily inspected and removed if found necessary. Experience has proved that motors suspended from the ceiling do not receive as careful attention, and a further disadvantage of this method of mounting lies in the fact that the motors are difficult to replace when set up in this way. With the proper equipment, a motor can be removed from a platform and a new motor installed in less than fifteen minutes. By carefully planning a group drive system, all the lineshafting can be run at the same speed and a standard size motor adopted for the entire shop. This does away with the necessity of carrying a number of different sized motors in stock and standardizes the motor equipment of a factory.

Construction engineers are unable to obtain reliable data for figuring the proper size of motors to drive machine tools. During the installation of mechanical equipment in an automobile engine factory, the machine shop was carefully laid out and a copy of the drawing, together with the sizes of machine tools, kind of work, speed and other technical information were sent to the different machine tool builders with the request that they give the exact power requirements for their machines when operating on the group drive system. The replies were carefully tabulated and after a careful analysis, it was shown that machine tool builders were giving the same results for group drive as for the individual drive, overlooking the fact that some of the machines would be idle and others consuming only a small amount of power at the time when the remaining machines were absorbing the maximum amount of power. These conditions all tend to equalize one another, so that the average power used by each machine would be considerably less for the group drive than the maximum power demanded for the individual drive.

Careful tests which have been made since the machine shop was placed in operation show that the shop takes less than one-fifth of the power recommended by the machine tool builders, or in other words, they were figuring over five times too high for the group drive. The machine shop where these tests were made has been in operation about nine months. The men work on a premium system; all work is laid out in the planning room, and the machines are carefully watched to see that they are operating at the proper speed. Time studies are also made at intervals, and to further increase the efficiency of the machines, expensive and cleverly designed jigs are used so that the work can be very quickly and accurately set up.

POWER REQUIREMENTS OF MACHINE TOOLS

Kind of Machine	Kind of Work	Per Cent of Machines Running	Floor Area for Machine and Operator in Square Feet	Total Average Power Per Machine in Watts*	Total Average Power Per Machine in Watts†	Friction and Lineshaft Load Per Machine in Watts†	Average Power Used in Doing Actual Work, in Watts*	Total Power Per Square Foot of Floor Area, in Watts
No. 2 Horizontal Rockford Boring Mills	Boring Bearings in Aluminum Cases	85	150	1620	1320	1100	300	8.8
No. 4 Cincinnati Millers	Light Milling on Aluminum	100	120	995	995	830	500	8.3
16-inch Lodge & Shipley Lathes	Turning Small Forgings	60	55	900	555	500	87	10.1
Double Disk Grinders; Double Buffers; Two Wheel Emery Stands	Grinding and Polishing	55	55	1800	1000	300	830	18.2
24-inch Bullard Vertical Lathes	Heavy Cuts on Cast Iron Flywheels	100	100	1350	1350	350	1000	13.5
24 inch Gould & Eberhardt Gear Cutters	Cutting Small Cast Iron Gears	100	65	333	333	250	83	5.1
Four Head Ingersoll Milling Machines	Making Four Cuts on Cast Iron Cylinders	100	300	3550	3550	2300	1250	11.8
Baker Single and Bausch Multi-Spindle Drills	Drilling and Tapping Cast Iron	40	70	1530	637	550	217	9.1
Heald Grinders, No. 60 Internal Grinders ‡	Cylinder Grinding	85	70	2830	2430	1860	500	34.7
No. 6 Whitney Hand Millers	Keyseating Small Cast Iron Gears	60	40	365	220	120	165	5.5
Landis No. 2 Grinders	Grinding Cam Shafts	80	90	1875	1500	1000	625	16.7
Norton 10 by 50 inch Grinders	Grinding Pistons and Small Forgings	70	100	2000	1400	1100	450	14
Jones & Lamson Flat Turret Lathes	Machining Small Forgings	85	65	675	560	200	375	8.6
Eight Spindle Cincinnati Gang Drills	Drilling and Reaming Connecting Rods (8 holes)	100	110	2840	2840	2000	840	25.8
Potter & Johnston Automatics	Turning Small Cast Iron Gears	100	75	690	690	440	250	9.2
1⅜-inch Gridley Automatics	Machining Cast Iron Pistons	100	200	1520	1520	1250	270	7.6
No. 4 Warner & Swasey Turret Lathe	Machining Small Forgings	65	55	560	360	310	70	6.5
24-inch Cincinnati Drill Presses	Small Drilling on Forgings	90	40	520	474	345	100	11.8

Machinery

* Deducting Idle Machines. † Including Idle Machines. ‡ Exhaust Fan not considered.

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* Address: 1537 Second Ave., Detroit, Mich.

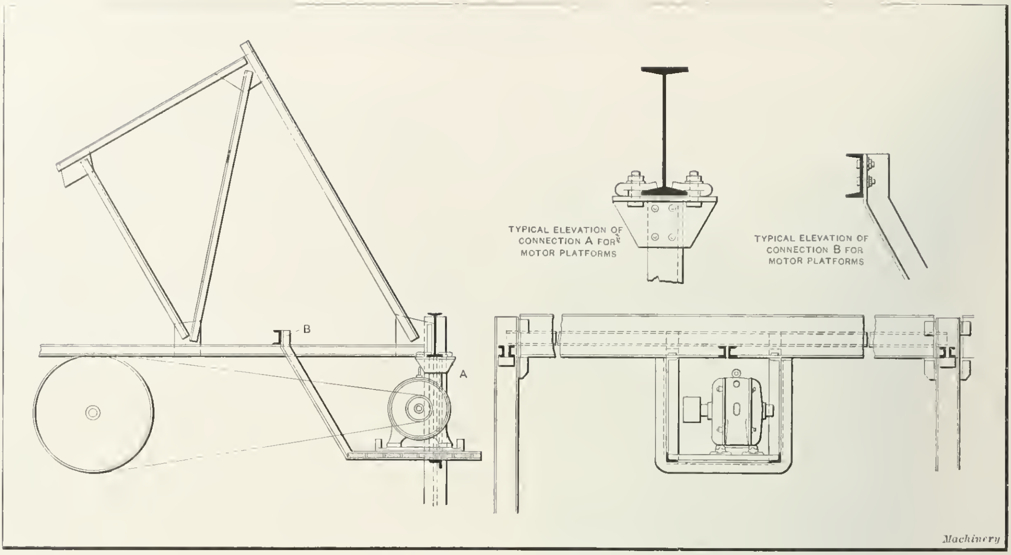

TYPICAL ELEVATION OF CONNECTION A FOR MOTOR PLATFORMS
TYPICAL ELEVATION OF CONNECTION B FOR MOTOR PLATFORMS
B
A
Machinery

Fig. 2. Design of Motor Platform for Use in Buildings with Saw-tooth Roof

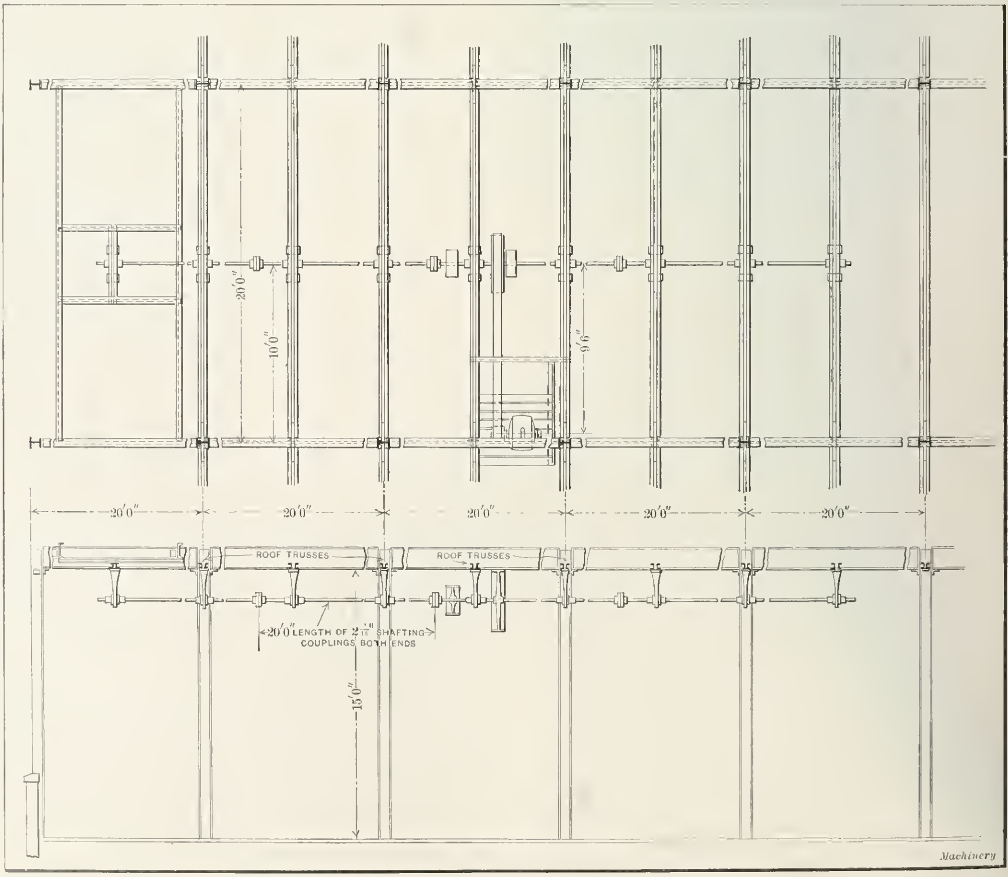


Fig. 3. Layout of Transmission System for Building with Saw-tooth Roof

The transmission equipment consists of a 20-horsepower motor for each department, mounted on a platform and driving two or three short lengths of lineshafting, each about seventy feet long. The shafting is 2 7/16 inches diameter, running at 240 revolutions per minute, and supported on Hyatt roller bearings in Wood type frames at intervals of ten feet. The frames have an 18- to 20-inch drop and are fastened directly to the steel work; the shafting was carefully lined up when installed and re-checked with a surveyor's level. Split cast-iron pulleys are used throughout the factory and special attention has been given to length of belt drives. The equipment is kept in excellent condition and not a single replacement has taken place for shafting, belting or pulleys.

In making the power tests, every precaution was taken to avoid errors. The motors were all tested for their efficiency at different loads and the electrical instruments were carefully calibrated. Readings were taken when the motor was driving the line and countershafts only, no machines being in operation. The electrical losses were deducted, which gave the net shafting and countershafting loss, and this was carefully proportioned among the different machines. The second reading was taken with the machines running light, which gave the total friction loss. After these tests were completed, the machines were put into operation and readings were taken every fifteen minutes. A record was also made of the number of machines in operation and the kind of work the machines were doing. Each motor in this factory drives only one kind of machine tools, which greatly assisted in obtaining accurate results for the amount of power consumed by each size and kind of machine. These data were carefully tabulated and the floor area occupied by each machine, and space allotted for the operator were noted; also the total length of lineshafting. The trucking aisles and all other space not used for manufacturing was deducted, so that the unit values per square foot of floor area include the machine and sufficient space for the operator and material. As a final re-check for accuracy, the total power utilized by the machine shop taken from these different tests was compared with the total power used by the machine shop as shown at the switchboard at the power house. These two figures checked within two per cent, and this was allowed for transmission losses between the motors and the power house.

Builders of transmission equipment have very little data showing friction losses with different kinds of bearings for lineshafting taken under actual working conditions. These results show that the lineshafting and countershafting consume thirty per cent of the total power, and the total friction losses absorb seventy-two per cent of the total power. This makes a forty-two per cent loss of power from the countershafting to the machine tools, and only twenty per cent of the total power is utilized in doing work. The electrical loss shows eight per cent of the total power. In the table there are two items mentioned as follows: Total average power per machine, deducting idle machines; total average power per machine, including idle machines. These items include all the mechanical power of that department, such as lineshafting, countershafting, machine friction and power consumed in doing work on the machines. In the first case this total power is equally divided among all the machines which are in operation. In the second case it is divided equally among all the machines, both running and idle. The electrical losses are omitted in all cases.

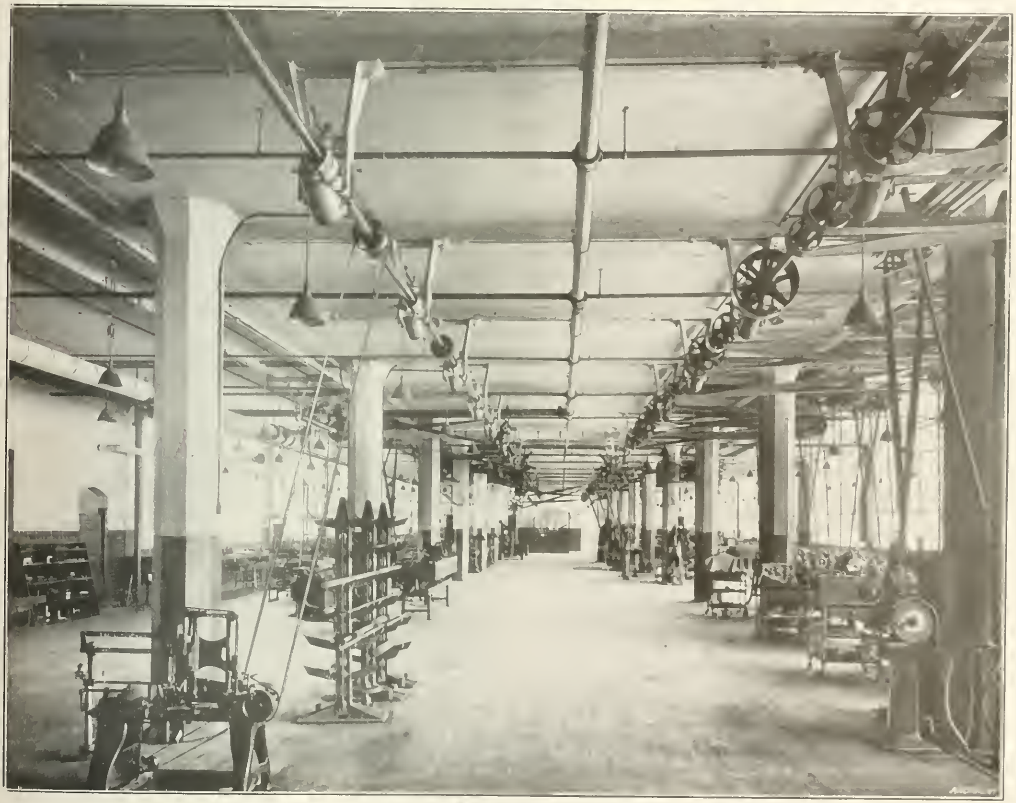


Fig. 4. General View of Tool-room showing Method of supporting Shafting on Concrete Ceiling

* * *

According to a bulletin of the United States Bureau of Education, an arrangement has been made between the school authorities and the Illinois Central Railroad Co. at McComb City, Miss., whereby high-school boys may work every other day in the railroad shops and on alternate days attend the high school. The boys receive a minimum wage of twelve cents an hour. It is stated that as an educational experiment this plan has proved successful so far.

CALCULATIONS AND DATA FOR SQUARE MILLING OPERATIONS

BY GEORGE W. BURLEY*

In order to be able to mill squares accurately on the ends of the shanks of such tools as taps and reamers, and on the ends of machine feed-screws, without having recourse to any cut-and-try method, it is necessary to know three dimensions; these are the distance between opposite flats or sides of the square, the diameter of the shank or screw end which corresponds to this distance, and the depth of the cut required from the circumference of the circle to the side of the square. The first dimension is generally the one upon which the other two are based. It is usually selected to agree with the general dimensions of the tap, reamer, or screw; and, in the case of taps, to suit standard wrenches. From this dimension the other two can be calculated, as shown by the following discussion.

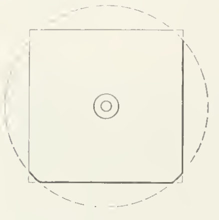
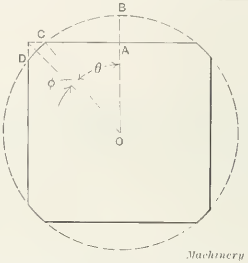


Fig. 1. End View of the Squared End of a Tap Shank



Machinery

Fig. 2. Diagram showing Method of Making Calculations

Usually, the square is formed without sharp corners, there being a small part of the original curved surface left on at what should be the corner of the square, as is indicated in Fig. 1. As a result of this practice the diameter of the required circle cannot be taken as equal to the diagonal of the square, as would be the case if it had square corners. The exact diameter in each case is dependent upon the ratio of the width of the land to the width of the square. The conditions which are involved in the determination of the values of the diameter and the depth of cut are indicated in Fig. 2. In this figure, *OA* represents one-half of the distance between the opposite sides of the square; *OB*, *OC*, and *OD* represent the radii of the circle; and *CD* represents the part of the original curved surface left on the squared section. Now, from this figure, we see that:

TABLE OF DIAMETERS AND DEPTHS OF CUT

Width of Square *Z*	Diameter *D*	Depth of Cut *d*	Width of Square *Z*	Diameter *D*	Depth of Cut *d*
1/16	0.0819	0.0097	1 9/16	2.0471	0.2425
1/8	0.1638	0.0194	1 5/8	2.1294	0.2522
3/16	0.2457	0.0291	1 11/16	2.2109	0.2619
1/4	0.3275	0.0388	1 3/4	2.2932	0.2716
5/16	0.4095	0.0485	1 13/16	2.3747	0.2812
3/8	0.4914	0.0582	1 7/8	2.4566	0.2908
7/16	0.5733	0.0679	1 15/16	2.5383	0.3004
1/2	0.6550	0.0775	2	2.6200	0.3100
9/16	0.7371	0.0873	2 1/16	2.7021	0.3198
5/8	0.8190	0.0970	2 1/8	2.7842	0.3296
11/16	0.9009	0.1067	2 3/16	2.8660	0.3394
3/4	0.9828	0.1164	2 1/4	2.9484	0.3492
13/16	1.0647	0.1261	2 5/16	3.0303	0.3589
7/8	1.1466	0.1358	2 3/8	3.1122	0.3686
15/16	1.2283	0.1454	2 7/16	3.1936	0.3783
1	1.3100	0.1550	2 1/2	3.2750	0.3880
1 1/16	1.3921	0.1648	2 9/16	3.3570	0.3977
1 1/8	1.4742	0.1746	2 5/8	3.4390	0.4074
1 3/16	1.5561	0.1843	2 11/16	3.5207	0.4171
1 1/4	1.6380	0.1940	2 3/4	3.6025	0.4268
1 5/16	1.7199	0.2037	2 13/16	3.6843	0.4365
1 3/8	1.8018	0.2134	2 7/8	3.7662	0.4462
1 7/16	1.8837	0.2231	2 15/16	3.8481	0.4556
1 1/2	1.9656	0.2328	3	3.9300	0.4650

Machinery

$$R = OC = \frac{OA}{\cos AOC} = \frac{OA}{\cos \theta}$$

where $\theta = (45 - \phi)$, ϕ being the angle at the center of the circle which is subtended by one-half of the arc *CD*. The value of ϕ is, therefore, $\frac{CD}{2R}$ radians or $\frac{CD}{R} \times 28.65$ degrees.

From an examination of a large number of cases it appears that the average value of the ratio $\frac{CD}{R}$ is $\frac{1}{6}$, in which case

$\phi = 4$ degrees 46.5 minutes

$\theta = 45 - \phi = 40$ degrees 13.5 minutes.

Therefore:

$$R = \frac{OA}{\cos 40^\circ\ 13.5'} = \frac{OA}{0.7635} = 1.310 \times OA$$

and $D = 2.620 \times OA = 1.310Z$

where Z = the whole width of the square.

The depth of the cut d is represented by the length of the line *AB* and has a value of:

$$d = \frac{D - Z}{2} = \frac{1.310 - 1}{2} \times Z = 0.155Z.$$

By means of these two expressions the diameter and the depth of cut for any given case can be calculated; but to facilitate matters, the values of D and d have been calculated by the writer for a large number of values of Z between 1/16 inch and 3 inches, and these have been embodied in the table which can, therefore, be used directly for the purpose of obtaining the values of these two quantities.

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* * *

DEVELOPMENT IN THE PLANING ART

The production of true flat surfaces has been accomplished on the planer since about 1835, but when very accurately fitting parts were desired, the surfaces in contact were generally finished by scraping. This operation done by hand is slow and expensive, and is one that progressive manufacturers have endeavored to eliminate as much as possible. Scraping all sliding flat surfaces was done by the greater number of machine tool builders up to the time when high-speed steel came into use, when planer manufacturers along with other machine tool builders found it necessary to redesign their tools to meet the new demands which this improvement in steel brought about.

A trained operator with a modern high-speed planer can produce true planed surfaces requiring very little scraping. In fact, some manufacturers of accurate and high-grade machine tools dispense with the use of the scraper almost entirely. To obtain these results it is necessary that the work be properly clamped, and cutting tools of the correct shape be used. The work should be rigidly clamped for the roughing cut, care being taken not to spring it out of shape, and using a round nose roughing tool on cast iron. The clamps should then be released slightly and a lighter cut taken.

After taking a roughing cut some manufacturers follow the practice of taking the work off the planer and allowing it to season for some time. Then it is put back on the planer, clamped lightly, and a light cut taken across the entire surface. The clamps are now released until they exert just sufficient pressure to prevent the work from lifting, the thrust of the cutting tool being taken by stops in the planer bed. For the finishing cut on cast iron a broad nose tool is used; this should be ground with the proper clearance in all directions, and should be strong and stiff in order to eliminate all spring. In the final clamping particular care should be taken to see that the clamps do not bear on the casting at its weakest points.

Upon the completion of the finishing cut, the work is removed from the planer, and if the surface planed is for the sliding portion of a machine, the loose iron "dust" is removed with the scraper. This is carefully done so that the original tool marks are not obliterated. If on the other hand the planed surface is for a joint fit no scraping is performed on it at all. This development of the planing art has put the planer in the class with other highly accurate machine tools. D. T. H.

FOUR-SLIDE TOOLS FOR A WIRE-FORMING JOB*

AN EXAMPLE OF DIFFICULT WIRE BENDING REQUIRING INGENIOUS MACHINE DESIGN

BY CHESTER L. LUCAS†

In making the tools for forming the wire hook shown in Fig. 1, some interesting points in wire working were involved. The diameter of the steel wire is 0.150 inch and it will be seen in the illustration that there are bends in both horizontal and vertical planes, small bends *A* and *B* being in one plane while the large hook bend *D* is in the opposite plane. It was essential that the sides of bend *B* be parallel or at least that they should not diverge as they would naturally tend to if not restricted, even though bent around a parallel form. Along section *C* a patent date was to be stamped at the same time as the forming was done.

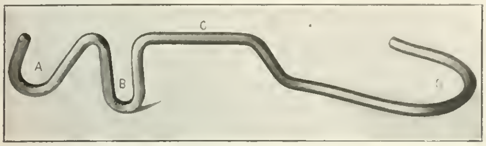

Fig. 1. The Wire Hook to be formed

The illustration Fig. 2 shows the way this piece was bent, step by step; Fig. 3 illustrates the tools in place on the bed of the four-slide wire-forming machine in which they were used; Fig. 4 shows the tools as viewed from the front with the vertical forming attachment removed; Fig. 5 shows the front and back tools closed upon the wire; Fig. 6 is shown to make the action of the vertical forming attachment clear; and in Fig. 7 may be seen the tools as viewed from the rear of the machine. In Figs. 4 and 5, the vertical forming attachment was removed in order to give a clearer view of the rest of the mechanism. In general, the tools employed for this job are similar to any set of four-slide wire-forming tools, except for the vertical attachment, the forming being done around a central form by tools entering successively from the front, back, left and right.

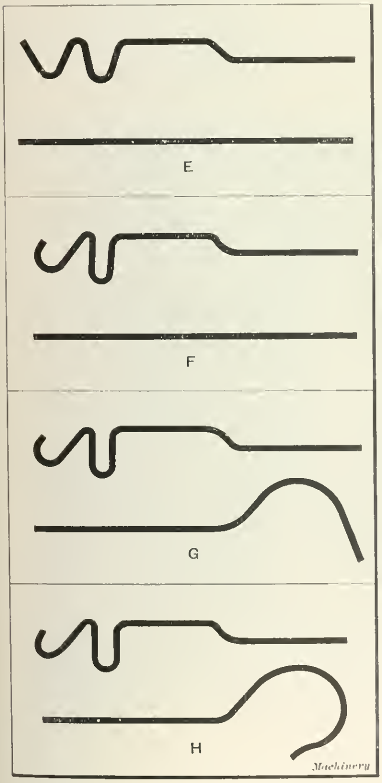

Fig. 2. The Development of the Hook

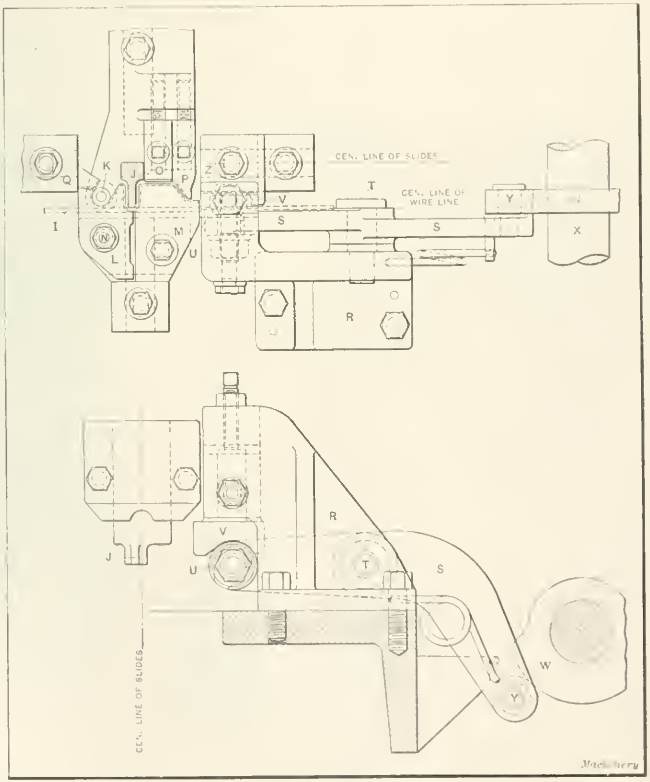

Fig. 3. Plan and Elevation of Tools used

In Fig. 3, referring to the plan view, the wire line is shown at *I*. The first operation consists in feeding the wire to the proper length just as it is shown in Fig. 4. After the wire has been fed to the proper length, passing just in front of the stationary former *J* and auxiliary former *K*, the front tools *L* and *M* come forward, pressing the wire against and around these two forms. This operation involves an interesting feature in that the front tools *L* and *M* are separately mounted, tool *L* being allowed a little play as it is pivoted about stud *N*, which is located near the center of the tool. Tool *M* is stationary, being tongued in position as may be clearly seen in Fig. 4. Another important feature is that auxiliary former *K* is set upon a ball and socket joint, hinged from a point lower down on the machine bed so that it is free to move a slight distance in any direction except to the rear. The object in having these tools flexible is to fulfill the condition that the bend *B*, as indicated in Fig. 1, shall be made parallel. In order to do this a side movement of the tool is necessary to close the wire in against former *J*, carrying the bend slightly beyond the point of parallelism, so that when the initial tension in the wire has opened the bend the sides will be just parallel. The forward movement of the front tools does not complete the two small bends *A* and *B*, but leaves the wire in the partly formed condition shown at *E* in Fig. 2. The back tools *O* and *P* next come in, and these are also mounted separately because tool *O* comprises a stamp containing the patent date which is imprinted on the wire. The function of tool *P* is merely to make the angular bend shown at the right of section *C*, Fig. 1.

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* For information on tools for the four-slide wire-forming machine, see MACHINERY, February, 1912, engineering edition; "Tools for Four-slide Automatic Wire Forming Machine."

† Associate Editor of MACHINERY.

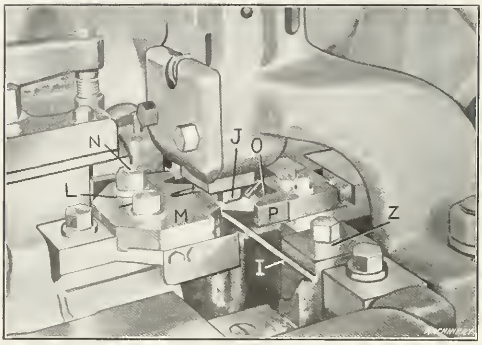

Fig. 4. Front View of Tools in Place on Wire-forming Machine

Just after the back tools come in, the left-hand side tool *Q* comes forward and its tip catches the outstanding end of the wire, wrapping it around auxiliary former *K*, and as former *K* and front tool *L* are free to move sideways a limited amount, when the shoulder of left-hand side tool *Q* strikes the right-hand side of the front tool *L*, the auxiliary former and wire are forced in against the thinner shoulder section of former *J*. This completes the work on this end of the wire, leaving bend *B* in a parallel condition just as is required. At *F*, in Fig. 2, may be seen the result of the action of front, back and left side tools.

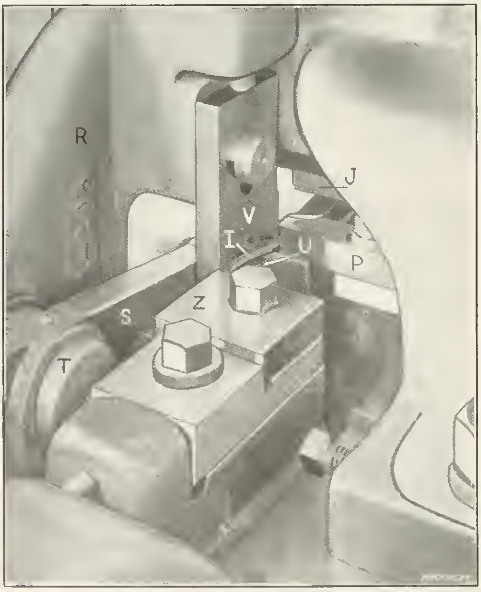

Fig. 6. The Vertical Forming Attachment in Place

At this point the wire and tools are in the relation shown in Fig. 5 and it is upon the end of the wire which projects that the vertical hook bend *D* must be made. In this illustration, Fig. 5, the vertical forming attachment has been removed, but it is adequately shown in Fig. 6 and also in the line illustration Fig. 3. By referring to this part of the mechanism it will be seen that the fixture consists of a bracket casting *R* which is bolted to the bed of the machine. This fixture supports the stationary forming tool *V*, most clearly shown in Fig. 6, into which the wire must be pressed. The position of this tool is adjustable vertically upon the bracket. For forcing the wire into the cavity of the tool, lever *S*, which is pivoted upon the body of the fixture on stud *T*, is employed. At the forming end of this lever, which is normally below the wire line, is the former-roll *U*. Thus, it will be seen that it is only necessary to depress the outer end of this lever so as to force roll *U* up, pressing the wire into the cavity in tool *V*. This is accomplished by means of cam *W* on the right-hand camshaft of the machine, indicated at *X* in Fig. 3. The cam bears against cam-roll *Y* and being timed properly, forces the wire up into tool *V*, which gives the hook the appearance indicated at *G* in Fig. 2, with the end of the hook unfinished. A dwell on the cam keeps roll *U* against the wire in tool *V*, while right-hand forming tool *Z* comes forward and curls the end of the hook around the roll, leaving it in the finished condition indicated at *H* in Fig. 2. The hook is ejected from the machine by an ejector plate on former *J*, as soon as the tools withdraw.

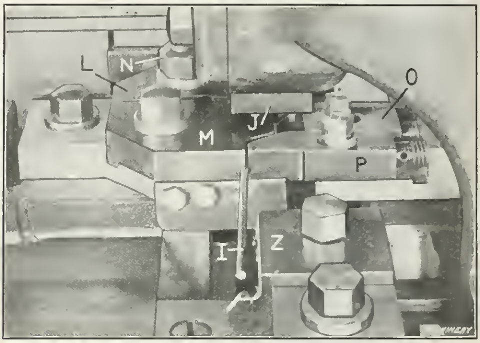

Fig. 5. Showing the Front and Back Tools closed on the Wire

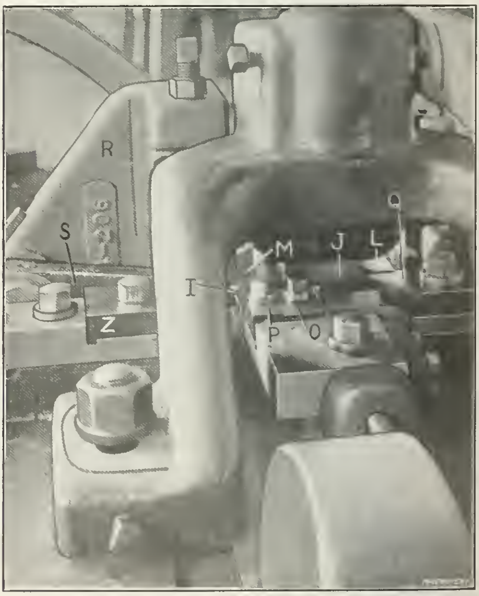

Fig. 7. View of Tools and Attachment from the Rear

After explaining the operation of the different tools, a better general idea may be obtained from the illustration Fig. 7, which shows all of the tools in place including the vertical forming fixture. The operation of the tools is very satisfactory and the wire pieces are cut off, formed and stamped, being turned out at the rate of eighty per minute. These tools were made by the Baird Machine Co., Bridgeport, Conn., for use in a Baird standard four-slide wire-former.

DUPLICATION OF GEARS HAVING LONG AND SHORT ADDENDA

COMPILED WITH SPECIAL REFERENCE TO THE CONDITIONS MET WITH IN AUTOMOBILE REPAIR SHOPS

BY E. WINSLOW BAXTER*

In designing bevel-gear drives for automobiles, a number of manufacturers have adopted the long and short addendum style of tooth, which is especially desirable where the pinion has a small number of teeth in proportion to the gear. This form of tooth avoids undercut in the pinion teeth, and makes it possible to obtain teeth of equal strength in both the gear and pinion. The larger or ring bevel gear is made with a short addendum and the pinion with a long addendum. The manner in which the pinion teeth are strengthened by increasing the addendum is shown by Figs. 1, 2 and 3. Fig. 1 shows the tooth outline of a thirteen-tooth pinion having standard teeth; and Fig. 2 shows the tooth outline of a pinion of the same number of teeth, but with the addendum increased about 50 per cent over the standard dimension, the dedendum being decreased by the same amount, thus keeping the depth standard. Both pinions have a 14½-degree pressure angle; if a 20-degree pressure angle had been selected, the undercut would have been less noticeable in the case of the standard tooth.

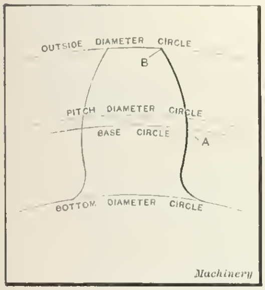

Fig. 1. Tooth Outline of a Thirteen-tooth Pinion with Standard Teeth

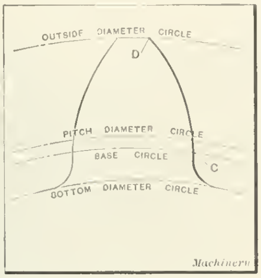

Fig. 2. Tooth Outline with Addendum increased Fifty Per Cent

We know that the involute curve is drawn by unwinding a cord from the base circle of a gear, as shown in Fig. 3. Therefore, we see that the outline of the tooth shown in Fig. 1 is taken from the involute curve between points *A* and *B*, while that of the gear shown in Fig. 2 is taken from the involute between points *C* and *D*. Thus, in order to prevent undercutting, and to strengthen the teeth of a pinion having a small number of teeth in relation to the gear, it is only necessary to have the tooth outline follow the involute curve to a point as close to the base circle as is necessary to accomplish the desired results. As the pitch diameter and the diameter of the base circle are not increased or decreased by this procedure, it necessarily follows that the addendum is increased and the dedendum decreased. The large gear has to be treated in the reverse manner in order to have the teeth mesh properly. Making the pressure angle 20 degrees instead of 14½ degrees lessens the undercut, as it reduces the base circle and produces the same results but in a lesser degree. In this connection, it may be mentioned that the base circle diameter is found by multiplying the pitch diameter by the cosine of the pressure angle, which is 0.96815 for 14½ degrees and 0.93969 for 20 degrees.

Theoretically, it is possible to figure the proper relation of gear and pinion addenda to each other for all ratios, in order to produce gear teeth of equal strength, and Mr. Hugo Bilgram has prepared charts for the purpose of selecting such addenda. The Gleason Works have adopted the following approximation for all high ratios:

Gear addendum = 3/10 of the working depth.
Pinion addendum = 7/10 of the working depth.

The working depth is equal to twice the standard addendum. In the examination of foreign made bevel gear drives using this style of tooth, the writer has found that the ratio of the gear addendum to the pinion addendum varies with each set of gears examined, and in order to render the duplication of such gears easier, the following formulas and tables were evolved. In order to explain the method, we will assume that a set of bevel gears has been ordered to duplicate samples which are measured as carefully as possible and the dimensions tabulated as follows:

	Gear		Pinion	
Number of teeth	48		13	
Measured outside diameter	9.66	inches	3.14	inches
Measured face angle	76¼	degrees	18⅓	degrees
Measured cutting angle	71¼	degrees	13½	degrees
Measured depth of tooth	0.43	inch	0.43	inch

The number of teeth on the pinion being odd, the outside diameter is found by adding to the diameter of the bore, twice the distance from the edge of the bore to the tip of a tooth.

If we figure the outside diameters according to the method used for standard gears and find that the outside diameter of the pinion is larger and that of the gear smaller than the dimensions of the gears to be duplicated, we will know that this pair of gears has been designed with long and short addendum teeth. After a little experience it will not be necessary to figure the standard dimensions, as ordinarily an inspection of the pinion tooth is all that is necessary. By referring to the table, we find that the nearest standard pitches having whole depths around 0.43 inch are ⅝ inch circular pitch (whole depth 0.429 inch) and 5 diametral pitch (whole depth 0.431 inch). We will therefore assume that the gears are 5 diametral pitch, as this will be the easiest dimension to use in the calculations. The standard outside diameters for 48 and 13 tooth, 5 pitch gears are 9.704 inches and 2.986 inches, while the measured diameters are 9.66 inches and 3.14 inches. As the measured diameter for the gear is smaller and that for the pinion is larger than the standard dimensions, we may safely assume that the gears are cut with long and short addenda. As the center angles remain the same as in the standard gears (on account of the pitch diameters not changing) we have only to look them up in a handbook on gearing or calculate them from the following formula. Calling α the center angle of the gear:

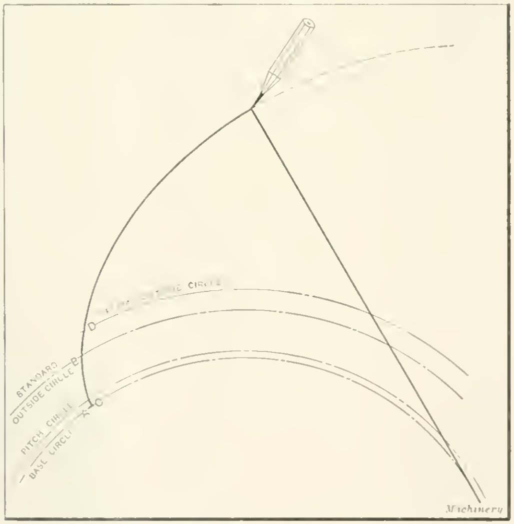

Fig. 3. Diagram illustrating Method of drawing the Involute Curve

$$\text{Tangent } \alpha = \frac{\text{Number of teeth in gear}}{\text{Number of teeth in pinion}}$$

Center angle pinion = 90 degrees — α

Calculating for 48 and 13 teeth, we have:

$$\text{Tangent } \alpha = \frac{48}{13} = 3.69230$$

Center angle gear = 74 degrees 51 minutes = α

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Center angle pinion = 90 degrees − α = 90 degrees − 74 degrees 51 minutes = 15 degrees 9 minutes.

Tabulating the known quantities and representing those that are unknown by suitable letters, we have the following:

Number of teeth on gear	48
Number of teeth on pinion	13
Center angle of gear	74 deg. 51 min.
Cosine of center angle of gear	0.26135
Center angle pinion	15 deg. 9 min.
Cosine of center angle pinion	0.96524
Measured outside diameter of gear	9.66 inches
Measured outside diameter of pinion	3.14 inches
Pitch diameter of gear	D
Pitch diameter of pinion	d
Addendum of gear (short)	X
Addendum of pinion (long)	Y
Standard addendum of gear and pinion or half the working depth	Z

Z also equals the pitch diameter of either gear divided by the number of teeth.

Pressure angle 14½ degrees.

The pressure angle may be found by taking an impression of the backs of the large gear teeth on paper and measuring with a protractor the angle which the side of the tooth makes with a line drawn through the center of the tooth in the direction of its length.

The formula for finding the outside diameters of a pair of bevel gears when the addenda are unequal in gear and pinion is as follows: Pitch diameter + 2 (special addendum × cosine of center angle) = outside diameter.

Substituting the known and unknown quantities, we get:

TABLE OF ADDENDA FOR DIAMETRAL AND CIRCULAR PITCHES

(Whole depth = 2.157 × addendum)

Addendum in Inches	Whole Depth in Inches	Diametral Pitch	Circular Pitch		Metric Pitch Module in Millimeters	Addendum in Inches	Whole Depth in Inches	Diametral Pitch	Circular Pitch		Metric Pitch Module in Millimeters	Addendum in Inches	Whole Depth in Inches	Diametral Pitch	Circular Pitch		Metric Pitch Module in Millimeters	Addendum in Inches	Whole Depth in Inches	Diametral Pitch	Circular Pitch		Metric Pitch Module in Millimeters
			Fraction, Inches	Decimal, Inches					Fraction, Inches	Decimal, Inches					Fraction, Inches	Decimal, Inches					Fraction, Inches	Decimal, Inches	
0.125	0.270	8				0.182	0.393	5½	4/7			0.239	0.516		3/4	0.7500		0.295	0.636				7.5
0.126	0.272				3.2	0.183	0.395					0.240	0.518				6.1	0.296	0.639	3⅜			
0.127	0.274			0.4000		0.184	0.397					0.241	0.520					0.297	0.641		14/15		
0.128	0.276					0.185	0.399				4.7	0.242	0.522	4⅛				0.298	0.643		15/16	0.9375	
0.129	0.278	7¾				0.186	0.401		7/12			0.243	0.524					0.299	0.645				7.6
0.130	0.280				3.3	0.187	0.403					0.244	0.526				6.2	0.300	0.647				
0.131	0.282					0.188	0.406					0.245	0.529					0.301	0.649				
0.132	0.285					0.189	0.408		13/32		4.8	0.246	0.531					0.302	0.651				
0.133	0.287	7½	5/12			0.190	0.410	5¼				0.247	0.533					0.303	0.654				7.7
0.134	0.289				3.4	0.191	0.412		3/5	0.6000		0.248	0.535		7/9		6.3	0.304	0.656				
0.135	0.291					0.192	0.414					0.249	0.537		25/32			0.305	0.658				
0.136	0.293		3/7			0.193	0.416				4.9	0.250	0.539	4				0.306	0.660				
0.137	0.295					0.194	0.419					0.251	0.541					0.307	0.662				7.8
0.138	0.298	7¼			3.5	0.195	0.421					0.252	0.544				6.4	0.308	0.664	3¼	31/32		
0.139	0.300		7/16	0.4375		0.196	0.423					0.253	0.546					0.309	0.667				
0.140	0.302					0.197	0.425				5.0	0.254	0.548					0.310	0.669				
0.141	0.304		4/9			0.198	0.427					0.255	0.550		4/5	0.8000		0.311	0.671				7.9
0.142	0.306				8.6	0.199	0.429		5/8	0.6250		0.256	0.552				6.5	0.312	0.673				
0.143	0.308	7				0.200	0.431	5				0.257	0.554					0.313	0.675				
0.144	0.311					0.201	0.434				5.1	0.258	0.557	3⅞				0.314	0.677				
0.145	0.313		5/11			0.202	0.436		7/11			0.259	0.559		13/16	0.8125		0.315	0.680				8.0
0.146	0.315				3.7	0.203	0.438					0.260	0.561		9/11		6.6	0.316	0.682				
0.147	0.317					0.204	0.440					0.261	0.563					0.317	0.684				
0.148	0.319	6¾				0.205	0.442	4⅞			5.2	0.262	0.565					0.318	0.686		1	1.0000	
0.149	0.321		7/15			0.206	0.444					0.263	0.567					0.319	0.688				8.1
0.150	0.324				3.8	0.207	0.447					0.264	0.569				6.7	0.320	0.690	3⅛			
0.151	0.326					0.208	0.449					0.265	0.572		5/6	0.8333		0.321	0.692				
0.152	0.328					0.209	0.451		21/32		5.3	0.266	0.574					0.322	0.695				
0.153	0.330				3.9	0.210	0.453	4¾				0.267	0.576	3¾				0.323	0.697				8.2
0.154	0.332	6½				0.211	0.455					0.268	0.578				6.8	0.324	0.699				
0.155	0.334					0.212	0.457		2/3	0.6666	5.4	0.269	0.580		27/32			0.325	0.701				
0.156	0.337					0.213	0.459					0.270	0.582					0.326	0.703				
0.157	0.339				4.0	0.214	0.462					0.271	0.585					0.327	0.705				8.3
0.158	0.341					0.215	0.464					0.272	0.587				6.9	0.328	0.708		1 1/32		
0.159	0.343		½	0.5000		0.216	0.466	4⅝			5.5	0.273	0.589		6/7			0.329	0.710				
0.160	0.345	6¼				0.217	0.468					0.274	0.591					0.330	0.712				
0.161	0.347				4.1	0.218	0.470					0.275	0.593				7.0	0.331	0.714				8.4
0.162	0.349					0.219	0.472		11/16	0.6875		0.276	0.595	3⅝	13/15			0.332	0.716				
0.163	0.352					0.220	0.475				5.6	0.277	0.598					0.333	0.718	3			
0.164	0.354					0.221	0.477					0.278	0.600		7/8	0.8750		0.334	0.720				
0.165	0.356				4.2	0.222	0.479	4½				0.279	0.602				7.1	0.335	0.723				8.5
0.166	0.358					0.223	0.481		7/10	0.7000		0.280	0.604					0.336	0.725				
0.167	0.360	6				0.224	0.483				5.7	0.281	0.606					0.337	0.727				
0.168	0.362					0.225	0.485					0.282	0.608					0.338	0.729		1 1/16	1.0625	8.6
0.169	0.365		17/32		4.3	0.226	0.488					0.283	0.611		8/9		7.2	0.339	0.731				
0.170	0.367					0.227	0.490		5/7			0.284	0.613					0.340	0.733				
0.171	0.369					0.228	0.492	4⅜			5.8	0.285	0.615					0.341	0.736				
0.172	0.371					0.229	0.494		23/32			0.286	0.617	3½	9/10	0.9000		0.342	0.738				8.7
0.173	0.373				4.4	0.230	0.496					0.287	0.619				7.3	0.343	0.740				
0.174	0.375	5¾	6/11			0.231	0.498		8/11			0.288	0.621		29/32			0.344	0.742				
0.175	0.378					0.232	0.500				5.9	0.289	0.623		10/11			0.345	0.744		1 1/12		
0.176	0.380					0.233	0.503					0.290	0.626					0.346	0.746				8.8
0.177	0.382		5/9		4.5	0.234	0.505					0.291	0.628				7.4	0.347	0.749		1 1/11		
0.178	0.384					0.235	0.507	4¼				0.292	0.630		11/12			0.348	0.751	2⅞	1 3/32		
0.179	0.386		9/16	0.5625		0.236	0.509				6.0	0.293	0.632					0.349	0.753				
0.180	0.388					0.237	0.511					0.294	0.634					0.350	0.755		1 1/10	1.1000	8.9
0.181	0.390				4.6	0.238	0.513																

For the gear, $D + 0.5227\,X = 9.66$ inches = outside diameter (1)

For the pinion, $d + 1.93048\,Y = 3.14$ inches = outside diameter (2)

As the clearance and whole depths are the same for both gear and pinion in this style of gearing, the long addendum and the short addendum added together equal the working depth and also equal twice the "diameter addendum" 2*Z*.

This gives us a third equation.

$$X + Y = 2\,Z \quad \text{or} \quad Z = \frac{X + Y}{2} \tag{3}$$

As previously stated, *Z* is the standard addendum for the depth, and *Z* multiplied by the number of teeth in each gear gives the pitch diameters of the gears. Therefore we derive the following:

$$48\,Z = D \tag{4}$$

$$13\,Z = d \tag{5}$$

Substituting these values of *D* and *d* in Equations (1) and (2) we get:

$$48\,Z + 0.5227\,X = 9.66$$

Simplifying $Z + 0.01089\,X = 0.20125$ (6)

$$13\,Z + 1.93048\,Y = 3.14$$

Simplifying $Z + 0.1485\,Y = 0.24154$ (7)

Substituting the value of *Z* from Equation (3) in Equations (6) and (7) and simplifying, we get:

$$\frac{X + Y}{2} + 0.01089\,X = 0.20125$$

$$X + Y + 0.02178\,X = 0.4025$$

$$1.02178\,X + Y = 0.4025 \tag{8}$$

$$\frac{X + Y}{2} + 0.1485\,Y = 0.24154$$

$$X + Y + 0.297\,Y = 0.48308$$

$$X + 1.297\,Y = 0.48308 \tag{9}$$

Multiplying Equation (8) by 1.297 and subtracting Equation (9) we get:

$$\begin{array}{ll} 1.32525\,X + 1.297\,Y = 0.52204 \\ \quad\;\; X + 1.297\,Y = 0.48308 \\ \hline 0.32525\,X & = 0.03896 \\ \qquad\quad X & = 0.11978 \text{ inch} = \text{addendum} \end{array}$$

for gear (short).

Substituting this value for *X* in Equation (9) we have:

$$0.11978 + 1.297\,Y = 0.48308$$

$$1.297\,Y = 0.3633$$

$Y = 0.28010$ inch = addendum of pinion (long).

We can now get the value of *Z* by substituting both *X* and *Y* in Equation (3).

$$0.11978 + 0.28010 = 2\,Z$$

$$0.39988 = 2\,Z$$

$Z = 0.19994$ inch = standard addendum.

Z is probably 0.200 inch and the pitch for this depth is 5 diametral pitch.

$X = 0.120$ inch which is 3/10 of 0.400 inch (whole depth)

$Y = 0.280$ inch which is 7/10 of 0.400 inch

as per the Gleason formula.

The large or ring gear is apt to shrink in hardening, the amount of this shrinkage depending upon the size of the gear, the kind of steel and the heat-treatment used. The shrinkage is not often more than 0.02 inch, but even this amount will affect the teeth of the gear by reducing the circular pitch, and if this shrinkage is not compensated for when turning and cutting the gear, the pinion will not mesh with the finished ring gear at the same place that it did before the ring gear was hardened. If we suppose that this shrinkage was not taken into account and amounted to 0.02 inch, the measured outside diameter of the large gear would be 9.64 inches and that of the small gear 3.14 inches, no appreciable shrinkage being evident in the pinion on account of its small size. By substituting these values in the preceding formulas, we can find whether or not the correct dimensions can be found under these conditions. If this calculation is made, it will be found that the small amount that the ring gear will shrink will not alter the results enough to cause any serious error.

From the above data, we can figure the correct face and cutting angles and outside diameters, using the measured values to check the calculations. The full data is tabulated below:

Long and Short Addendum Gears with 14 1-2 Degrees Pressure Angle

Ratio, 3 9/13 to 1
Diametral pitch, 5
Working depth 0.4000 inch
Whole depth, 0.4314 inch

	Gear	Pinion
Addendum	0.1200 inch	0.2800 inch
Dedendum	0.3114 inch	0.1514 inch
Face angle	76 deg. 14 min.	18 deg. 22 min.
Center angle	74 deg. 51 min.	15 deg. 9 min.
Cutting angle	71 deg. 16 min.	13 deg. 24 min.
Pitch diameter	9.600 inches	2.600 inches
Outside diameter	9.662 inches	3.140 inches
Difference between special and standard addendum angles	55 minutes	55 minutes
Difference between Bilgram system and standard addendum angles for the above ratio	59 minutes	59 minutes

* * *

Within the last ten years there has come about a tremendous change in the art of machine making, due largely to the advent of high-speed steel and possibly still more largely to the advent of the automobile. The tremendous orders for these machines have enlisted the brightest intellects and abilities of our best engineers, and while high-speed steel has taught many things to the machine manufacturer, the automobile manufacturers are teaching him many more; among the things that are taught, for example, is the rapidity with which machine operations can be performed in comparison to former practice. Let us consider for a moment, that, in the beginning of the making of automobiles, the four-throw crank would require, in many cases, ten hours' time to machine, and this same four-throw crank can be machined to-day, four each hour. Let any one who is familiar with cylinders, pistons, piston rings and other parts used in the manufacture of the automobile look upon their first experience and then look upon what is being done to-day and it is a revelation that, if it had been foretold ten or twelve years ago would be looked upon just as skeptically as we should have looked upon the statement that a machine would fly within a year had such a prediction been made a year before it happened.—*William Lodge in paper "Pension Plan for Employes," read before National Metal Trades Association Convention April 10, 1913.*

* * *

A properly made drawing, correctly dimensioned, will ordinarily give a machine builder all the information required to make the part of machine represented, and it will also afford him the data for estimating the cost of producing when limits, etc., are specified. But notwithstanding this well-known fact many men are likely to send samples instead of drawings. Samples are desirable sometimes when of complicated shapes difficult to show clearly on a drawing, but hardly otherwise. Certainly the example of an Austrian concern in the matter of sending a sample should be avoided. It wanted a quotation of price on a machine and a guarantee of production on a single forging. A sample of the forging weighing two hundred pounds was sent. The machine tool builder had to pay freight and duty and was thus put to considerable trouble to get the piece to his plant. A drawing which could have been sent by mail without delay or expense would have answered the requirements fully, except that of making an actual test on precisely that shaped piece which was hardly necessary.

* * *

Allgemeine Elektricitäts Gesellschaft, Berlin, has produced a series of moving picture films showing the process of manufacturing electric cables from start to finish. These films are lent for lectures to technical societies and institutions. Every stage of manufacture is shown, from the arrival of the copper ingots to the shipping of the completed cable.

COLORING IRON AND STEEL PRODUCTS[*]

PROCESSES OF METAL COLORING—PREPARING WORK—PICKLING—COLORING BY HEAT—BROWNING

BY E. F. LAKE[†]

How to give various iron and steel products a desired color in the easiest and cheapest manner, is often a problem with manufacturers. The art of coloring metal is very old. Some very good specimens have been found in the ruins left by the Aztecs and Incas. The Japanese and East Indians have done such work for several centuries. Probably the Japanese excel all others, it having become a real art with them. Americans and Europeans are so far ahead of Japan in chemistry that there is no comparison and yet we are not able to produce the bloom of fruit on metals, which they do almost to perfection.

Three General Processes of Metal Coloring

There are three ways in which to produce colors on metals, namely: First, by heat-treatment; second, by dipping in a bath; third, by electroplating. Often two of these methods are used in combination. A fourth might be added, that of brushing or rubbing a powder, or liquid, onto the piece to be colored. This is so similar to the dipping process, however, that it can be classed under that head. None of these metal coloring processes can be learned from a few receipts that may be printed. Metal coloring is in reality a trade in itself and must be learned.

Some of the solutions get weaker with use, and the last article treated will be of a different color from the first. Nearly all of the coloring materials have different effects on cast iron, wrought iron and malleable iron and will produce different shades, if not different colors. The chemical composition of the steels is so varied that no set of rules will apply to all steels. Likewise the preparation of the metal before coloring and the treatment given it after coloring must be changed to suit the kind of metal being colored. Hence it is necessary to know the metal that is being worked upon. It is always best to first experiment with a few pieces and see if uniform results are being obtained. It is a good rule not to treat miscellaneous steel pieces by the one coloring process, although some of the plating processes that deposit heavy coatings might be relied upon.

Preparing Work for Coloring

Preparing the work for the coloring operation is of the most vital importance. It is absolutely necessary to remove all grease, and the removal of all other foreign substances for the surfaces to be colored is of just as much importance. In fact, only the clean metal surface should present itself to the coloring materials, no matter what their nature may be. When all the layers of oxide, grease, dirt, etc., have been removed the entire exposed surface can be given a uniform color and a quantity of pieces will be the same shade if the other conditions are properly looked after.

Rust-proof Black Finish

When a rough surface, such as is presented by castings, forgings, etc., is to be given the rust-proof black finish, sand blasting is the quickest and cheapest method of cleaning the work. In this black finish the metal is oxidized and coated with black magnetic oxide of iron. One method of producing this is to heat the work to a red heat in a muffle furnace in the presence of steam and hydrogen gas. A small amount of gasoline, injected with the steam, improves the color. The work should be subjected to red heat in the muffle for about an hour. If the work is given a thin coating of linseed oil after it has cooled off the color will be deepened and present a smoother appearance.

This coating is quite hard and not easily worn away, and is a dead black. It is free from the red oxide that has spoiled so much work of this kind. The hydrogen gas is generated by passing steam over red hot iron chips or turnings. Cast iron, malleable iron and steel may all be given this black finish. The principle on which it is based is that of giving the surface all the oxide it will take up so the oxygen in the air cannot reach it and cause corrosion. Tests have shown it to resist this action for many years and the color to be preserved.

Black Oil Finish

Black oil finish is produced by heating the work to a bright red; then quenching it in lard oil, afterward putting it back in the furnace to burn the oil off, and then quenching it in water. The oil must be kept cool and the water clean. A thin coat of linseed oil applied to the black gives the same results as described above. This coating is not durable but it will prevent rusting until the goods are sold, and is useful for such tools as can be heat-treated in the same operation.

Gun-metal Finish

Gun-metal finish is based on the same fundamental principle as the black finishes described above but is a great improvement over them and applicable to a finer class of work. For this work, as well as for the browns, blues or other fine colors that are produced on polished surfaces, the pieces must be cleaned by methods that will not injure these surfaces, as does the sand blast.

Grease and dirt are readily removed by boiling the work in a solution of one pound of potash to one gallon of water. This turns the grease to soap, which is absorbed by the water, and the dirt falls off from the work. The potash will last a long time and the water can be replenished as it boils away. When exhausted, the bath can be renewed by adding fresh potash. On small work, or a few pieces, stirring about in benzine or paraffine will remove the grease and dirt. If used continuously three vessels should be provided. In the first the bulk of the grease would be cut from the work; in the second the balance of it would be cleaned off; and the third should be kept clean to remove any particles that might still remain. The first two could contain paraffine and the third benzine.

After this cleaning the pieces should be washed with clean water and thoroughly dried. If boiling water is used they will dry in the air; if cold water is used clean sawdust is effective for drying them. The work should never be touched with the bare hands as the fingers are likely to leave grease marks.

Pickling Preparatory to Coloring

Scale, oxide, etc., are not removed by the above washing methods and hence a pickling in acid solutions is required. One part of sulphuric acid to twenty parts of water is often used for iron. This mixture leaves the work dark colored and sometimes it has a different appearance at the edges. To make the work bright, the following pickling solution should be used: Dissolve two ounces of zinc in one pound of sulphuric acid and mix this with one gallon of water; then add one-half pound of nitric acid. The volume of the bath should be twenty times that of the work, to prevent it from becoming weakened too soon. The glassy patches on cast iron, which are usually iron silicate, can be removed by hydrofluoric acid.

After pickling, the solution should be thoroughly washed off and the work brushed with steel scratch brushes revolving at from 600 to 1000 R. P. M. Cleaned work can be protected from rusting by keeping it immersed in water containing some caustic alkali until it is needed. Caustic soda and sodium carbonate are both effective for this purpose.

Polished steel surfaces can be pickled by immersing them, in contact with a piece of clean zinc, in a moderately strong solution of the acid potassium sulphate and water. Hydrogen gas is liberated when the zinc decomposes the solution and this removes the oxide of iron or rust from the steel. Another good pickling solution for steel is made of twenty parts hydrochloric acid and eighty parts water. Iron and steel can also be pickled white, in concentrated nitric acid to which has been added some lampblack. After pickling, the work should always be thoroughly washed and scratch brushed.

Other Gun-metal Receipts and Methods

Several different chemical solutions have been used successfully in giving steel the gun-metal finish or black color. Among these are the following: Bismuth chloride one part, copper chloride one part, mercury chloride two parts, hydrochloric acid six parts and water fifty parts. Ferric chloride one part, alcohol eight parts and water eight parts. Copper sulphate two parts, hydrochloric acid three parts, nitric acid seven parts and perchloride of iron eighty-eight parts. Other solutions have been prepared from nitric ether, nitric acid, copper sulphate, iron chloride, alcohol and water, and from nitric acid, copper sulphate, iron chloride and water.

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[*] For further information on coloring metals, see "Shop Receipts and Formulas," published in MACHINERY, 1905, to date; "The Niter Process for Bluing Iron and Steel," April, 1910; "Producing Black Nickel Coatings on Metal Surfaces," January, 1909; "Metal Coloring," December, 1903.

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Applying these and finishing the work is practically the same in all cases. The surface of the work is given a very thin coating with a soft brush or sponge that has been well squeezed, and is then allowed to dry. If put on too thick the surface will be unevenly corroded and white spots will appear. The work is then put into a closed retort to which steam is admitted and maintained at a temperature of about 100 degrees F. until covered with a slight rust. It is then boiled in clean water for about fifteen minutes and allowed to dry. A coating of black oxide will cover the surface, and this is scratch brushed. After brushing, the surface will show a grayish black. By repeating the sponging, steaming and brushing operation several times a shiny black surface will be obtained that is lasting. For the best finishes these operations are repeated as many as eight times.

Another process employs a solution of mercury chloride and ammonium chloride which is applied to the work three times and dried each time; a solution of copper sulphate, ferric chloride, nitric acid, alcohol and water is then applied three times and dried as before; a third solution of ferrous chloride, nitric acid and water, is applied three times and the work boiled in clean water and dried each time; the third and last solution of potassium chloride is then applied and the work boiled and dried three times. The work is then scratch brushed and given a thin coating of oil. Ordnance for the French Government was treated in this way.

The above methods are useful for hardened and tempered steels, as they are only heated to about 100 degrees F. and this temperature does not draw the hardness. For steels that will stand 600 degrees temperature without losing the desired hardness, better and much cheaper methods have been devised.

The color does not form a coating on the outside, as with the other processes, but a thin layer of the metal itself is turned to the proper color, which should make the color wear well. By varying the temperature of the furnace, the time the work is in it, and the chemical, different colors can be produced from the light straws to the browns, blues, purples and black, or gun-metal finish. Rough or sand-blasted surfaces will have a frosted appearance, while smooth, polished surfaces will have a shiny brilliant appearance.

A variety of colors can also be produced on iron and steel by immersing the pieces, for different lengths of time, in a boiling hot solution of the following composition: Lead acetate fifty grains, sodium thiosulphate fifty grains, water five fluid ounces. A half-hour immersion will make the work black and a shorter time will make it steel-gray, blue, mixed purple and blue, purple, dark brown and light brown. By controlling the time, the desired color can be obtained. These colors are very beautiful but fade quickly. A coat of lacquer on top of the color, however, will preserve them for years. On top of a nickel plating these colors are exceptionally brilliant.

Coloring Steel by Heat

Producing colors on steel by heat-treatment is almost too well known to comment on here. Suffice it to say that 430 degrees F. produces a faint yellow, 460 degrees dark yellow, 490 degrees light brown, 500 degrees dark brown, 520 degrees light purple, 540 degrees dark purple, 560 degrees light blue, 580 degrees dark blue, 600 degrees blue green and 620 degrees black. By mixing potassium nitrate and sodium nitrate in an iron pot and melting them, the bath can be maintained at any of these temperatures. By immersing the work in this bath until it absorbs its temperature and then cooling it, any of these colors can be obtained. The work can be cooled by plunging it into boiling water and the coating of salt removed at the same time. A thin coating of these salts sticks to the steel and prevents the oxygen in the air from attacking the metal and altering the color while it is being transferred from the nitrate bath to the boiling water. The contained heat will dry the work when removed from the water.

Browning Iron and Steel

A good brown color can be obtained as follows: Coat the steel with ammonia; dry in a warm place; then coat with muriatic or nitric acid; dry in a warm place; then place in a solution of tannin or gallic acid; and again dry. The color can be deepened by placing the work near the fire, but it should be withdrawn the minute the desired shade is reached or it will turn black.

The U. S. Government adopted the following formula for browning gun barrels: Alcohol three ounces, tincture of iron three ounces, corrosive sublimate three ounces, sweet spirits of niter three ounces, blue vitriol two ounces, nitric acid one and a half ounce and warm water two quarts. The solution is applied with a sponge, allowed to dry for twenty-four hours. and after this the loose rust is removed by scratch brushing. A second coat is given in the same manner. After that the piece is boiled in water and dried quickly. A thin coat of boiled linseed oil or lacquer is then put on to preserve the color.

Another process for browning iron and steel consists of dissolving four ounces of copper sulphate in two quarts of water and then adding one ounce of nitric acid, one ounce of spirits of niter, two ounces of alcohol and one ounce of ferric chloride. Scratch brushing and rubbing with a piece of smooth hard wood will polish and burnish the work and a coat of shellac or lacquer will preserve the color. Rubbing with the polishing wood will give the lacquer or shellac a polished surface.

A solution that may be used in place of the above is spirits of niter one ounce, copper sulphate one ounce and water twenty ounces. This must be allowed to remain on the work for twenty-four hours and then brushed off with a stiff brush. The operations can be repeated enough times to get the depth of color desired.

To Produce Bronze-like Color

A warm bronze-like color can be produced by exposing iron or steel to the vapors of heated aqua regia, dipping them in melted vaseline, then heating until the vaseline begins to decompose and wiping it off with a soft cloth.

Another method of producing this bronze-brown color is to slightly heat the work, cover the surfaces evenly with a paste of antimony chloride, known as "bronzing salt," and let it stand until the desired color is reached. It can be made more active by adding a little nitric acid.

Still another bronzing process consists of soaking the work for some time in an acid solution of ferric chloride, then vigorously moving it about in hot water and allowing it to dry, and finally brushing with a waxed brush. The oxygen, liberated by the decomposition of the water, combines with the iron and forms a dark layer of oxide.

To Produce Gray Color

A gray color can be obtained by immersing the work in a heated solution of ten grains of antimony chloride, ten grains of gallic acid, 400 grains of ferric chloride and five fluid ounces of water. This is doubtless due to the antimony. The first color to appear is pale blue and this passes through the darker blues to the purple and finally to the gray. Thus if immersed long enough the metal will assume the gray color, but if not any of the intermediate colors may be produced. Used cold it is also one of the bronzing solutions.

Mottling

The mottled colors can be produced by heating the steel pieces to a good cherry red for several minutes in cyanide of potassium, then pouring the cyanide off and placing the pot of work back in the fire for five minutes and then quickly dumping the contents into clean water. To heighten the colors the work should afterward be well boiled in water and oiled while hot. This also carbonizes the work and larger lots could be handled in the regular carbonizing furnaces.

With the various plating methods and processes nearly any kind of solid or mottled colors can be produced. They can also be laid in different combinations of stripes in various ways. This, however, is a trade or professional art that is distinctly different from the chemical coloring methods described above and hence it will not be described in this article. There are also ways of electrolytically coloring metals but as this is usually done with electroplater's apparatus it can be classed with the plater's art.

MAKING BALL PLAYERS' SHOE PLATES

TOOLS USED FOR BLANKING, SWAGING, PIERCING, FORMING AND GRINDING

BY A. F. HORTON*

The discussion which has been published in the papers during the past season in regard to a discontinuance of the use of plates on ball players' shoes to avoid accidents in sliding bases, has been read by a large number of people, but very few of this number know anything of the work involved in making these plates. An idea of the magnitude of this industry and the revenue derived from it will, however, be appreciated when it is known that a single firm manufactured nine thousand sets of plates during one season. Before entering into a discussion of the methods used in making plates of this kind, it may be mentioned that a set consists of one right- and left-hand plate, to go under the ball of the foot, and a heel plate for both feet. These plates are made from a low grade of carbon steel and are tempered just enough to give them the required wearing quality, the temper used being approximately a "spring temper." It is necessary to make the plates as light as possible, and at the same time have them strong and hard enough to retain their edge when coming constantly into contact with all sorts of material on the ground. The manufacture of these plates involves twelve separate operations, which naturally means that a considerable amount of work is put on them, as each individual plate must be handled twelve times. Fig. 1 shows a plate at different stages in the process of manufacture. A blank is shown at *A*, as it comes from the blanking die; at *B* the blank has been swaged and trimmed on the inside and outside; at *C* the holes have been pierced for the rivets that secure the plate to the shoe; and at *D* the ends of the blank have been bent over and ground, thus completing the plate.

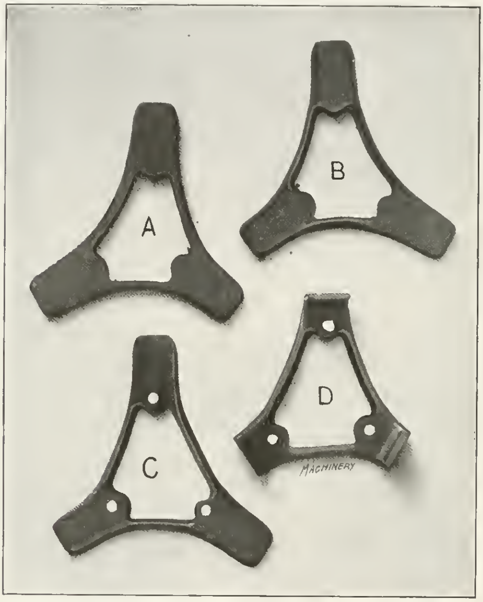

Fig. 1. Plate in Various Stages of the Process of Manufacture

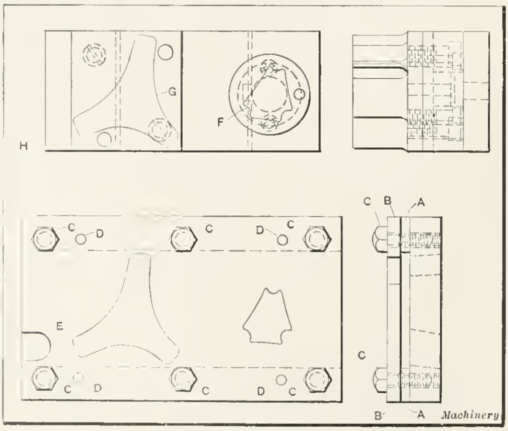

Fig. 2. Punch and Die used for punching the Hole in Middle of Plate and stamping the Blank from Ribbon Stock

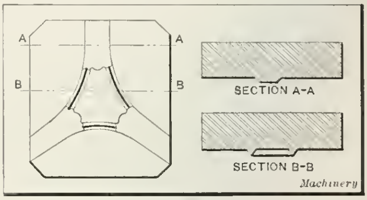

Fig. 3. Forces used in making Swaging Dies

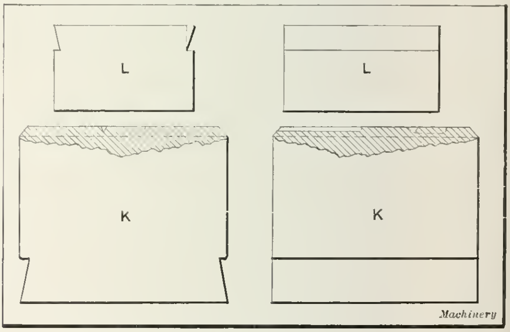

Fig. 4. Dies used for swaging Shoe Plates under a Drop Hammer

Fig. 2 illustrates the punch and die used for stamping the blanks from ribbon stock and punching out the metal that is to be removed from the center. The stock is fed over the face of the die between the gages *A* which are fastened to the die with screws *C* and dowel pins *D*. The slot *E* is cut in the end of the stripper plate to provide for the use of a finger gage which operates from the crankshaft of the press by means of a cam. The stock is fed over the die until it is stopped by the finger gage dropping into the hole in the stock from which the blank was stamped by the preceding stroke. When the stock has been located in this way, one stroke of the press blanks out the plate punched in the preceding operation and, at the same time, punches the hole in the next plate. This is continued until the strip is completely blanked. The stock is then reversed

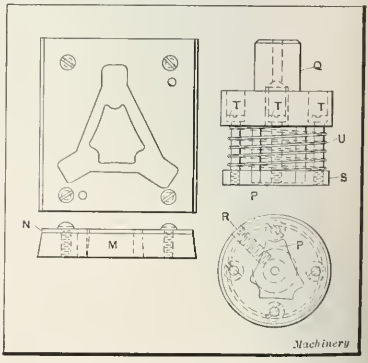

Fig. 5. Punch and Die used for trimming Inside of Plates

and run through the die a second time, thus interlocking the blanks with those that were stamped out during the preceding passage of the stock over the die. The punches *F* and *G* are made of tool steel and are fastened to the punch pad *H* by means of screws and dowel pins to prevent them from turning. The top of the punch pad is machined to dovetail into the gate of the press.

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The next operation consists of swaging the blanks, this work being done under a drop hammer with the metal hot. The same blanks can be used for both right- and left-hand toe plates, but the blanks are placed on one side to be swaged for right-hand plates and on the other side to be swaged for left-hand plates. Fig. 3 shows the forces used for making the female swaging dies. Three different forces are required for the production of dies for right- and left-hand toe plates and heel plates respectively. The forces are made of tool steel and machined to the shape indicated in Fig. 3. The section *B-B* on a well made shoe plate must be formed to a sharp edge and be as light as possible in order to reduce weight and enable the soil to be shed from the plate. After these forces have been machined and finished, they are hardened and tempered ready to be used in the following manner: The lower swaging die, shown at *K* in Fig. 4, is made of composite steel, the lower part consisting of wrought iron while the upper part is made of tool steel to a depth of about one inch. The joint between these two parts is welded together. The bottom of the die is machined to fit the dovetail in the bed of the drop hammer and the top surface of the die is left flat. The die block is next placed in the furnace and heated to a red heat, and then placed in position under the drop hammer. The force illustrated in Fig. 3 is then placed in the desired position on the die and the hammer allowed to drop on it; this drives the force into the face of the die and the required number of blows of the hammer is applied to secure an impression of the desired depth. The die is then allowed to cool, and while it still retains a certain amount of heat muriatic acid is poured upon its face to remove the scale produced by the hot forging. After the die is cool it is returned to the drop hammer and again struck to remove all shrinkage; it is then polished, hardened and tempered. The upper die *L* in Fig. 4 is made of tool steel and machined to fit the dovetail in the hammer; it is hardened and tempered and the lower face is ground to an accurate flat surface. The dies are now ready to be mounted in the drop hammer for use. The blanks are heated in a large gas furnace built especially for this class of work. The hot blanks are then taken from the furnace one by one and placed in position on the die where one blow of a five-hundred pound hammer forces the metal down into the impression in the lower die.

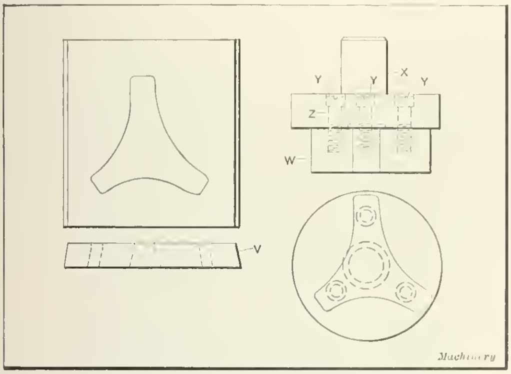

Fig. 6. Punch and Die used for trimming Outside of Plates

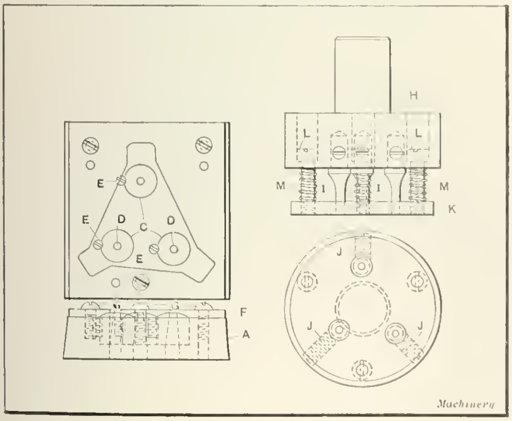

Fig. 7. Punch and Die which pierce Rivet Holes

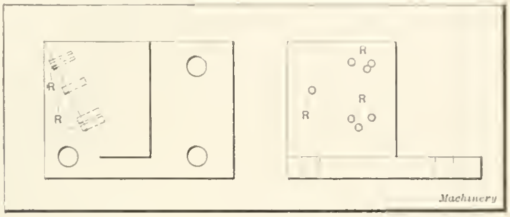

Fig. 8. Fixture used for grinding the Plates on a Disk Grinder

The next operation consists of trimming the insides and outsides of the plate to remove the surplus stock which is left after the swaging operation has been completed. The trimming tools used for this purpose are illustrated in Figs. 5 and 6. In Fig. 5, the die *M* is made of tool steel with the sides machined to fit the dovetail in the die-holder. The hole in the die is machined to the required shape and the hole in the gage plate *N* locates the work in the required position. The lower end of the punch *P* trims the hole in the plate to the required shape and a shank is provided at its upper end to fit into the punch-holder *Q*. The screw *R* is used to hold the punch in position in the punch-holder. The round stripper *S* is made of machine steel and fastened to the punch-holder by screws *T* which pass through counterbored holes from the top. The spring *U* passes around the outside of these screws and operates the stripper. In using this punch and die, the work is placed in position in the gage and the press tripped; the punch then trims the fin from the inside of the plate, and as it rises the stripper forces the plate off the punch. Referring to the tools for trimming the outside of the plates shown in Fig. 6, the die *V* is of similar construction to the one just described, but no gage is required to locate the work, as the shoe plate is located in position to be trimmed when dropped into position in the die. The trimming punch *W* is made in two sections, the lower part of the punch being of tool steel and made to fit the punch-holder *X* which is made of machine steel. The punch is secured to the punch-holder by screws *Y* and is hardened and tempered; no stripper is required as the trimmings remain on the face of the die and the plate is forced down through the hole. The press used for this purpose is equipped with a compressed air attachment to blow the trimmings off the face of the die after each operation.

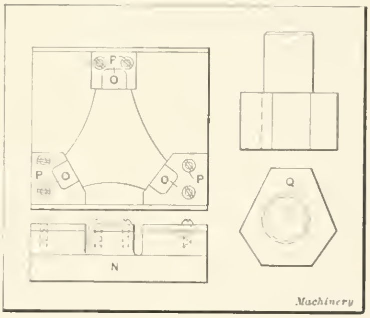

Fig. 9. Punch and Die used for bending up the Ends of the Spikes

The piercing punch and die shown in Fig. 7 are used for piercing the rivet holes in the plates. The die-block *A* is made of machine steel and has the dies *C* inserted in it and held in position by screws *E*. The die-block *A* is machined on all sides and fitted in the dovetail of the die-holder. The holes are then laid out and bored and counterbored to receive the dies *C*. The center holes *D* in the dies are drilled to the size of the rivets which are to be used in securing the plates to the shoe. The dies are next placed in position in the holder and the holes for the screws *E* are drilled and tapped. The dies are then hardened and tempered ready for use. The gage plate *F* is fitted in the proper position and fastened to the die plate with screws and dowel pins. The piercing punch is made with a machine steel punch-holder *H* which has a shank to fit in the ram of the press. The holes for the piercing punches *I* are transferred through the corresponding holes in the die and these holes are then drilled to the required size. The punches are fitted to the punch-holder and held in position by the screws *J*. After completing these operations the punches are hardened and tempered. The round stripper *K* is made of machine steel and is fastened to the punch-holder by means of three screws *L*. The springs *M* surrounding these three screws actuate the stripper and force the plate from the punches after the piercing operation has been completed.

The fixture shown in Fig. 8 is used for grinding the spikes on the plates. This fixture is mounted on the table of a disk grinder and provides for bringing the spikes of the plates against the disk wheel at the right angle. Holes are drilled in the block of this fixture to receive the small pins *R*, which fit through the holes in the plates that were pierced in the preceding operation, and it will be seen that there are three combinations of holes in which the three pins can be placed in order to bring each of the spikes of the plate into the right position for grinding.

The punch and die shown in Fig. 9 are used for the final operation on the plate, which consists of bending the spikes over the required angle. The die *N* is made of tool steel. The bottom or face of the die is machined to the same contour as the sole of a shoe, and the gage plates *O* which locate the work in the die are held in position by means of screws *P*. The punch *Q* is made of tool steel with a shank to fit into the press. The sides of this punch are machined to the same angle as the die and provided with the necessary clearance to allow the spikes to be bent up between the sides of the punch and die. The punch is hardened but not tempered, as the plates are formed hot. The press used for this purpose is fitted with a compressed air attachment to remove the scale which is left in the die as the result of the hot forming.

The plates are now ready to be tempered and for this purpose they are placed in a continuous hardening furnace. After being hardened, they are passed through a lead bath which draws the temper to the required point, which, as previously mentioned, is in the nature of a "spring temper." Considerable care is required to get the temper exactly even, as it will be remembered that the heel plates are smaller than the toe plates. The importance of this precaution lies in the fact that it is desired to produce a product having a uniform temper color.

* * *

POWER TRANSMITTED BY HERRINGBONE GEARS*

BY J. E. HOLVECK†

The advantages claimed for herringbone gears are a smooth transmission due to continuity of engagement, adaptability to high pitch line velocities, quieter operation, higher efficiency and greater wearing qualities than are possessed by spur gearing. Since the teeth of herringbone gears are stronger than the teeth of spur gears, and as a wider face is possible for a given pitch, a further advantage is obtained through the more compact space which is occupied by a transmission system of this type. In designing drives of this kind, however, excessive pitch line velocities should be avoided, and for ordinary conditions, where the gears do not run in oil, 1500 feet per minute is a fair average velocity. Herringbone gears will operate satisfactorily at much higher speeds, but with correspondingly increased wear and noise.

TABLE I. POWER TRANSMITTED BY HERRINGBONE GEARS

Pitch	Teeth	Pitch Dia., Inches	Face, Inches											
6 D. P. 0.5236″ C.P.	21	3½		Velocity	400	600	800	1000	1200	1400	1500	1600	1800	2000
				R. P. M.	436	655	873	1090	1310	1525	1635	1745	1960	2180
			4	Cast iron	7	10	12	14	15	17	18	19	20	21
				Cast steel	13	18	23	27	31	35	36	37	40	42
			5¼	Cast iron	9	13	16	18	20	22	24	25	26	28
				Cast steel	17	24	30	35	41	46	47	49	53	55
5 D. P. 0 6283″ C P.	21	4.2		R. P. M.	364	545	725	910	1090	1270	1360	1450	1630	1820
			5	Cast iron	10	14	17	20	23	25	26	27	29	31
				Cast steel	19	27	34	40	46	51	53	55	59	63
			6¼	Cast iron	13	18	21	25	29	31	32	34	36	39
				Cast steel	24	34	43	50	58	64	66	69	74	79
4 D. P. 0.7854 C.P.	21	5¼		R. P. M.	292	437	584	730	875	1020	1090	1160	1310	1460
			6¼	Cast iron	16	22	27	31	36	40	41	43	46	49
				Cast steel	29	41	53	62	71	80	83	86	93	99
			7¾	Cast iron	20	27	34	39	44	50	51	53	57	61
				Cast steel	36	51	66	77	88	99	103	107	116	122
3½ D. P. 0 8976″ C.P.	21	6		R. P. M.	255	382	510	637	765	892	955	1020	1150	1275
			7½	Cast iron	21	29	36	42	47	52	55	57	61	65
				Cast steel	39	55	70	83	95	105	110	114	123	131
			9	Cast iron	26	36	45	52	58	65	68	71	76	81
				Cast steel	48	68	87	103	118	130	136	141	154	162

Machinery

TABLE II. POWER TRANSMITTED BY HERRINGBONE GEARS

Pitch	Teeth	Pitch Dia., Inches	Face, Inches											
3 D. P. 1.0472″ C.P.	21	7		Velocity	400	600	800	1000	1200	1400	1500	1600	1800	2000
				R. P. M.	218	327	436	546	655	765	820	875	983	1090
			8½	Cast iron	28	39	48	55	63	69	71	75	80	84
				Cast steel	51	72	92	110	126	139	146	151	165	173
			10½	Cast iron	36	50	61	70	80	89	90	96	102	107
				Cast steel	65	92	117	140	160	177	184	192	210	220
2½ D. P. 1.2566″ C.P.	21	8.4		R. P. M.	182	273	364	455	546	637	683	729	820	910
			10	Cast iron	41	57	70	80	91	101	106	109	116	122
				Cast steel	74	105	134	160	185	202	211	220	240	251
			12½	Cast iron	51	71	87	100	114	126	132	137	145	152
				Cast steel	93	130	167	200	228	253	264	274	300	314
2 D. P. 1.5708″ C.P.	21	10½		R. P. M.	145	218	291	364	437	510	546	580	655	730
			12½	Cast iron	64	89	109	125	143	158	166	171	182	195
				Cast steel	116	164	207	250	285	316	329	342	375	392
			15½	Cast iron	79	111	136	154	178	196	206	213	226	242
				Cast steel	144	204	259	309	355	393	410	425	465	488
1¾ D. P. 1.7952″ C. P.	21	12		R. P. M.	127	190	254	318	382	445	477	510	572	636
			14½	Cast iron	86	118	146	166	190	210	219	228	241	258
				Cast steel	155	218	279	331	378	420	438	455	496	522
			18	Cast iron	106	146	180	206	234	261	272	282	300	320
				Cast steel	192	271	345	413	470	521	515	562	610	710

Machinery

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* For further information on this subject see "Herringbone Gears," published in MACHINERY, January, 1912.

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The usual conditions met with in designing any form of gear drive are that power is to be transmitted from a motor spindle or other prime mover running at high speed to a machine which is required to operate at a considerably reduced speed. In selecting a pair of herringbone gears (as in the case of any other form of gearing) the designer naturally selects the smallest size of pinion which can be conveniently adapted to the service for which it is desired. By so doing, the size of the gear is reduced so that the least possible amount of space is required. Another reason for selecting a small pinion and corresponding gear to give the required speed reduction is to reduce the pitch line velocity to a minimum, as a higher velocity means increased wear and objectionable noise. Both the pinion and gear have the same pitch line velocity, and consequently, the same tooth strength. In the design of herringbone gears, a pinion with 21 teeth will be found satisfactory for average conditions, although it is possible to have a pinion with a smaller number of teeth, pinions with as few as 13 teeth having been used with satisfactory results. Where such small sized pinions are used, however, they are made solid on the shaft.

TABLE III. POWER TRANSMITTED BY HERRINGBONE GEARS

Pitch	Teeth	Pitch Dia., Inches	Face, Inches											
1½ D. P. 2.0944″ C.P.	21	14		Velocity	400	600	800	1000	1200	1400	1500	1600	1800	2000
				R. P. M.	110	160	220	270	330	380	410	435	490	540
			16	Cast iron	110	152	187	215	244	270	282	292	311	333
				Cast steel	199	280	358	426	488	540	564	585	640	671
			20	Cast iron	137	190	234	269	305	338	343	366	388	406
				Cast steel	249	350	447	534	610	675	707	732	800	838

Machinery

FORMULAS

H. P. = horsepower.
N revolutions per minute.
P = tooth pressure lbs.
K = admissible stress in lbs. per sq. in.
D = pitch circle dia. in inches
p = circular pitch in inches. For diametral pitch take nearest circular pitch.
W = total width of face in inches, including non-bearing width equal to 1 p.
V = velocity of pitch circle dia. ft. per min.

$$P = \frac{H.P.\ 33{,}000}{V}$$

$$P = \frac{p}{2.5} W K$$

The formulas and tables are based on a tooth angle of 23 degrees and the shearing stress of an imaginary straight tooth at pitch line thickness, assuming length of tooth contact equal to the total width of face. The values of the stress curves are entirely empirical, based on results of extended experience by the manufacturers, and lead to dimensions which are safe and reliable.

The above tables give H. P. transmitted by gears for various pitches and at pitch line velocities noted, also for two widths of faces corresponding to 8 and 10 p. H. P. given also for two materials, cast iron and cast steel.

As it is usual to first select the pinion and then determine the gear, a common size of pinion having 21 teeth is inserted for each pitch with the revolutions per minute corresponding to the velocities.

To find the H. P. of any other size pinion of a certain pitch, ascertain the velocity and under the nearest velocity in the table and opposite the pitch find the H. P.

Fig. 1 gives the value K by which the H. P. for pinions of other materials not given in the tables can be readily determined as follows: At 1500 feet per minute:

A brass gear will transmit	$\frac{375}{475}$	times that of C. I.—multiplier	0.79
A gun metal gear will transmit	$\frac{600}{475}$	" " " " " "	1.26
A phosphor bronze gear will transmit	$\frac{775}{475}$	" " " " " "	1.63
A H. C. fgd. steel gear will transmit	$\frac{1350}{925}$	" " " C. S. "	1.46

To compensate for wear the pinion should be of a tougher material than the gear. With cast iron and cast-steel gears use forged steel pinions. Note. Tables and formulas compiled from data by the Falk Co., Milwaukee, Wis., manufacturer of Wuest gears.

Tables I, II and III give the horsepower transmitted by this type of gearing for various pitches in cast iron and cast steel, with pitch line velocities ranging from 400 to 2000 feet per minute. The method by which these tables were calculated will be understood by referring to the formulas given in connection with Table III. These tables are used for determining the gear which is necessary for transmitting a given power at a specified speed. It is customary to use a pinion of tougher material than the gear, owing to the greater wear to which it is exposed, and the curves in Fig. 1 are used for obtaining the relative toughness of the different metals which are customarily used. These curves give the admissible stress in the gear teeth in pounds per square inch, and the values of *K* used in calculating the tables were taken from these curves. Figs. 2 and 3 show the relation between the revolutions per minute and pitch line speeds in feet per minute for pinions and gears of various pitch diameters.

To illustrate the method of using the tables, it is assumed that a herringbone gear drive is required to transmit 100 horsepower from a motor running at 650 revolutions per minute with a speed reduction of 12 to 1. In Table II, opposite 2½ pitch, 10-inch face and under 637 revolutions per minute, 101 horsepower is found to be the capacity of a cast-iron gear running at a pitch line velocity of 1400 feet per minute. This

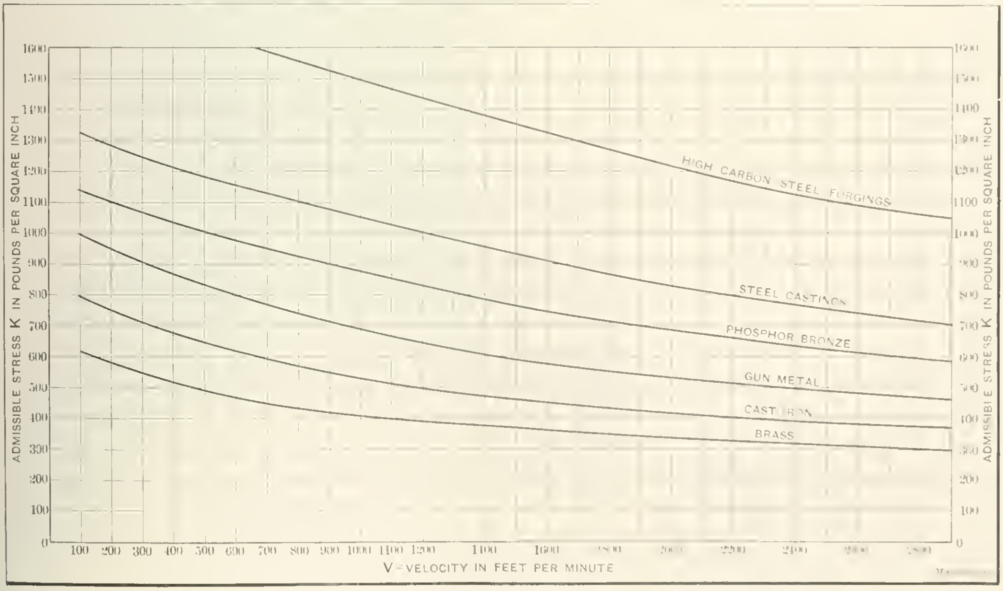

Fig. 1. Values of Admissible Stresses in Herringbone Gear Teeth of Various Metals

would necessitate $\frac{12 \times 21}{2.5} = 100.8$ inches pitch diameter for the gear. The pitch line velocity of a 17-tooth pinion would be 1150 feet per minute, and in the 1200 foot column, it is seen that a gear running at this speed would transmit 91 horsepower. This means that a wider face gear must be used, if a 17-tooth pinion is to find successful application, the width of face required being $\frac{100 \times 10}{91} = 11$ inches. The pinion in either case should be made of cast steel or preferably of forged steel, to compensate for the greater wear to which it is exposed. If it is required to find the horsepower transmitted by a 2-pitch cast-steel gear having a pitch diameter of 90 inches by 10-inch face, running at 50 revolutions per minute, we find from Fig. 3 that the pitch line velocity is 1180 feet per minute. Under the 1200 column, in Table II, opposite 2 pitch and 12½-inch face, we find 285 horsepower, while the capacity of a gear of 10-inch face would be $\frac{10 \times 285}{12.5} = 228$ horsepower. Although the tables are calculated for 21-tooth pinions, they are universal in their application, it being merely necessary to find the corresponding pitch line velocity for any number of teeth.

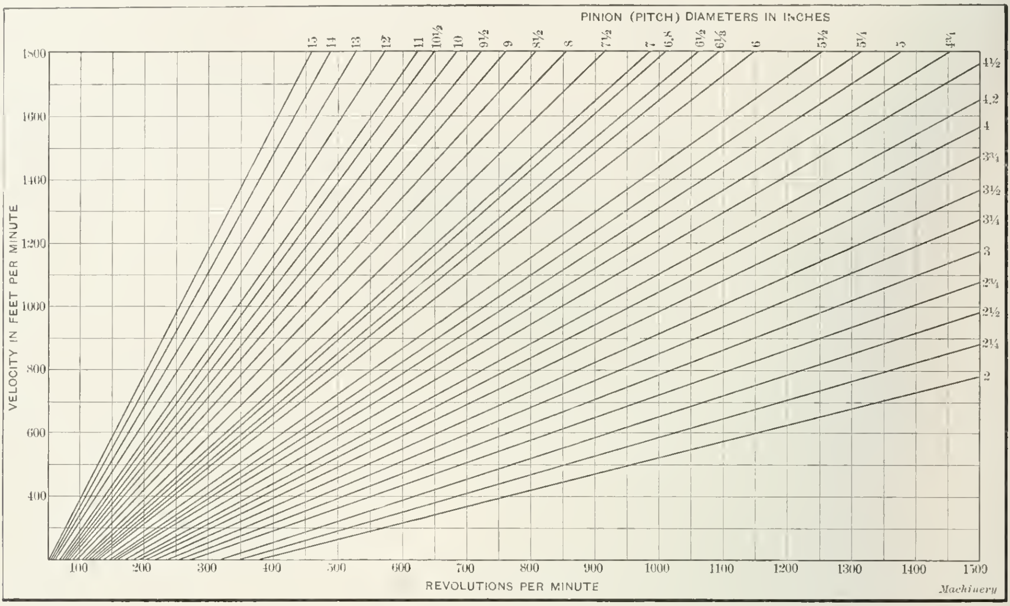

Fig. 2. Pinion Pitch Line Velocities for Various Diameters and Revolutions per Minute

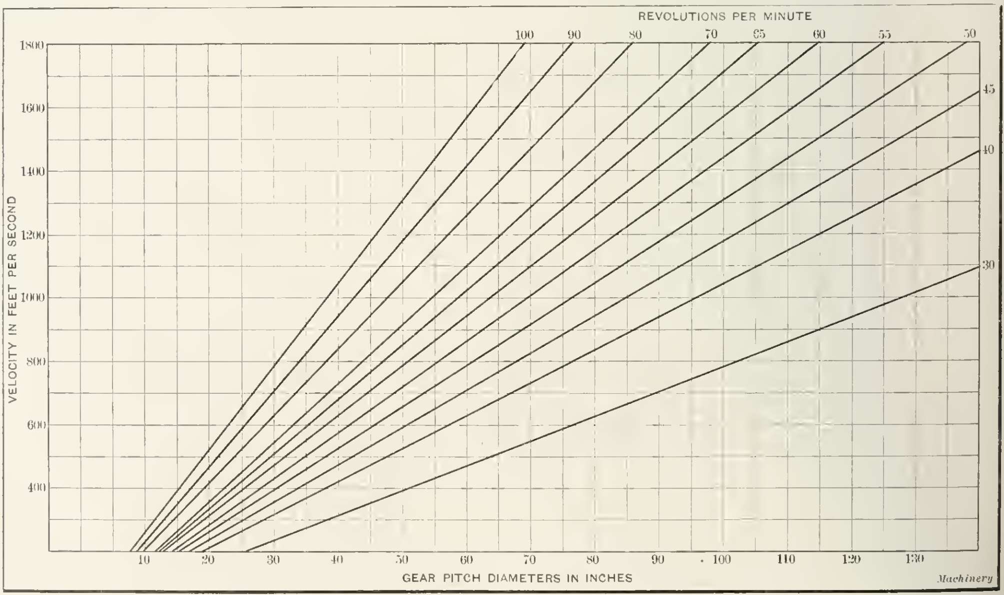

Fig. 3. Gear Pitch Line Velocities for Various Diameters and Revolutions per Minute

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Wireless messages were recently sent from the Sayville station, Long Island, N. Y., to the Nauen Tower near Berlin, Germany, a distance of about 3600 miles.

ECCENTRIC OR DIFFERENTIAL GEARS

AUTOMOBILE ENGINE REDUCTION MECHANISM—FORMULAS FOR VELOCITY RATIO

BY H. B. HEIGN*

No other field of mechanical design has brought about a more rapid development in gear mechanism than has that of the automobile. Not only have the different forms of gear teeth been perfected, but the combinations of gears used for velocity reduction have also been greatly improved. Almost all forms of gearing, as spur, helical, worm, annular and bevel, are represented in the modern automobile, and strength, quietness and efficiency are required from these combinations. It is the degree to which these requirements are attained which is largely responsible for the reputation of a car. In some of the recent developments in automobile accessories, such as self-starters and speedometers, conditions exist which require a high velocity ratio in a comparatively small space; this requirement has led to the development of what are commonly known as eccentric gear combinations. There are two general types of eccentric gears, *viz.*, those comprising two gears—a spur gear and an annular gear—and those consisting of four or more gears.

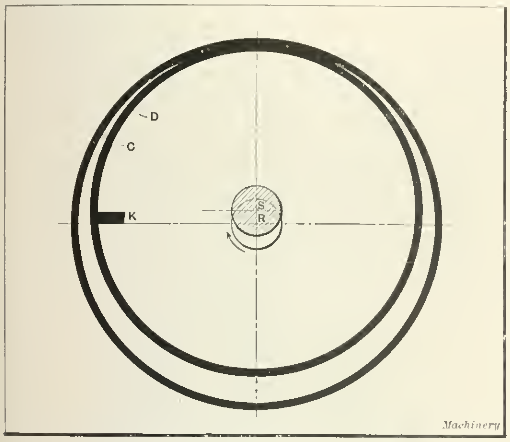

Fig. 1. Diagram illustrating Principle of Two-gear Eccentric Combination

Principle of the Two-gear Type

The principle of the two-gear type of eccentric gear combination is illustrated in Fig. 1, where C and D represent an annular gear and a spur gear in mesh. The center of rotation of C is on the shaft R and the center of rotation of D on the crank S. We will assume that the shaft R is the driving shaft, and as it turns in the right-hand direction as indicated by the arrow, we shall be able to hold the gear D from absolute rotation on its own center by some external means K, thus limiting the movement of the gear D to the rotation of the crank S. As the shaft R rotates, the gear D measures off its circumference on the annular gear C, and as there is a difference in the circumferences of C and D, the point on the annular gear C that was in engagement with the spur gear D for the position shown in Fig. 1 will be moved ahead, as the result of the rotation, when the two gears reach this position again. The amount which this point is moved forward is equal to the difference in the circumference of the two gears, and it is this difference in circumference which determines the velocity ratio of the combination. Let

d = number of teeth in spur gear D
c = number of teeth in annular gear C

Then as the number of teeth in a gear is in direct proportion to the circumference, we have

$$\frac{\text{Circumference } C - \text{Circumference } D}{\text{Circumference } C} = \frac{c-d}{c}$$

That is, if R represents one revolution of the driving shaft and S the corresponding movement of the driven shaft, the equation for the velocity ratio is:

$$S = R\,\frac{c-d}{c} \qquad (1)$$

Principle of Four-gear Type

The principle of the four-gear type of eccentric combination is illustrated in Fig. 2, where R is the driving shaft which has annular gears A and C loosely mounted upon it. The crank or eccentric S has the gears B and D, which are integral with each other, loosely mounted upon it. The gear A in this combination is held and prevented from rotating by an external device K, and the reduced velocity is obtained from gear C. If we assume that these gears have numbers of teeth represented by a, b, c and d, respectively, and that rotation in the right-hand direction is positive and in the left-hand negative, the rotation of the shaft R in the right-hand direction, with the gear A stationary, will cause the gear B to rotate $\frac{b-a}{b}$ revolutions in the left-hand direction. As the gears B and D are integral with each other, the gear D will rotate $\frac{b-a}{b}\,d$ teeth in the left-hand or negative direction.

Gear D meshes with gear C, and gear C will move the same distance and in the same direction as previously determined for the rotation of the gear D. If we suppose that the gear D has no absolute rotation about its center S, then for each revolution of the shaft R, the gear D would move the gear C through $\frac{c-d}{c}$ revolutions in the right-hand direction or through $c-d$ teeth. To determine the absolute rotation Y of the gear C, we must add its rotations in either direction that correspond to one revolution X of the driving shaft R. This absolute rotation of the gear C is determined as follows:

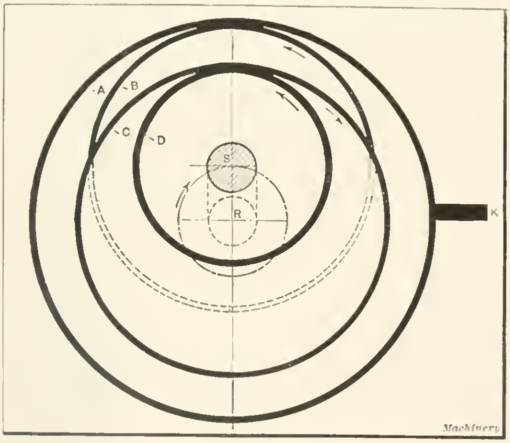

Fig. 2. Diagram illustrating Principle of Four-gear Eccentric Combination

$$Y = X\left(-d\,\frac{(b-a)}{b} + (c-d)\right) \div c \qquad (2)$$

Simplifying (2) we have

$$Y = X\,[(bd \div bc) - (ad \div bc) + (c \div c) - (d \div c)]$$

$$Y = X\left(1 - \frac{ad}{bc}\right) \qquad (3)$$

By substituting in Equation (3), we are able to determine the required velocity ratio. Since we have considered rotation in the right-hand direction as positive and in the left-hand direction as negative, it is evident that if the fraction $\frac{a\,d}{b\,c}$ is greater than unity, the gear C will be rotated in the negative direction by the driving shaft R, which has positive rotation. From an analysis similar to the foregoing, it has been proved that if the gear B is fixed instead of the gear A, the velocity ratio between the shaft R and gear C will be

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$$Y = X\left(1 - \frac{b\,c}{a\,d}\right) \qquad (4)$$

Assembly of the Two-gear Type

An assembly view of the two-gear type of eccentric gearing is shown in Fig. 3, which illustrates a typical reduction gear combination that changes automatically from the reduced velocity to direct drive. This combination is similar to those used by several manufacturers of electric automobile starters. The driving shaft A is connected to the electric starting motor and has the eccentric sleeve B secured to it. Sleeve B has four plungers C inserted in its flange; these plungers pick up the internal gear when the sleeve D becomes the driving shaft, due to the starting of the automobile engine and the conversion of the electric motor into an electric generator. Plungers C do not engage as long as shaft A is the driving shaft, on account of the difference in velocities of shaft A and internal gear E. In order to prevent the spur gear F from absolute rotation on its own axis, and to provide means for having it free on the roller bearings G, an oscillating plate H has been used which has four slots located at 90 degrees from one another that fit loosely over the rollers I and J. Rollers I are secured to gear F and rollers J to the gear-case; the oscillating plate H then has freedom of movement equal to the eccentricity of the crank, and still holds the gear F from turning. As the sleeve D is connected to the automobile engine, and the gear F is prevented from rotating, it is evident that if the engine should back-fire, the mechanism would be wrecked. This possibility has been guarded against in the following manner: The sleeve D has friction disks K bearing upon it, the pressure to produce the friction being obtained by springs L. When back-fire occurs, the clutch will slip if the back-fire torque is greater than the motor cranking torque. As an extra precaution, either friction roller clutches or electrically controlled pawls M also engage with the case if there is a tendency for the gear E to rotate in the reverse direction.

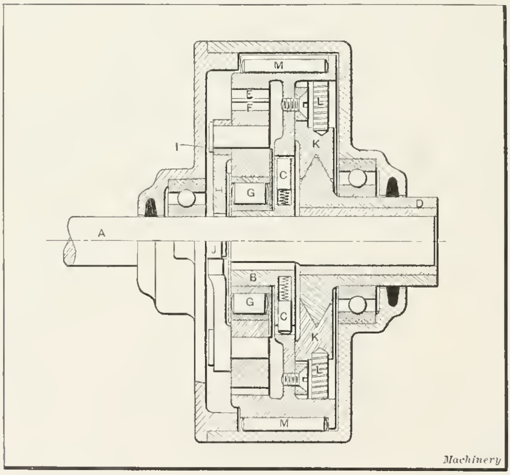

Fig. 3. Assembly of the Two-gear Eccentric Combination

With this type of reducing mechanism, a reduction of from 23 to 1 to 26 to 1 is customarily used, and it is possible to obtain this reduction with gears having a difference of only two or three teeth. One electric starter company used 48 teeth on the spur gear and 50 teeth on the internal gear, which gives the following value of the velocity ratio $\frac{S}{R}$:

$$\frac{S}{R} = \frac{c-d}{c} = \frac{50-48}{50} = \frac{1}{25}$$

which is a reduction of 25 to 1; this appears to be about the proper reduction for the different sizes of commercial motors. It is evident that with internal gears meshing together and having a difference of only two teeth, a special tooth form must be used. It has been found by commercial tests that the ordinary form of bastard tooth gear has a very low efficiency, due to the oscillating contact of the teeth as the internal gear is moved forward. To partially overcome this low efficiency, a special form of tooth is used which has a total height of about 0.070 inch and a diametral pitch of 14; this gives the teeth the appearance of short rack teeth. The efficiency of this special gear tooth is about 80 per cent.

Assembly of the Four-gear Type

When the two-gear type of eccentric combination is used, it is evident that the reduction ratio is limited to about 50 to 1 unless very large gears are used. To avoid increasing the size of the units, the use of special gear teeth, and the oscillating contact of teeth, an eccentric combination of four gears may be adopted. As previously explained, two of the gears in such a combination are spur gears, which are made integral with each other, and two are independent annular gears. An assembly view of such a combination is shown in Fig. 4, which provides a reduction of 18 to 1 in starting the automobile engine, and then changes automatically to direct drive when the electric motor is converted into a generator. The high-speed shaft A is connected to the electric motor-generator, and the low-speed sleeve B is connected to the automobile engine. C_1 are roller clutches which engage with the gears D and E when the latter rotates in the right-hand direction. The roller clutches C_2 engage with the gear G when the latter rotates in the left-hand direction. As the shaft A drives in the left-hand direction, the resistance of the sleeve B against rotation causes the gear G to rotate in the left-hand direction, thus locking the clutches C_2. As soon as the gear G becomes stationary, the desired reduction of velocity is obtained by the rotation of the remaining gears. As soon as the automobile engine drives the gear combination, and the electric motor becomes an electric generator, the gears D, E and G tend to rotate in the right-hand or opposite direction, thus locking the clutches C_1 and releasing the clutches C_2; the gear combination then rotates as a flywheel. Solving Equation (3) for the reduction of the gear combination, we have

$$\frac{Y}{X} = 1 - \frac{a\,d}{b\,c} = 1 - \frac{17}{18} = + \frac{1}{18}$$

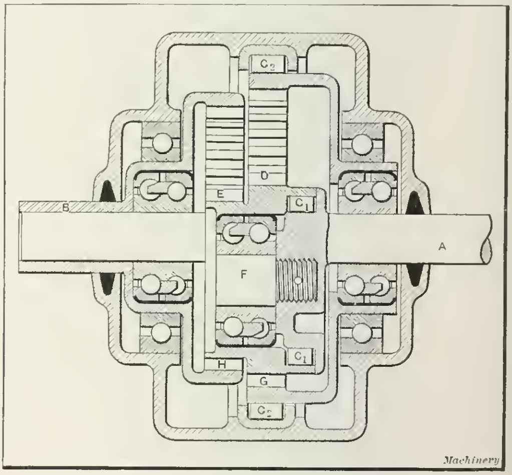

Fig. 4. Assembly of the Four-gear Eccentric Combination

The sign of $\frac{1}{18}$ must be positive in order to have B rotate in the right-hand direction. In the selection of gears for such a combination, it is customary to have a difference of 15 teeth on the gears that mesh, in order to avoid the use of special teeth. From the fraction $\frac{17}{18}$, it is found that a suitable combination is as follows:

$$X = 1 - \frac{51 \times 30}{45 \times 36} = + \frac{1}{18}$$

As an example of the flexibility of the velocity ratio, we will assume: $E = 35$ teeth $= d$; $H = 49$ teeth $= c$; $D = 36$ teeth $= b$; $G = 50$ teeth $= a$.

This gives a velocity ratio of 126 to 1. The flexibility of the velocity ratio is an important advantage of this mechanism because it makes its application possible on practically any mechanical device in which large speed reductions are necessary.

* * *

BROACHING AUTOMOBILE PARTS

BY CHESTER L. LUCAS[*]

The operation of broaching is too often viewed in the light of a process used principally for cutting keyways or square holes, but with proper equipment the broaching machine is really a machine tool capable of handling a great many otherwise impracticable jobs. Incident to the manufacture of automobile parts there are several interesting broaching operations carried on in the shops of the Hartford Automobile Parts Co., Hartford, Conn.

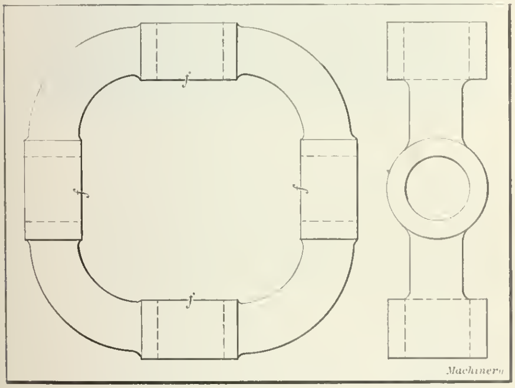

Fig. 1. Ring-coupling to be broached

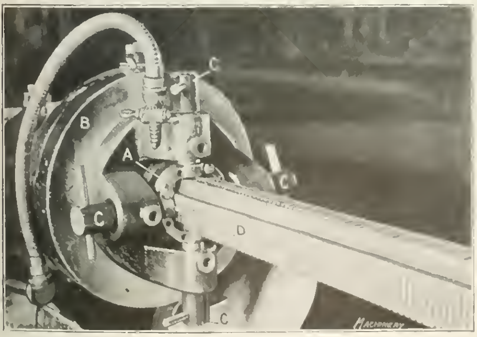

Fig. 2. Broaching the Ring-coupling

One of these jobs consists of broaching the inside of a ring-coupling which is a part of a universal joint made by the company. The ring-coupling, which is shown by itself in Fig. 1, has been previously drilled and broached through the four round holes and as it is essential that the inside faces, adjacent to the four holes be finished true with the holes, broaching is resorted to. In order to accomplish this successfully, the work is held upon a special fixture, in turn mounted upon the faceplate of a broaching machine made by the Lapointe Machine Tool Co., Hudson, Mass. Fig 2 illustrates the method of holding and broaching the work. In this illustration the work is shown at A supported on the fixture B by means of four pins C which engage the holes in the coupling. These pins are merely a sliding fit through the bosses of the fixture, and the cross handles are added to assist in withdrawing them. The broach itself is shown at D and is pulled through the work in the usual manner. In order to facilitate the centering of the broach in the work as well as to distribute the cutting over the length of the broach, the cutting surfaces of the teeth are made very narrow at the beginning of the tool, gradually increasing in width until at the end of the work they are full width, finishing the entire surface. These pieces are broached at the rate of twenty-five per hour, the surfaces are finished true with the holes and, of course, the sizing is accurate.

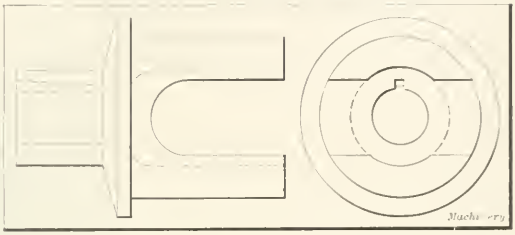

Fig. 3. Universal Joint Yoke to be broached with Tapered Keyway

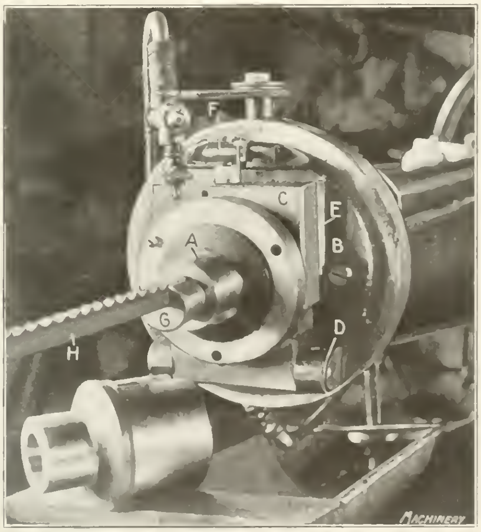

Fig. 4. Broaching the Tapered Keyway

Cutting the tapered keyway through the yoke shown in Fig. 3 is a broaching operation that has some interesting features. The keyway must be cut through the bore of the work at an angle of ten degrees. The cut is 5/16 inch deep at the beginning and only 5/32 inch deep at the end of the cut. The method of doing the work is illustrated in Fig. 4 in which the yoke is shown lying in the foreground and again on the machine at A. It is supported on the special fixture B which consists of a faceplate provided with a leaf C that is hinged at D. This leaf is held in an upright position by a clamp F and the work A fits closely in the bushing in the leaf C. As the broaching must be done at an angle to the machined hole the leaf of the fixture is not held at right angles to the broach, but is backed up by a tapered wedge *E* so that the work is thrown off at an angle to the broach. When broaching, the work is placed in the leaf of the fixture and the tapered plug *G* is entered into the hole around the broach *H*. This plug is cut out to receive the broach, and serves as a "filler," preventing the broach from springing away from the work. The broaching is then carried on in the usual manner. When broaching must be done at a different angle it only requires the substitution of a wedge of a different angle, in place of wedge *E*. Thus the fixture can be used on more than one job. This broaching operation is performed at the rapid rate of thirty-three pieces per hour.

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[*] Associate Editor of MACHINERY.

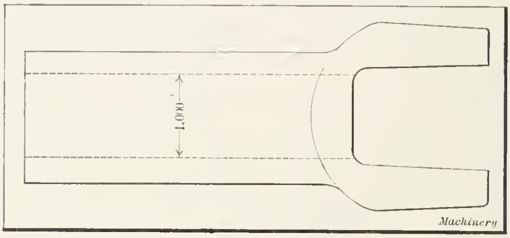

Fig. 5. Slip-hub in which the Round Hole is finished by broaching

The universal slip-hub shown in Fig. 5 is first rough-drilled throughout its length. It is necessary, however, that this hole be finished true to size and exactly in line with the projections at the end. This is accomplished by broaching, as shown in Fig. 6, and in this illustration the piece may be seen lying beneath the fixture. The fixture which is shown at *A* has a leaf *B* provided with an adjustable bushing *C*. The leaf is dropped and the work placed within the fixture so that the projecting lugs are centered. Then replacing the leaf, securing it with pin *G*, and screwing the bushing up against the work so that the countersunk inner end will engage the piece from the outside edge, it is held in a central position ready for broaching. The broach is then inserted and one pass finishes the piece, leaving it exactly to size and finished as smooth as if done with a reamer. Twenty-five broached pieces per hour is the rate of production.

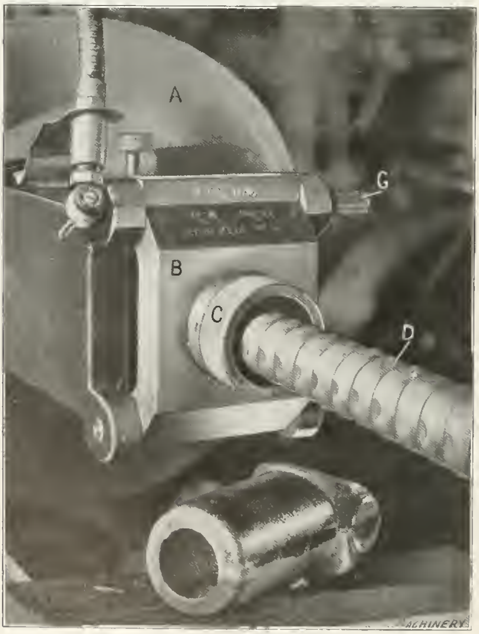

Fig. 6. The Broaching Fixture for the Slip-hub

THE PRECISION LATHE AS A MANUFACTURING MACHINE

The illustration Fig. 1 shows a precision bench lathe made by the Elgin Tool Works, Elgin, Ill., and used by the Aurora Automatic Machine Co., of Aurora, Ill., in the manufacture of motorcycle parts, finishing driving shafts, etc., as they come from the automatic screw machines. The part shown in Fig. 2 is an example. The piece is roughed out in the automatic, leaving 1/32 inch stock on the sides. It is finish-turned all over in the bench lathe at the rate of eleven per hour. The same work was formerly done in an engine lathe at the rate of five per hour. The chip pile shown behind the lathe is the accumulation of four days' work. The company makes a number of brass bushings for motorcycles, and has reduced the cost of their manufacture in about the same proportion as indicated above, by the use of bench lathes.

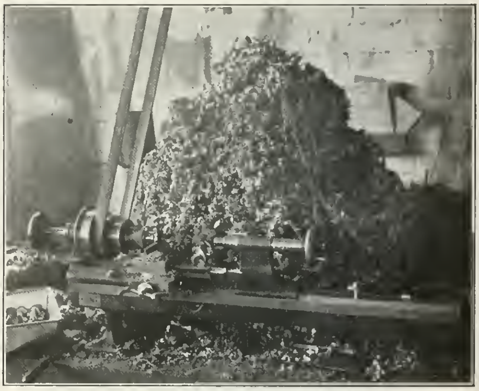

Fig. 1. Elgin Tool Works Co.'s Precision Lathe working on Motorcycle Parts

Many manufacturers are not fully aware of the possibilities of bench lathes as economical adjuncts in manufacturing, especially where close limits of size and smooth finish are required on parts ordinarily produced by automatic machines. An expert workman can manipulate these lathes at astonishing speeds when reducing parts to finished dimensions, especially when several diameters are involved and some of the faces are angular, as for example, in the case of small bevel-gear blanks.

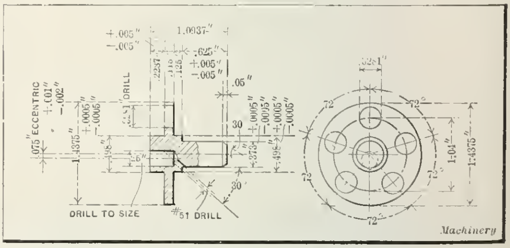

Fig. 2. Motorcycle Driving Shaft roughed on Automatic and finished on Precision Lathe

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INSTRUCTION IN ACCIDENT PREVENTION

The State of New Jersey has enacted a law providing for instruction in preventing accidents. The law provides that the teachers of public, private and parochial schools in New Jersey shall devote not less than thirty minutes in each two weeks during the school terms to instructing the pupils on ways and means of preventing accidents. It also provides that a handbook or manual on accident prevention shall be published by the state, and provision is made for the delivery of lectures before the schools by representatives of the American Museum of Safety, the headquarters of which is at 29 W. 39th St., New York City.

MACHINE FORGING—3

MACHINES AND METHODS EMPLOYED IN THE MANUFACTURE OF BOLTS, RIVETS, NUTS, MACHINE PARTS, ETC.

BY DOUGLAS T. HAMILTON*

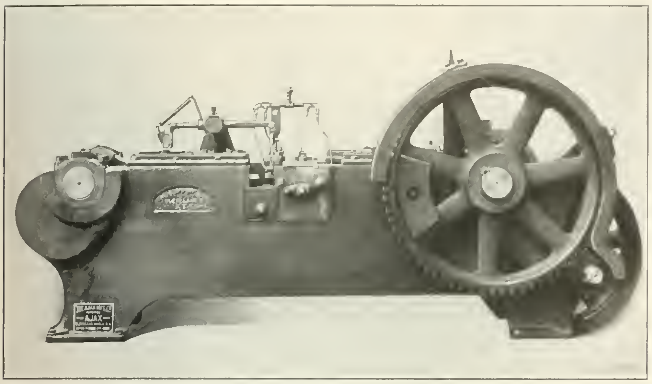

Fig. 35. Side View of "Ajax" Hot-pressed Center-feed Nut Machine showing Operating Side and Water Pipes for cooling Dies and Tools

The plain type of upsetting and forging machine which is used to a certain extent in the manufacture of bolts and rivets, especially the larger sizes, is also used for producing the ordinary square and hexagon nuts in sizes from 2 inches up. In making nuts by this process, the diameter of the round bar from which the nut is made should not exceed the root diameter of the thread in the finished nut, so it is evident that an extremely large upset is required to produce a full nut. When large nuts are produced in a plain forging machine, the usual method is first to form an upset on the end of the bar and then pierce the hole in the nut by punching the bar back, the metal removed to form the hole in the nut being attached to the bar. This operation requires considerable pressure, and as little, if any, material is wasted it is a very successful method of producing nuts 2 inches and larger on a commercial basis. The application of upsetting and forging machines to the production of other than the ordinary square and hexagon nuts will be dealt with in a future article. In the following, two types of machines, especially built to produce square and hexagon nuts, will be described. One of these machines is known as the hot-pressed center-feed nut machine, and the other as the hot-forged type; the latter is applicable only to the production of square nuts. This article will also include tables and other data used in connection with bolt and nut making.

Hot-pressed Center-feed Nut Machine

The hot-pressed center-feed nut machine, as its name implies, produces nuts by pressing a heated blank of iron or steel into the required shape (the latter first being cut off as the bar is fed into the machine) and not by what might be strictly called a forging operation. The bar stock, which is rectangular in shape, is fed in and placed in front of the face of the dies from the side through a recess in the center of the machine. Fig. 35 shows one type of center-feed hot-pressed nut machine that works on the principle just stated. This machine consists essentially of two movable rams or slides which carry the cutting-off, crowning, piercing and wad-extracting punches, respectively. One ram is operated directly from the main crankshaft, while the other is operated by eccentrics and a connecting-rod.

Fig. 36 shows a closer view of this machine, and gives some idea of the construction of the dies, tools, etc. Here *A* is the cutting-off punch, *B* the crowning punch, *C* the piercing punch, *D* the wad extractor, *E* the nut dies, and *F* the ejector. The pipes *G* furnish a copious supply of water to keep the dies and tools cool when in operation. A device for centering the bar in relation to the dies and tools is shown at *H*.

Another center-feed hot-pressed nut machine, which produces hexagon and square nuts in the same manner as that shown in Fig. 35, is shown in Fig. 37. In this machine, however, both rams or slides are operated directly from the source of power by a pinion and two large gears, one gear driving each slide. The majority of manufacturers produce nuts from a material known as soft, mild, open-hearth steel, which has a comparatively fine grain and consequently when forged has less tendency to crack than does wrought iron. It also threads much easier and with a smooth finish. This grade of steel is much more suitable for the manufacturing of nuts than wrought iron, owing to the fact that great difficulty is met with in working the latter material, as the grain opens up, thus making it difficult to thread. Wrought iron, however, has one point in its favor, and that is it can be worked at a much higher temperature than steel without affecting its structure, and hence does not need to be handled quite so carefully.

Operation of a Conter-feed Hot-pressed Nut Machine

In operating a center-feed hot-pressed nut machine, the rectangular bar is heated to the correct temperature for a length of four or five feet. Then it is brought to the machine and fed in from the side in front of the face of the main dies, as indicated at *A* in Fig. 38. The cut-off tool *c* then moves up and shears the blank from the end of the bar, carries it into the main dies *a* and *b*, and presses it against the crowning tool *c*, which has also advanced, as indicated at *B*. The piercing tool *f* now advances, punches the hole in the nut, and carries the wad into the cutting-off tool, as shown at *C*. Then the cutting-off and piercing tools *c* and *f* recede, and the crowning tool *e* advances, forcing the nut out of the dies. As the cut-off

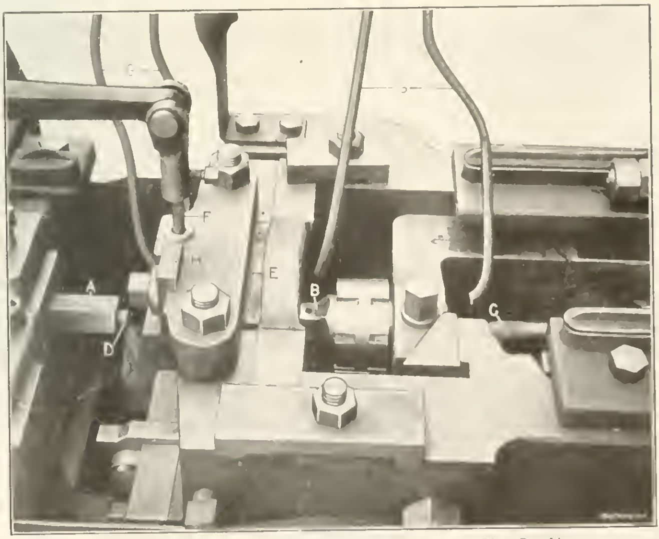

Fig. 36. Detail View of Machine shown in Fig. 35 showing Dies, Punching, Piercing, Crowning Tools, etc.

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*Associate Editor of MACHINERY.

tool *c* recedes, the extractor *d* forces the wad out of the punch at the same time that the nut is ejected from the dies. The ejector, which is operated by a lever and cam, as shown in Fig. 37, is provided to prevent the nut from adhering to the crowning tool; this very seldom happens, however. A completed nut is produced at each revolution of the large gears.

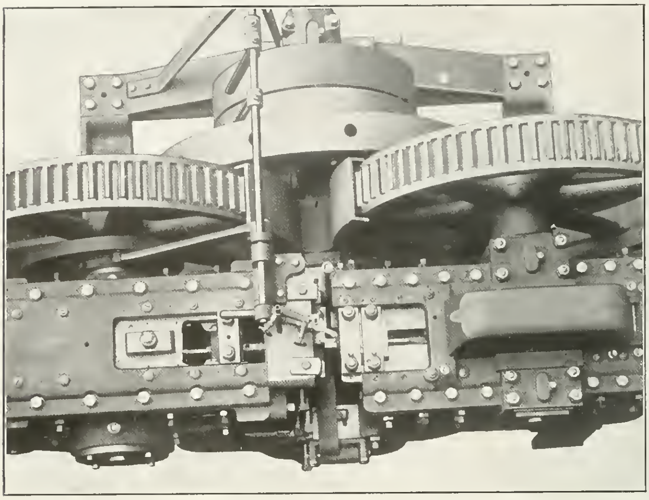


Fig. 37. Top View of "National" Hot-pressed Center-feed Nut Making Machine

The operations just described are repeated until the heated portion of the bar has been exhausted, after which the operator places the bar in the furnace to be reheated, takes a freshly heated bar from the furnace, and proceeds as before. The machine is run continuously, and is not stopped for the insertion of a freshly heated bar. Finished nuts are turned out at the rate of from 40 to 70 per minute, depending upon the size of the machine and the skill of the operator. Fig. 39 shows how a hexagon nut is produced from a rectangular bar of stock in a center-feed hot-pressed nut machine. Upon a close inspection of this illustration, it will be seen that considerable scrap is lost in the production of a nut of hexagon shape, *viz.*, the wad removed to form the hole, and the triangular pieces which are removed to form the corners. On a square nut the material wasted is not quite so great, as in this case only the wad and a slight amount of stock sheared off the end of the bar to form a square corner are removed.

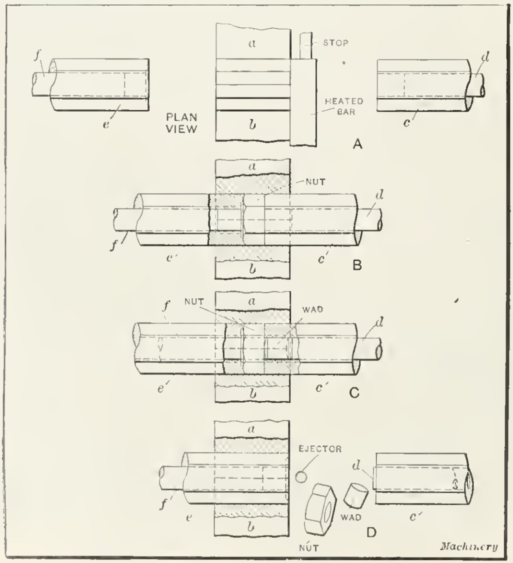


Fig. 38. Diagram illustrating Sequence of Operations in making Nuts in a Hot-pressed Center-feed Nut Machine

There are two common methods of saving stock without sacrificing the shape of the nut. One is to set the stop so that the rounded end of the bar is sheared off, leaving a square corner. This, of course, wastes a little more stock, but has the advantage of producing a fuller nut. The rounded corner is caused by the cut-off tool, which in removing the block of metal from the end of the bar to form the nut, rounds over the end of the bar due to the hot metal drawing over, and thus makes this waste of stock necessary if a full-shaped nut is to be secured.

Another method in common use to save stock and at the same time produce full nuts, is to invert the bar after each stroke of the machine. By this method opposite sides of the bar are alternately presented to the dies, which overcomes, to a large extent, the effect of the fin on one side and the rounded corner on the other, and produces a fuller nut without shearing any material from the end of the bar. The only objection to this method is the necessity of turning the bar, which, if heavy, soon tires the operator. On the larger sizes of nuts, the first method is used, as the bars are quite heavy and the operator would find it difficult to turn them and keep up with the operation of the machine.

Fig. 40 shows a typical group of nuts which can be produced economically and on a commercial basis in the center-feed hot-pressed nut machines. In this illustration it will be noticed that several of the nuts have fins on the under side, both around the outer edges and hole. This is caused by the sharp edges of the cut-off tool becoming rounded and allowing the hot metal to "leak" past the edges. The clearance allowed between the cut-off punch and dies also tends to produce a slight fin. When the tools are new the burr or fin produced is very slight, but it increases as the tools wear. These fins are removed in a succeeding operation in a burring machine, which will be described in a future article.

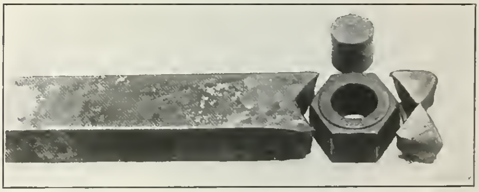


Fig. 39. Showing how a Hexagon Nut is produced from Rectangular Bar in a Hot-pressed Nut Machine

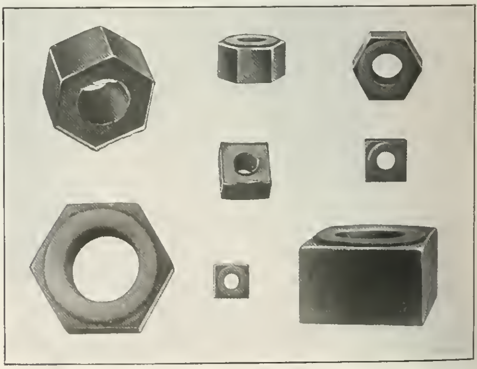


Fig. 40. Group of Square and Hexagon Nuts, showing Character of Work turned out in Hot-pressed Nut Machines

Hot-forged Nut Machine

Fig. 41 shows a type of nut making machine which is only applicable to the manufacture of square nuts, but produces this class of nuts free from fins and burrs at a rapid rate. Large nut manufacturers are extensive users of this type of machine, but a concern making a variety of nuts in small quantities would not attempt to use it, owing to the delay incident to changing the dies and tools from one size to another. Briefly stated, it consists principally of a suitable mechanism for operating a shearing and crowning tool, four horizontal hammers which form the four sides of a square nut, and piercing and flattening punches. Power is received by the pulley *A* and is transmitted to the two shafts *B* and *C* located at right angles to each other and connected by miter gears. Shaft *C* carries eccentrics and cams which operate the left-side hammer and sizing tool for gripping the bar while it is being sheared; and shaft *B*, through cams, levers and eccentrics, operates the blank shearing tool, nut ejector, front and rear hammers, piercing punch and flattening tools.

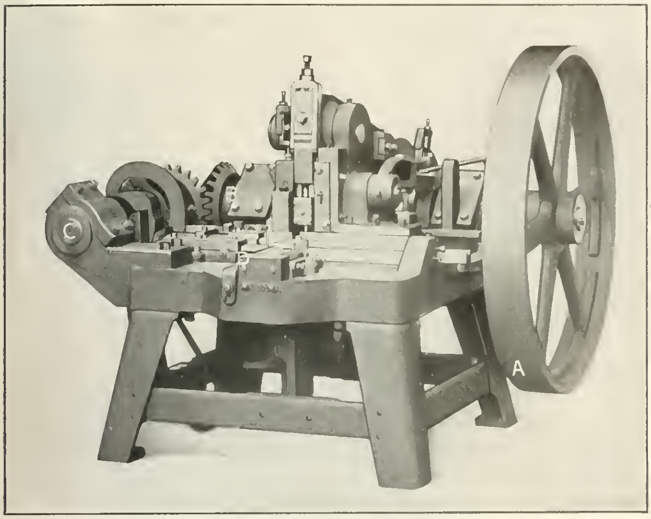


Fig. 41. "National" Hot-forged Nut Machine used exclusively for the Manufacture of Square Nuts from Rectangular Bar Stock

Operation of Hot-forged Nut Machine

In order to illustrate how this hot-forged nut machine produces square nuts, the diagrams shown in Fig. 42 are included. These views show plan and sectional elevations which illustrate the relative positions of the various dies and tools, and the stages through which the nut passes before being ejected. In operating this machine, rectangular bar stock heated to a length of four or five feet is fed into the machine (see *D*, Fig. 41), along the line *C—D*. The stock is equal in width to the diameter of the nut across the flats, and of the same thickness as the nut. It is fed into the machine with the greatest width horizontal and is located by the gage *G*.

As the heated bar is fed in, a shearing tool *H* operated from the bottom of the machine, forces the heated end of the bar against the knife *K* and cuts off a suitable blank; as this tool continues to rise, it presses the nut blank into the crowner cup *M*, which is located directly above the shearing tool. While the shearing operation is taking place, the sizing tool *L* which moves in a line parallel with the side hammer *J*, holds the bar tightly against the stationary sizer *K*. Gripping the bar in this manner tends to give a better shearing cut. The shearing tool *H* is now lowered until its top face is in line with the bottom of the side hammer *J*, and at the same time the kickout *N*, operated through a hole in the crowner *M*, ejects the nut, preventing it from sticking in the cup. The shearing tool now remains in its "down" position while the side hammer *J* carries the nut along the line *A—B* until the center of the nut is in line with *E—F* and directly under the piercing punch *O*.

As the side hammer *J* moves the nut blank under the piercing punch, the rear hammer *P* advances and presses the nut into the square box formed by the side hammer *J*, rear hammer *P*, stationary hammer *R* and front hammer *Q*. This tends to square up the sides of the nut and form it to the proper shape. While in this position, the punch *O* pierces the hole in the nut, forcing the wad through the die *V*, and immediately withdraws. The rear hammer *P* and side hammer *J* then return to their original positions, and the front hammer *Q* moves the nut back to the flatter bed *T*, which is located directly under the rear hammer *P*. While the nut is located on the flatter bed, the flattening tool *U*, which is over the rear hammer, comes down onto the nut, gives it a slight squeeze, which corrects any distortion of the top and bottom faces caused by the squeezes between the four hammers previously described, and also serves to flatten any fins resulting from the piercing operation. The flattening tool *U* then rises, and the flatter bed *T* withdraws, allowing the finished nut to drop out of the machine. A completed nut is made at each revolu-

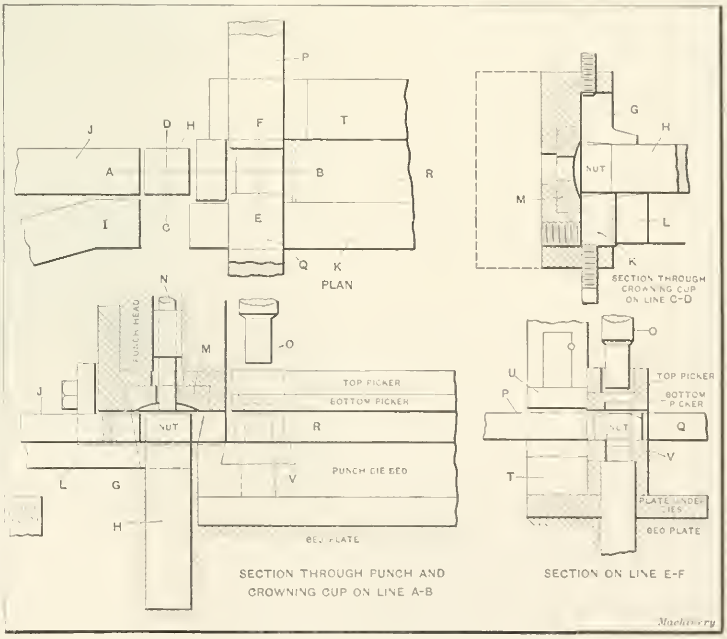


Fig. 42. Diagrams illustrating Construction of Tools and Operation of the Hot-forged Type of Nut Machine shown in Fig. 41

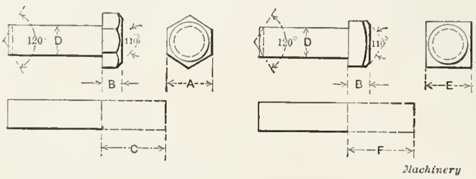
tion of the flywheel, and the machine is operated at from 60 to 90 revolutions per minute, depending upon its size.

Some idea of the character of the work turned out by the hot-forged nut machine can be obtained from Fig. 43, which shows a representative group of square nuts just as they come from the machine. The nuts produced by these machines are entirely free from fins or burrs, are of excellent finish, and are ready for tapping directly after being forged.

Dies and Tools Used in Hot-pressed Center-feed Nut Machines

The type of dies and tools used in the hot-pressed center-feed nut machine shown in Fig. 37 is shown in Fig. 44. To obviate confusion the reference letters used here are the same as those given in Fig. 38. The dies *a* and *b*, which are reversible, are usually made from chilled iron castings, and are ground to size. Dies made from this material, it is claimed, will last fully eight times as long as those made from ordinary carbon steel, but as it is somewhat of a problem to get the proper amount of "chill," many manufactnrers use a good grade of open-hearth crucible steel instead. A crucible steel which has been found to give good results for this class of work contains from 90 to 110 points carbon. Some nut manufacturers have found that a certain grade of high-speed steel having a carbon content of from 15 to 30 points gives excellent results when used for nut dies. In all cases, of course, it is necessary to harden the dies, and those made from crucible tool steel are hardened and drawn so that they can just be touched with the file, or in other words, the temper is drawn to a light straw color.

TABLE I. PROPORTIONS OF U. S. STANDARD AND MANUFACTURERS' STANDARD HEXAGON AND SQUARE HEAD BOLTS AND APPROXIMATE AMOUNT OF STOCK REQUIRED TO FORM HEAD



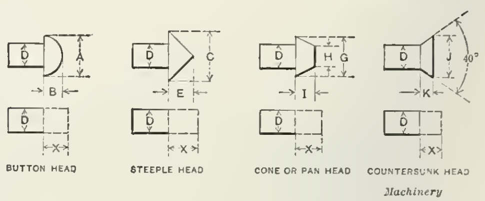
United States Standard						Manufacturers' Standard					
Dimensions in Inches						Dimensions in Inches					
D	A	B	C	E	F	D	A	B	C	E	F
1/4	1/2	1/4	1 3/32	1/2	1 9/32	1/4	7/16	3/16	23/32	3/8	17/32
5/16	19/32	19/64	1 3/16	19/32	1 3/8	5/16	17/32	1/4	3/4	15/32	11/16
3/8	11/16	11/32	1 1/4	11/16	1 1/2	3/8	5/8	9/32	15/16	9/16	13/16
7/16	25/32	25/64	1 3/8	25/32	1 5/8	7/16	23/32	21/64	1	21/32	31/32
1/2	7/8	7/16	1 1/2	7/8	1 23/32	1/2	13/16	3/8	1 3/32	3/4	1 1/16
9/16	31/32	31/64	1 5/8	31/32	1 13/16	9/16	29/32	27/64	1 1/4	27/32	1 7/32
5/8	1 1/16	17/32	1 11/16	1 1/16	2	5/8	1	17/32	1 13/32	15/16	1 11/32
3/4	1 1/4	5/8	1 15/16	1 1/4	2 7/32	3/4	1 3/16	9/16	1 9/16	1 1/8	1 5/8
7/8	1 7/16	23/32	2 5/32	1 7/16	2 1/2	7/8	1 3/8	21/32	1 7/8	1 5/16	1 7/8
1	1 5/8	13/16	2 3/8	1 5/8	2 3/4	1	1 9/16	3/4	2 1/32	1 1/2	2 5/32
1 1/8	1 13/16	29/32	2 19/32	1 13/16	3	1 1/8	1 3/4	27/32	2 7/32	1 11/16	2 13/32
1 1/4	2	1	2 27/32	2	3 1/4	1 1/4	1 15/16	15/16	2 7/16	1 7/8	2 11/16
1 3/8	2 3/16	1 3/32	3	2 3/16	3 9/16	1 3/8	2 1/8	1 1/16	2 27/32	2 1/16	3 1/32
1 1/2	2 3/8	1 3/16	3 5/16	2 3/8	3 13/16	1 1/2	2 5/16	1 1/8	3	2 1/4	3 7/32
1 5/8	2 9/16	1 9/32	3 1/2	2 9/16	4 1/16	1 5/8	2 1/2	1 7/32	3 1/4	2 7/16	3 15/32
1 3/4	2 3/4	1 3/8	3 3/4	2 3/4	4 3/8	1 3/4	2 11/16	1 5/16	3 15/32	2 5/8	3 3/4
1 7/8	2 15/16	1 15/32	4	2 15/16	4 5/8	1 7/8	2 7/8	1 13/32	3 23/32	2 13/16	4 3/32
2	3 1/8	1 9/16	4 1/4	3 1/8	4 7/8	2	3 1/16	1 1/2	4	3	4 5/16
2 1/4	3 1/2	1 3/4	4 25/32	3 1/2	5 7/16	2 1/4	3 7/16	1 11/16	4 9/16	3 3/8	5
2 1/2	3 7/8	1 15/16	5 3/16	3 7/8	5 15/16	2 1/2	3 13/16	1 7/8	4 13/16	3 3/4	5 3/8
2 3/4	4 1/4	2 1/8	5 1/2	4 1/4	6 7/16	2 3/4	4 3/16	2 1/16	5 3/8	4 1/8	5 29/32
3	4 5/8	2 5/16	6 1/16	4 5/8	7	3	4 9/16	2 1/4	5 11/16	4 1/2	6 7/16
3 1/4	5	2 1/2	6 1/2	5	7 9/16	..	..	..	..	..	..
3 1/2	5 3/8	2 11/16	7	5 3/8	8 1/8	..	..	..	..	..	..
3 3/4	5 3/4	2 7/8	7 1/2	5 3/4	8 11/16	..	..	..	..	..	..
4	6 1/8	3 1/16	8	6 1/8	9 5/16	..	..	..	..	..	..

The cut-off tool *c* is generally made from ordinary carbon tool steel, hardened and drawn. Some attempts have been made to use high-speed steel for this tool, but as this material is rather expensive, and as this particular tool wears away very rapidly, a cheaper brand of steel is generally adopted. The piercing tool *f* when made from "Rex A" high-speed steel has been found very satisfactory for hot punching. The crowning tool *e* and wad extractor *d* can be made from ordinary carbon tool steel, hardened and drawn.

In order that the tools in a center-feed hot-pressed nut machine may work freely, it is necessary to provide a certain amount of clearance, especially between the cut-off tool, crowning tool and dies. On ordinary sizes of nuts from ½ to 2 inches in diameter (this is the size of the bolt for which the nut is used), 1/64 inch clearance is allowed. On sizes smaller than ½ inch, 0.010 inch clearance is allowed, whereas for tools used in making nuts larger than 2 inches, a clearance of from 0.020 to 0.060 inch is provided. The hole formed by the junction of the two halves of the dies is made perfectly straight, but the piercing tool is slightly tapered—being smaller at the front end. This enables it to withdraw more easily from the hole in the nut, and also increases its life. It is evident, of course, that after the hole is punched in the nut, the chilling effect of the dies (which are kept cool by water flowing over them), tends to "freeze" the nut onto the piercing tool, and the slight taper on the piercing tool obviates this.

There is no allowance made in the hole of the nut to provide for shrinkage, as the holes regularly punched in nuts are made considerably larger than the root diameter of the threads on the tap. This enables the nuts to be more easily tapped, and

TABLE II. DIMENSIONS OF RIVET HEADS OF VARIOUS SHAPES



Dimensions in Inches									
D	A	B	C	E	G	H	I	J	K
1/4	7/16	3/16	1/2	1/4	7/16	1/4	7/32	29/64	1/8
5/16	35/64	15/64	5/8	5/16	35/64	5/16	17/64	37/64	5/32
3/8	21/32	9/32	3/4	3/8	21/32	3/8	21/64	11/16	3/16
7/16	49/64	5/16	7/8	7/16	49/64	7/16	3/8	51/64	7/32
1/2	7/8	3/8	1	1/2	7/8	1/2	7/16	29/32	1/4
9/16	1	13/32	1 1/8	9/16	1	9/16	1/2	1 1/32	9/32
5/8	1 3/32	15/32	1 1/4	5/8	1 3/32	5/8	17/32	1 5/32	5/16
11/16	1 3/16	1/2	1 3/8	11/16	1 3/16	11/16	19/32	1 1/4	11/32
3/4	1 5/16	9/16	1 1/2	3/4	1 5/16	3/4	21/32	1 3/8	3/8
13/16	1 7/16	19/32	1 5/8	13/16	1 7/16	13/16	23/32	1 1/2	13/32
7/8	1 17/32	21/32	1 3/4	7/8	1 17/32	7/8	3/4	1 19/32	7/16
15/16	1 5/8	11/16	1 7/8	15/16	1 5/8	15/16	13/16	1 11/16	15/32
1	1 3/4	3/4	2	1	1 3/4	1	7/8	1 27/32	1/2
1 1/16	1 27/32	25/32	2 1/8	1 1/16	1 27/32	1 1/16	15/16	1 15/16	17/32
1 1/8	1 31/32	27/32	2 1/4	1 1/8	1 31/32	1 1/8	1	2 1/16	9/16
1 1/4	2 3/16	15/16	2 1/2	1 1/4	2 3/16	1 1/4	1 3/32	2 9/32	5/8
1 3/8	2 13/32	1 1/32	2 3/4	1 3/8	2 13/32	1 3/8	1 3/16	2 17/32	11/16
1 1/2	2 5/8	1 1/8	3	1 1/2	2 5/8	1 1/2	1 5/16	2 3/4	3/4

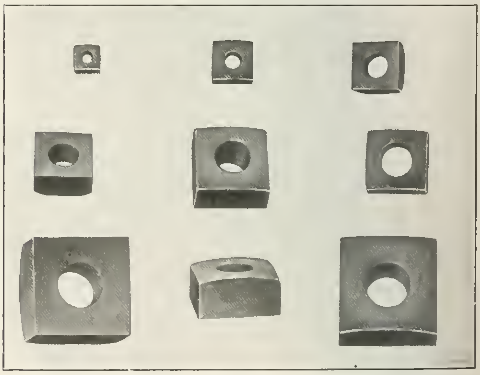
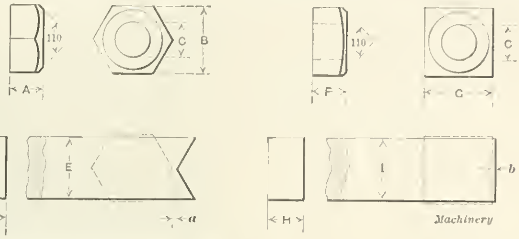


Fig. 43. Samples of Square Nuts produced on Hot-forged Type of Nut Machine—Note Absence of Burrs or Fins

also increases the tap life. Making the hole in the nut larger than the root diameter of the threads on the tap does not affect the efficiency of the nut, but it does make a great difference in tapping.

In Fig. 45 is shown the shape of the dies used for making square nuts in a center-feed hot-pressed nut machine. It will be noticed that these dies are made in four pieces, and it is possible to raise or lower the outside blocks *A* and *B*, so that new cutting edges are secured. In addition to this the top and bottom dies *C* and *D* can be reversed, and also the two side pieces, thus giving long life to one redressing of the dies. As a rule, this type of dies is made from ordinary crucible tool steel containing from 90 to 100 points carbon, hardened and drawn, and ground all over.

TABLE III. PROPORTIONS OF U. S. STANDARD AND MANUFACTURERS' STANDARD HEXAGON AND SQUARE NUTS AND SIZES OF RECTANGULAR STOCK REQUIRED TO PRODUCE THEM



United States Standard

Dia. of Bolt	A	B	C	D	E	F	G	H	I
	Dimensions in Inches								
1/4	1/4	1/2	13/64	17/64	15/32	1/4	1/2	17/64	15/32
5/16	5/16	19/32	1/4	11/32	9/16	5/16	19/32	11/32	9/16
3/8	3/8	11/16	5/16	13/32	21/32	3/8	11/16	13/32	21/32
7/16	7/16	25/32	23/64	15/32	25/32	7/16	25/32	15/32	25/32
1/2	1/2	7/8	27/64	17/32	13/16	1/2	7/8	17/32	13/16
9/16	9/16	31/32	15/32	19/32	29/32	9/16	31/32	19/32	29/32
5/8	5/8	1 1/16	17/32	21/32	1	5/8	1 1/16	21/32	1
3/4	3/4	1 1/4	41/64	13/16	1 3/16	3/4	1 1/4	13/16	1 3/16
7/8	7/8	1 7/16	3/4	15/16	1 3/8	7/8	1 7/16	15/16	1 3/8
1	1	1 5/8	55/64	1 1/16	1 9/16	1	1 5/8	1 1/16	1 9/16
1 1/8	1 1/8	1 13/16	31/32	1 3/16	1 3/4	1 1/8	1 13/16	1 3/16	1 3/4
1 1/4	1 1/4	2	1 3/32	1 3/8	1 7/8	1 1/4	2	1 3/8	1 7/8
1 3/8	1 3/8	2 3/16	1 7/32	1 1/2	2 1/16	1 3/8	2 3/16	1 1/2	2 1/16
1 1/2	1 1/2	2 3/8	1 11/32	1 5/8	2 1/4	1 1/2	2 3/8	1 5/8	2 1/4
1 5/8	1 5/8	2 9/16	1 27/64	1 3/4	2 7/16	1 5/8	2 9/16	1 3/4	2 7/16
1 3/4	1 3/4	2 3/4	1 17/32	1 7/8	2 5/8	1 3/4	2 3/4	1 7/8	2 5/8
1 7/8	1 7/8	2 15/16	1 21/32	2	2 13/16	1 7/8	2 15/16	2	2 13/16
2	2	3 1/8	1 49/64	2 1/8	3	2	3 1/8	2 1/8	3
2 1/4	2 1/4	3 1/2	2 1/64	2 3/8	3 3/8	2 1/4	3 1/2	2 3/8	3 3/8
2 1/2	2 1/2	3 7/8	2 15/64	2 5/8	3 3/4	2 1/2	3 7/8	2 5/8	3 3/4
2 3/4	2 3/4	4 1/4	2 31/64	2 7/8	4 1/8	2 3/4	4 1/4	2 7/8	4 1/8
3	3	4 5/8	2 11/16	3 1/8	4 1/2	3	4 5/8	3 1/8	4 1/2
3 1/4	3 1/4	5	2 15/16	3 3/8	4 7/8	3 1/4	5	3 3/8	4 7/8
3 1/2	3 1/2	5 3/8	3 11/64	3 5/8	5 1/4	3 1/2	5 3/8	3 5/8	5 1/4
3 3/4	3 3/4	5 3/4	3 3/8	3 7/8	5 5/8	3 3/4	5 3/4	3 7/8	5 5/8
4	4	6 1/8	3 5/8	4 1/8	6	4	6 1/8	4 1/8	6

Manufacturers' Standard

Dia. of Bolt	A	B	C	D	E	F	G	H	I
	Dimensions in Inches								
1/4	1/4	1/2	7/32	17/64	15/32	1/4	1/2	17/64	15/32
5/16	5/16	5/8	9/32	11/32	19/32	5/16	5/8	11/32	19/32
3/8	3/8	3/4	11/32	13/32	23/32	3/8	3/4	13/32	23/32
7/16	7/16	7/8	13/32	15/32	13/16	7/16	7/8	15/32	13/16
1/2	1/2	1	7/16	17/32	15/16	1/2	1	17/32	15/16
9/16	9/16	1 1/8	1/2	19/32	1 1/16	9/16	1 1/8	19/32	1 1/16
5/8	5/8	1 1/4	9/16	21/32	1 3/16	5/8	1 1/4	21/32	1 3/16
3/4	3/4	1 3/8	21/32	13/16	1 5/16	3/4	1 1/2	13/16	1 7/16
7/8	7/8	1 5/8	25/32	15/16	1 9/16	7/8	1 3/4	15/16	1 11/16
1	1	1 3/4	7/8	1 1/16	1 11/16	1	2	1 1/16	1 15/16
1 1/8	1 1/8	2	15/16	1 5/16	1 15/16	1 1/8	2 1/4	1 5/16	2 3/16
1 1/4	1 1/4	2 1/4	1 3/32	1 1/2	2 3/16	1 1/4	2 1/2	1 1/2	2 3/8
1 3/8	1 3/8	2 1/2	1 3/16	1 5/8	2 3/8	1 3/8	2 3/4	1 5/8	2 5/8
1 1/2	1 1/2	2 3/4	1 5/16	1 3/4	2 5/8	1 1/2	3	1 3/4	2 7/8
1 5/8	1 5/8	3	1 7/16	1 7/8	2 7/8	1 5/8	3 1/4	1 7/8	3 1/8
1 3/4	1 3/4	3 1/4	1 9/16	2	3 1/8	1 3/4	3 1/2	2	3 3/8
1 7/8	1 7/8	3 1/2	1 11/16	2 1/8	3 3/8	1 7/8	3 3/4	2 1/8	3 5/8
2	2	3 1/2	1 13/16	2 1/4	3 5/8	2	4	2 1/4	3 7/8
2 1/4	2 1/4	3 3/4	2	2 3/8	3 7/8	2 1/4	4 1/4	2 3/8	4 1/8
2 1/2	2 1/2	4 1/4	2 1/4	2 5/8	4 1/8	2 1/2	4 1/2	2 5/8	4 3/8
2 3/4	2 3/4	4 1/2	2 7/16	2 7/8	4 3/8	2 3/4	4 3/4	2 7/8	4 5/8
3	3	4 3/4	2 11/16	3 1/8	4 5/8	3	5	3 1/8	4 7/8

Dies and Tools Used in Hot-forged Nut Machines

The four hammers used in the hot-forged nut machine are made from rectangular blocks of steel, shaped as shown in Fig. 42. The rear, front and stationary hammers are made wider than the nut, but of approximately the same thickness, and the front and rear hammers are rounded on the forward corners, to facilitate the insertion of the nut. The side hammer, which carries the nut into the "box-shaped impression" formed by all four hammers, is of the same width and thickness as the nut. The crowner, flatter tool and the four hammer blocks are all made from ordinary crucible tool steel, hardened and drawn, whereas the shearing tool and piercing punch and die are usually made from high-speed steel. A brand of steel known as "Rex A" has been found very satisfactory for this purpose. The tools used in the hot-forged nut machine do not wear out nearly so quickly as those used in the hot-pressed type of machine, owing to the fact that there is not the same scraping action against the surfaces of the tools.

Stock Required for Making Bolt and Rivet Heads

In forming a head on a bolt or rivet, the heated metal on the end of the bar is upset or formed into the desired shape by a plunger held in the ram of the forging machine. To produce the head requires considerably more metal than the thickness of the head—because of the increase in diameter—and hence it is necessary to allow a certain amount of excess stock to form the head. Table I gives proportions of U. S. standard and Manufacturers' standard hexagon and square bolt heads, and also the approximate amount of stock required to form the head—this information being listed in Columns "C" and "F." The excess amount of stock given is not exact, but is close enough for starting the machine, as the stop can afterward be adjusted to suit.

In making rivets in a continuous-motion rivet machine, the amount of excess stock required is generally obtained by trial, but of course when definite shapes and proportions of rivet heads have been decided upon, the amount of excess stock required can be calculated approximately. The great difficulty in giving tables covering the amount of excess stock required is that no standard for rivet heads is universally followed, with the result that a slight difference in the curve or height of the head changes the amount of stock necessary. In addition to this, the scale of the furnace, depending upon whether gas, oil or coal is used for heating, so changes the amount of stock required that it necessitates a special setting of the stop in different cases. This is one of the reasons why up-to-date continuous-motion rivet making machines are provided with stops which can be adjusted while the machine is in motion. It is evident, therefore, that the exact amount of stock required is a question of some nicety, and it is surprising to what extent even the scaling off in the furnace will affect the stock required for the rivet head. What are considered in some shops standard shapes and sizes for rivet heads are given in Table II.

Sizes of Rectangular Stock used in Making Square and Hexagon Nuts

In making nuts in center-feed hot-pressed nut machines of the types shown in Figs. 35 and 37, rectangular bar stock as shown in Fig. 39 is used, and a block of metal is cut off this bar, forced into the dies by the cutting-off punch, crowned, pierced and formed into a nut of the required shape. To allow for upsetting the stock slightly and pressing it into the desired shape, a rectangular bar is used which is slightly thicker than the finished nut, and slightly less in width than the diameter of the nut across the flats. As explained in a previous paragraph, in order to produce a perfectly shaped nut it is necessary to waste a certain amount of stock as indicated at *a* and *b* in the illustration accompanying Table III. The amount of stock wasted depends upon the size of the nut and to a slight extent upon the temperature at which the bar is being worked.

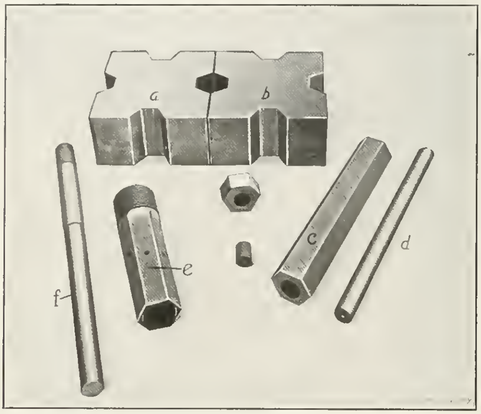


Fig. 44. Type of Dies and Tools used in making Hexagon Nuts in Center-feed Hot-pressed Nut Machine shown in Fig. 37

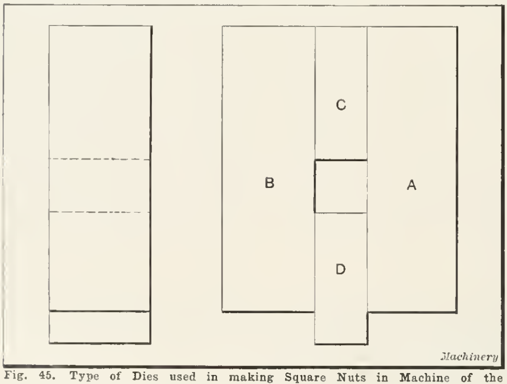


Fig. 45. Type of Dies used in making Square Nuts in Machine of the Type shown in Fig. 37

In producing a hexagon nut only the front triangular corner is rounded (owing to the drawing over of the hot metal), whereas on a square nut, the entire front corner of the nut is rounded. A considerable saving of metal can be effected by turning the bar after each stroke of the machine, thus presenting opposite faces of the bar to the dies, as was previously explained. This can easily be done in making the smaller size of nuts where the bar does not exceed 40 to 80 pounds in weight. For large nuts, instead of turning the bar, a small amount of stock is wasted, as indicated at *a* and *b* in the illustration accompanying Table III, which varies from 1/16 to ¼ inch, depending on the size of the nut.

The hot-forged type of nut making machine shown in Fig. 41 has the advantage over the center-feed hot-pressed machine of not wasting any stock. The hot-forged nut machine, however, is only suitable for the manufacture of square nuts, and is only used where this type of nut is made in large quantities.

* * *

USEFUL SHOP MIXTURES

BY JOSEPH H. CHEETHAM*

Most engineers, draftsmen and machinists consider it a pleasure to collect various useful formulas, receipts and "shop secrets." The following are several which have been selected from the writer's own notebook as being worthy to be passed on. Among them, there are several that were obtained from two diemakers who are "old timers," having followed their trade in Germany and the United States for forty years or more. All are receipts which the writer has had a chance to see tried out, and they were considered either better or cheaper than the usual ones.

Drilling Composition.—Thirty gallons of water; 5 gallons of lard oil; 20 pounds of washing soda. Put the material in a lard oil barrel, invert a steam hose into the bung and boil thoroughly. Don't use a drop of mineral oil or a barrel that has contained it. This is a cheap mixture and will not rust the bright parts of the machine.

Oil for Screw Machine Cutting.—Two gallons of No. 520 paraffine oil; 1 gallon of lard oil. Mix the ingredients well. This oil is used instead of a cutting compound or lard oil.

Recovering Copper from Dipping Acids.—Some copper is dissolved when dipping brass castings in acid to clean them. In order to recover this copper, run the acid liquors from the washing tanks into a large wooden vat containing milk of lime, and stir thoroughly. The lime neutralizes the acids and precipitates the sulphuric acid as sulphate of calcium This acid is neutralized first, then the nitric acid is acted upon, and nitrate of calcium is produced. The clear liquid contains nitrate of calcium and nitrate of copper. Run this solution through any kind of scrap iron. The iron removes the copper from the solution, dissolving and taking the place of the copper. The copper settles at the bottom of the tank as a slush. At intervals, the copper may be taken out of the vat, dried and melted into ingots. All of the copper may be recovered if the supply of scrap iron is kept up.

Dipping Brass Castings to Clean Them.—Formula 1. Two parts nitric acid; 1 part sulphuric acid (vitriol).

Formula 2. For a bright dip: One part nitric acid; 1 part sulphuric acid.

Formula 3. For stripping nickel: Two parts nitric acid; 1 part sulphuric acid.

Dipping Solution to Preserve Iron Castings.—Mix 100 pounds dry lamp black to a paste with benzine. Then make a mixture of 5 gallons lamp black paste; 2 gallons turpine japan; 1 gallon boiled oil; 1 to 2 gallons cheap varnish. For very good work, add to the above 12½ pounds of refined lamp black ground in japan. Dilute the mixture with turpentine until it is as thin as water, and have the castings clean before dipping.

Mixture for Cementing Emery Cloth to a Lapping-Wheel.—4½ pounds of rosin; 3 pounds of paraffine; 9 ounces of vaseline. Melt the ingredients and mix them thoroughly. Heat the surface of the lapping wheel and spread on the mixture. Then rub the emery cloth down so as to exclude all air from between the surface of wheel and cloth. The surface of the lapping wheel should be clean before the cement is applied.

* * *

A new German invention for which very strong claims are being made makes use of a miniature transformer in each electric incandescent lamp and therefore has the advantage of allowing the use of a low-voltage metallic filament of, say, fourteen volts. These filaments are much stronger than those for a higher voltage. It is claimed that the new lamp is more economical in its use of current and from fifty to seventy per cent cheaper to make than the ordinary type. The small transformer is fitted in the socket, and the switch turns off the primary coil of the transformer so that there is no leakage current.

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MAKING THE HORTON-MORROW CHUCK

MANUFACTURING METHODS EMPLOYED IN PRODUCING A MODERN HAND-OPERATED DRILL CHUCK

BY CHESTER L. LUCAS[*]

Some interesting methods are employed in the manufacture of the Horton-Morrow drill chuck at the factory of the E. Horton & Son Co., Windsor Locks, Conn. The Horton-Morrow chuck is prominent among the hand-operated drill chucks, and a distinguishing feature is its quick-releasing device. By referring to the phantom illustration in Fig. 1 the construction and operation of the chuck may be readily understood.

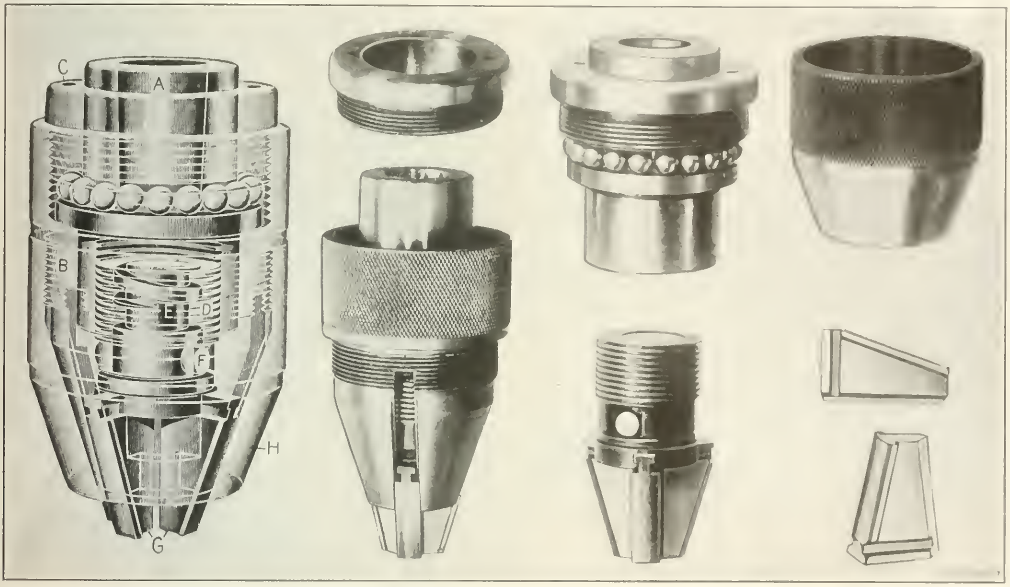

Fig. 1. Groupings of the Parts of a Horton-Morrow Chuck, illustrating Construction

In connection with the separate views of the parts shown beside this illustration, it will be seen that the chuck comprises a head *A*, which is fitted into the body *B* and held in place by a ring *C*, separated from the head by means of a row of ball bearings. The lower part of the head is fitted with a fine-pitch left-hand square-threaded screw into which is fitted the part *D*, known as the releaser. The active part of this releasing mechanism is the screw *E*, which is of coarse pitch and operates in the releaser. The screw, however, is restricted to a small movement by the cross-pin *F*, operating in a slot which permits the screw to turn but a very few degrees in the releaser, the operation of which will be made apparent later. Into the bottom flange of the screw the three jaws *G* are tongued. These slide in longitudinal slots provided in the body, and are confined radially by means of hood *H*. By observing these parts in detail in the separate illustrations and in place in the phantom view, it will be seen that when the hood and body are turned the releaser and jaws turn in the head *A* and the chuck jaws, through their contact with the inside taper of hood *H*, move up or down in accordance with the direction of the turning. One of the stumbling blocks encountered in designing a hand-operated drill chuck is that the drill in action tends to cause the jaws to grip harder, in proportion to the strain upon the drill. This, of course, is an advantage while the drill is in operation, but tends to make releasing very difficult. It is here that the releasing device of the Horton-Morrow chuck proves most effective. When releasing pressure is applied to the chuck, it operates first on the quick-pitch screw within the releaser, causing it to move the slight amount allowed by the cross-pin. While this distance is relatively small, the screw is of quick pitch, and the jaws are released just enough to bring them out of contact with the drill, and from this point on, the fine-pitch screw on the releaser actuates the jaws. Thus, we have all the advan-

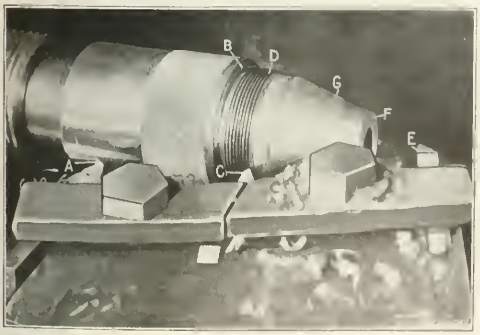

Fig. 2. Method of sizing Threading and turning Taper on the Body

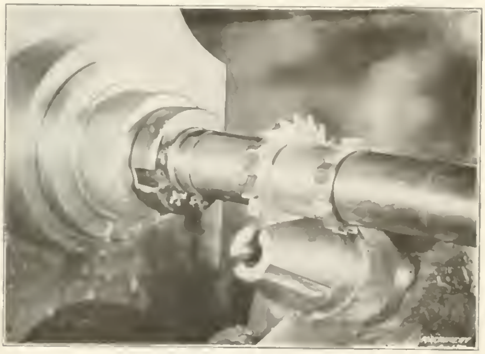

Fig. 3. Milling the Slots in the Body

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[*] Associate Editor of MACHINERY.

tages of the fine-pitch screw for tightening and gripping the chuck jaws upon the drill, and yet the presence of the quick-pitch screw allows the drill to be released readily.

Manufacturing the Chuck

Having the construction and operation of the chuck in mind, it will be easier to understand the manufacturing operations which have to do with the different parts, and it seems most natural to treat each piece separately, as in this manner we can obtain a better idea of the way each part is prepared for the work it must perform.

The body shown beside the phantom view in Fig 1, as in all other cylindrical parts, is roughed out on the screw machine. As it leaves the screw machine, this part is 0.010 inch over size on all dimensions which require fitting. The rough body is first held in a three-jawed chuck, being gripped by the blank section which is later to be threaded—next to the knurled part. In this position the internal thread is chased and sized by a simple tapping operation. This being done, the body is held upon a threaded stud as shown in Fig. 2, and by means of the three-tool set-up the shoulder adjacent to the knurled screw is sized, the thread cut, the end of the chuck sized and the taper turned. Three stops are provided.

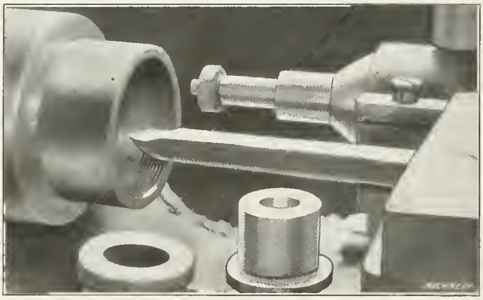

Fig. 4. Fitting the Head and Ring by boring and grinding

One of these serves to locate tool *A* in position to turn the side of the shoulder, as indicated at *B;* then changing over to a second stop, tool *C* is brought into the proper position to start the turning of the thread *D*. The lathe is, of course, kept in gear for the thread-cutting operation. Now by locating the carriage at a third stop, tool *E* is in position to finish off the end *F* and turn the taper *G*, the taper-turning being accomplished by a compound rest.

The next operation which is performed upon the body is that of milling the slots in which the jaws slide. These slots are spaced 120 degrees apart, and are milled with a wider slot at the top which forms a seat for the flanged edge of the jaw. The milling is done with the aid of two cutters mounted upon the arbor of the milling machine, the chuck body being screwed upon a stud on the milling machine table. Three wide cuts are first milled in the body, and then by setting over the milling machine table with the aid of the micrometer collar to the exact distance between the cutters, three narrow cuts are made in line with the three wide cuts. After this operation comes the fitting of the ring. The ring shown separately above the body, in Fig. 1, is another screw machine product, and the subsequent comparatively simple turning operations are performed with a gang-tool after the same manner that the turning of the body was done. As the lower face of the ring forms the upper member of the ball bearing, it is, of course, essential that it be hardened and ground. When it comes to the operation of fitting the ring to the body of the chuck it is in a hardened condition and ground on the shoulder which seats against the chuck body and also on the face against which the balls run.

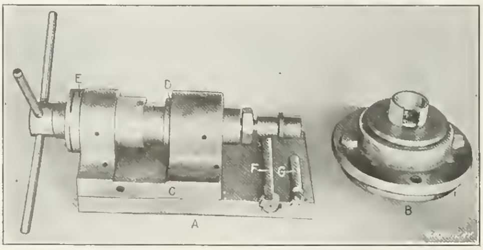

Fig. 5. Thread-milling Fixture and Draw-in Collet

Before the ring can be fitted to the body it is essential that the head shown with the ring and bearings in Fig. 1 be taken into consideration. This part is roughed out on the screw machine, and the first operation which follows is the milling of the left-hand internal square thread. This thread milling operation will be described in detail later. The taper in which the shank of the chuck is to be fitted is next reamed to size, and the piece is then capped at each end and casehardened, so that the internal taper and thread are left soft enough for subsequent fitting. After hardening, the sides of the flange and all of the external diameters are ground, for it will be remembered that the flange of the head forms the lower member of the ball bearing fixture.

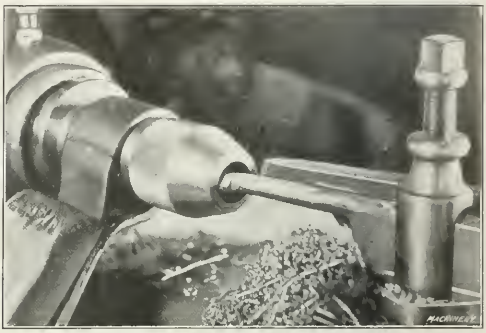

Fig. 6. Boring and turning the Hood simultaneously

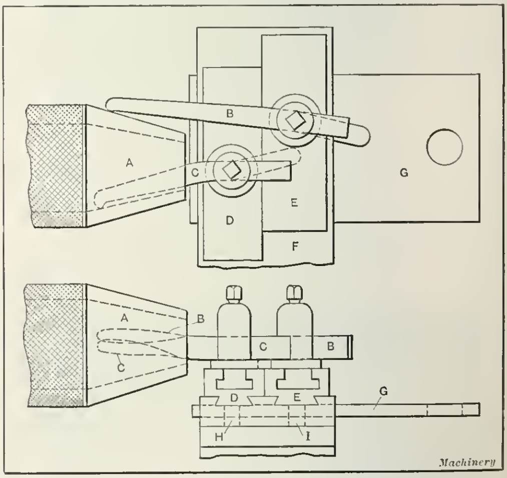

Fig. 7. Method of guiding the Boring and Turning Tools

Fitting the Ring and Head to the Body

For this operation, the body of the chuck is screwed into a bushing on the lathe spindle, and by means of a boring tool enough stock is removed from the inside surface to allow the head to slip freely into place. The ring is next screwed into the body, and by means of a grinding wheel located beside the boring tool, on the lathe carriage, the center of the ring is ground out until the upper part of the head will enter freely. This being done the only operation remaining is the facing off of the end of the body until the lower edge of the ring just comes in contact with the balls which run between the upper surface of the flange on the head and the ring.

The Operations on the Hood

The work performed on the hood of the Horton-Morrow chuck after it leaves the turret lathe is interesting. The hood which is shown at the upper right-hand corner of Fig. 1, is left from 0.005 to 0.010 inch oversize on all parts which must be fitted. The first work performed is that of chasing the internal threads, and for this part of the work the hood is held in the draw-in collet chuck illustrated at *B* in Fig. 5. In this view, the hood has been cut away to show just how it is held in the chuck and needs no explanation other than that the chuck is threaded to fit the lathe spindle and a draw bar runs through the lathe, being threaded to the taper plug shown in the hood. The threading is done in the ordinary way and the hoods next pass to a bench-worker where the threads are tapped out to size. From this point on, the hood may be held at the threaded section for performing succeeding operations. One of these operations is that of boring the internal taper and chamfering the outside as illustrated in Fig. 6. This operation is interesting, as the internal and external sections are both turned simultaneously with their proper tapers. To do this the boring tool and turning tool are held upon separate auxiliary slides, mounted upon the lathe cross-slide and by referring to Fig. 7, the operation of this arrangement may be followed. In this view the hood is shown at *A*, the turning tool at *B*, and the boring tool at *C*. Tools *B* and *C* are mounted on the cross-slide *F*, upon auxiliary slides *D* and *E*. A steel plate *G* is fitted under these auxiliary slides and studs *H* and *I* extend from the slides into inclined slots, shown in dotted lines in plate *G*. Plate *G* is held stationary, being bolted to the tailstock. From this construction it will be seen that when the lathe carriage is moved toward the work, the studs that reach into the inclined slots in *G* cause the auxiliary slides, and hence the tools, to traverse paths agreeing with the slots. As these slots are at the right angles for the taper of the bore and chamfer, it is only necessary to take successive cuts until the tapers are of the proper size. This size is determined by a taper plug gage. The strap loop encircling the lathe spindle is for the purpose of removing the hoods without injuring the knurled portion.

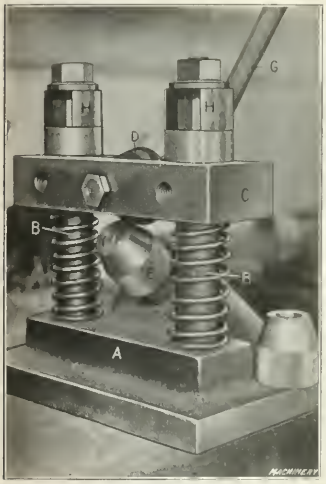

Fig. 8. Rolling the Horton-Morrow Name into the Hood

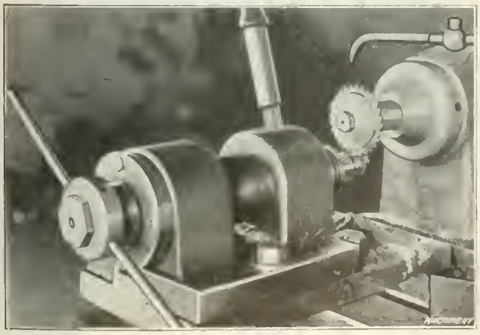

Fig. 9. Milling the Threads on the Releaser

After the turning operations have been completed, the name is rolled upon the hood in the stamping fixture shown in Fig. 8. This consists of a body *A* from which extend two heavy studs *B*. Sliding upon these studs is the saddle *C* which supports the stamping roll *D*. The hood *E* is slipped loosely over the arbor *F*, and, by means of handle *G* which is a lever from the stamp arbor, the stamp *D* is rolled over the hood thus impressing the letters upon its surface. For quickly removing the work from the fixture, slip-washers *H* are taken from the studs, allowing saddle *C* to be raised freely and the work removed. After hardening the hood, the internal taper is ground out, using a Heald internal grinding machine, to fit a taper plug gage.

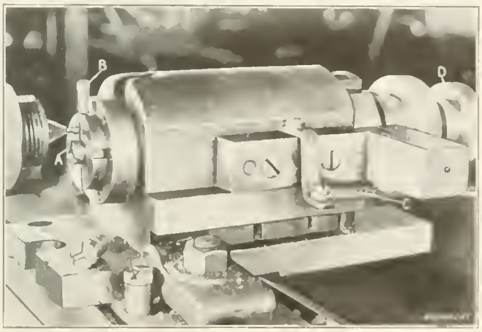

Fig. 10. Fixture used in T-slotting the Screw for the Jaws

Machining the Screw and Releaser

The screw and releaser shown in Fig. 1, with the jaws, form the basis of interesting thread milling operations, all of which are performed after the manner indicated in Fig. 9. The machine used is a small milling machine which has the thread milling cutter used for the square threads mounted upon the arbor. A fixture is mounted on the table of this machine for holding the work and turning it during the thread milling operation. This fixture is more clearly shown at *A*, Fig. 5, and consists of a main casting *C*, having a sleeve *D* in the front post and a threaded sleeve *E* in the rear post. Within this threaded sleeve a barrel which is threaded to fit the sleeve, works. This thread is of the same pitch as that which must be milled upon the work, and several barrels and corresponding sleeves with threads of different pitches may be used in the same fixture. The barrel is turned by means of hand levers radiating from the end of the barrel. The work is held upon the end of the spindle. In Fig. 9 one of the releasers is shown being milled while on the fixture shown separately in Fig. 5, a head is mounted, and is wrung onto a taper stud, so that the internal threads may be milled. When on internal work hobs are used as indicated at *F* and *G* in Fig. 5. Even though the work is turned by hand, it is surprising how smooth and accurate the resulting threads are. The coarse thread on the screw and the corresponding internal thread on the releaser are milled in the same manner, and in all there are two internal threads and two external threads to be milled on the chuck parts.

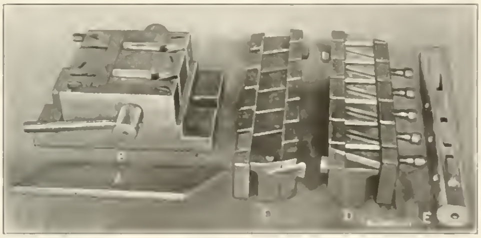

Fig. 11. Tools used in making the Jaws

Referring to the separate illustration of the releaser, screw, and jaws shown in the lower part of Fig. 1, it will be seen that the jaws are held in place by being keyed into the flange of the screw. The milling of these T-slots is a delicate operation and is done with end-mills as shown in Fig. 10.

The screw indicated at *A* is held in an indexing fixture by means of pin *B*. A straight end-mill is held in the spindle of the milling machine and three radial slots are milled 180 degrees apart. The barrel of the fixture is indexed by releasing an indexing pin connected with lever *C* and turning the barrel by means of handwheel *D* until the next position is reached. A T-slotting cutter is next run through so as to widen the slots at the bottom and provide for the reception of the jaws.

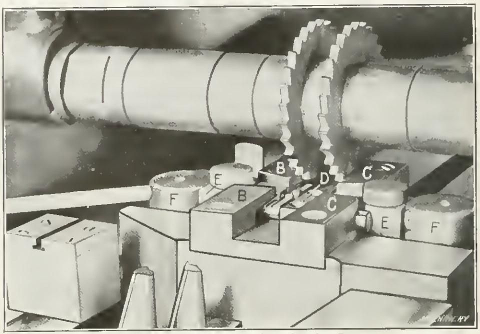

Fig. 12. Milling the Slots in the Jaws

Manufacturing the Jaws

The manufacturing operations connected with the jaws of the Horton-Morrow chuck comprise an interesting branch of the work for the reason that at the outset it was a difficult piece to produce economically, and for that reason considerable attention was paid to developing the process. Two views of the jaws may be seen in Fig. 1. The stock from which they are made is a high grade of carbon steel, and the first step consists in cutting the long bars to lengths of eight or ten inches, according to the size of jaw being made. One of these lengths of steel may be observed at *A* in Fig. 11, and it should be especially noticed that the ends of the bar are not at right angles to the sides, but are cut at an angle. The reason for this angular cutting will soon be apparent. The next operation performed upon the jaw-blanks is to mill them along one edge to give a working point from which the following operations can be located. Next a channel cutter which mills the stock from the central portion of the sides of the blank is run across each side, leaving the flanged edges which are to form the bearing sides of the jaws. A third milling operation follows which is to round the edges of the strip. After this point has been reached the strips are placed in an ordinary milling machine vise which is set up with the special jaws shown at *C* in Fig. 11. A pin at the end serves as a stop against which the lengths are located, and by swinging the milling machine vise at an angle with the gang-cutter which is used, five cuts are made through the steel, severing it into six rhombi. Each of these rhombi when split in the other direction form two jaw-blanks. The splitting operation is accomplished by means of the special jaws *D*, which fit in the milling machine vise. Set-screws at the side serve to take up the slight differences in length between the blocks, and a gang of six cutters separates the blocks into twelve jaw-blanks.

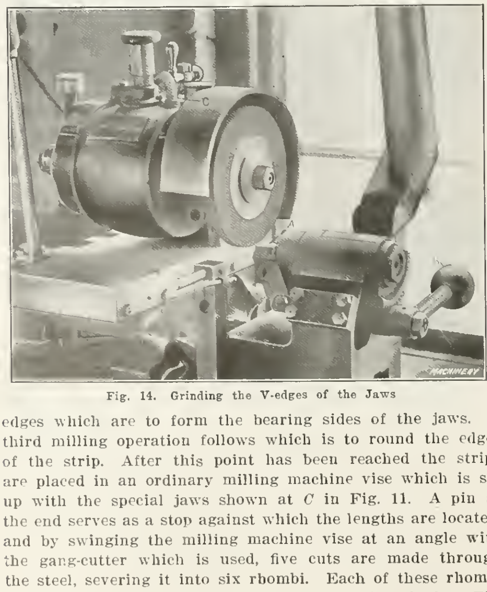

Fig. 14. Grinding the V-edges of the Jaws

It is next necessary to mill the angles on the gripping edges of the jaws and for this operation they are held in the fixture shown at *B* in Fig. 11, which accommodates two jaws, and by means of a pair of angular cutters the V-shaped edges are given to the jaws. The fixture is recessed so that the jaws slip down almost flush with the top surface and the clamping levers at the sides bind the blanks in place for the milling. A second milling operation follows which consists in tonguing the ends of the jaws to fit the T-slots in the screw which were shown being milled in Fig. 10. This is a simple milling operation making cuts in four jaws at once. The fixture and the operation are shown in Fig. 12, and the jaws are held by being placed two at a time, back to back, in the slots formed by blocks *B* and *C*. The tops of the jaws bear against the center stop *D*. Filler blocks *E* which are wedge-shaped are placed between each two jaws and simple clamping cams *F* are brought to bear against the ends of these blocks, thus holding the four jaws firmly in place against the center stop. The fixture is extremely simple in its operation and holds the jaws positively in place.

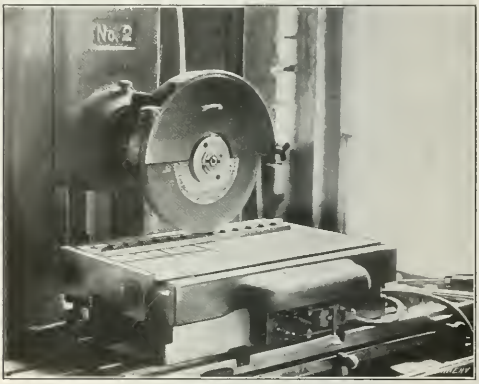

Fig. 13. Grinding the Sides of the Jaws

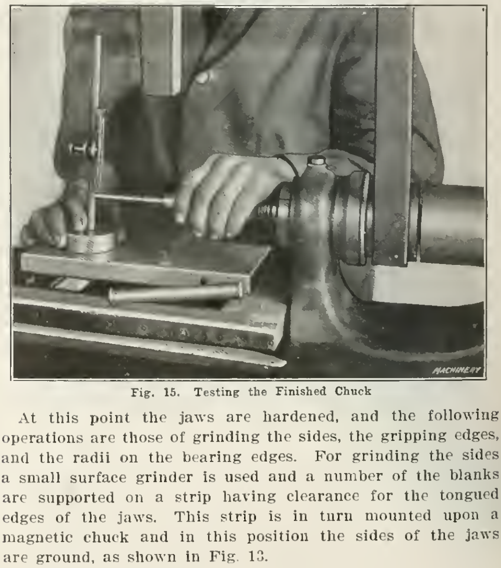

Fig. 15. Testing the Finished Chuck

At this point the jaws are hardened, and the following operations are those of grinding the sides, the gripping edges, and the radii on the bearing edges. For grinding the sides a small surface grinder is used and a number of the blanks are supported on a strip having clearance for the tongued edges of the jaws. This strip is in turn mounted upon a magnetic chuck and in this position the sides of the jaws are ground, as shown in Fig. 13.

The machine for grinding the gripping edges of the jaws is very interesting and in Fig. 14 it may be seen that it consists of a motor-driven grinding wheel mounted upon a sliding head, which can also be rapidly reciprocated in a lateral direction. The jaw, indicated at *A*, is held in the chuck at the opposite end of the machine. This fixture holds the jaw so that it may be swung to either of two positions, to agree with the two faces which must be ground. The swinging is done by means of a hand-lever *B* which may be seen at the right-hand end of this illustration. After the jaw has been firmly gripped in the machine the grinding wheel is moved by hand with a combined lateral and longitudinal motion over the side of the edges of the jaw being finished. The wheel is then drawn back, the jaw swung to the opposite position and the other side of the jaw finished. By means of a micrometer adjustment shown at *C* the depth of the grinding may be accurately controlled. In making the Horton-Morrow chuck no grinding is done upon the jaws after they have been fitted to the chuck. The jaws are absolutely interchangeable, and no fitting is required when assembling.

The edges of the chuck jaws which bear against the inside surface of the hood must be finished at a radius slightly smaller than that of the side surface of the hood. This is done by holding the jaws in the special arbor illustrated at *E* in Fig. 11. This arbor is slotted so that six jaws may be held in position with set-screws, there being three jaws on each side of the arbor. From this point the grinding operation is a simple one, being merely a question of finishing them to size.

Assembling and Testing the Chuck

The manufacturing operations on the parts of the chuck are performed as accurately as possible, so that the assembling department will have as little as possible to do in fitting the parts of the chuck, only such operations as cleaning out the threads after hardening and reaming out the taper for the spindle and a few minor operations are necessary in putting the chuck together.

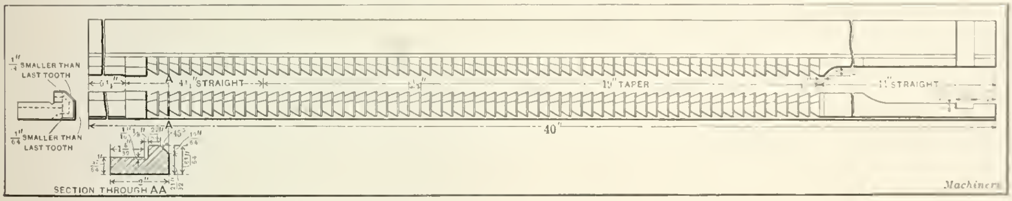

Fig. 3. The Type of Broach used for finishing Work shown in Fig. 1

The testing of the assembled chuck is shown in Fig. 15; this is particularly rigorous, every chuck being tested with ground spindles in conjunction with an indicator, the requirements being that they run within a maximum variation of 0.002 inch.

* * *

BROACHING VS. MILLING

BY FRANK J. LAPOINTE*

The field of usefulness of the broaching machine has been greatly broadened during the past few years, and machines of this type are now being used for many classes of work that were formerly finished by milling. The following gives a description of an operation which was recently handled on a J. N. Lapointe broaching machine in place of a milling machine. Fig. 1 shows an end view of the piece to be broached; Fig. 2 shows the work in place on the machine ready for the broaching operation; and Fig. 3 illustrates the type of broach which was used for this operation. By referring to Fig. 1 it will be seen that there are four surfaces to be finished on each side of the work. The material is drawn steel and there was about 1/32 inch of metal to be removed from each face. These pieces were formerly milled, and by this method about five or six pieces were finished per hour, the accuracy of the work being so unreliable that the pieces were not considered interchangeable. The present method is to employ twin broaches—one on each side of the work—the two broaches operating at the same time. By this method the pieces are held within a very close limit and can be relied upon to be interchangeable. Adjustments are provided on the fixture for regulating the depth of cut so that any wear which may develop can be readily compensated for. Two pieces of work are placed in the machine at once and from one to one and one half minute is required to pull the broaches through. This gives a production of from 80 to 100 pieces per hour.

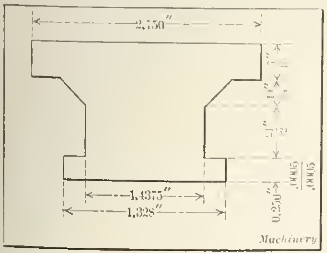

Fig. 1. End View of Work finished by the Broaching Operation

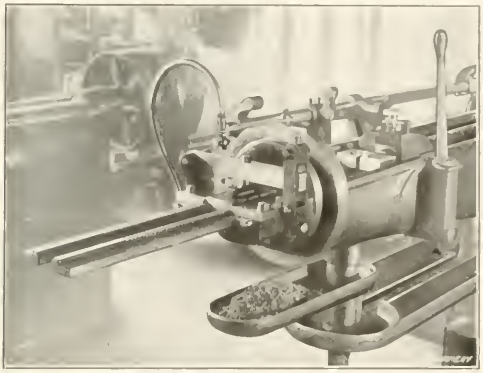

Fig. 2. J. N. Lapointe Machine with Work in Place ready for the Broaching Operation

Comparing the accuracy and production obtained through finishing these pieces by broaching with that obtained by milling, it will be seen that the broaching machine effected a considerable economy on this work. The broaches were made of high-speed steel, ground all over and operated at a cutting speed of six feet per minute. The No. 3 J. N. Lapointe broaching machine was used and the finish produced on the work was entirely satisfactory. The fixture for holding the work is made so that the work can be released by merely turning a knurled knob, and removing the finished work and replacing it with fresh blanks takes only a few minutes of an operator's time.

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* Address: J. N. Lapointe Co., New London, Conn.

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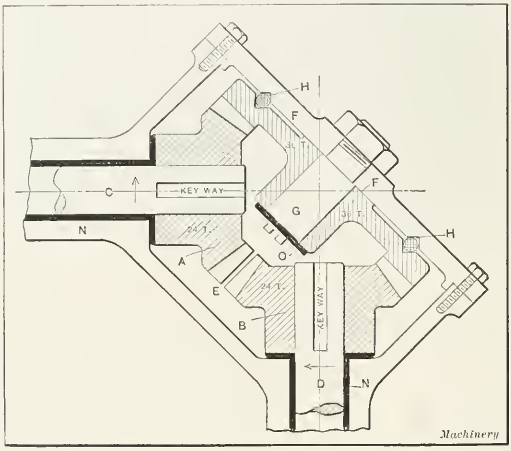
The American Museum of Safety has appointed a committee to award annually the medals given by Mrs. E. H. Harriman to the railroad which shall have done most to promote the "safety first" idea. Three medals will be awarded each year. A gold medal will be given to the railroad company itself, a silver medal to the official of the operating department of that road who has done most to promote safety on his road, and a bronze medal to the employe of the winning road who has been most conspicuous in the promotion of safety. It is planned to give with each medal an engraved certificate which will bear the name of the giver and that of the recipient. The first medals will be awarded in January, 1914.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

BEVEL-GEAR DRIVE FOR SHAFTS RUNNING IN THE SAME DIRECTION

The miter or bevel-gear drive is one common means of driving shafts at angles. The ordinary miter, bevel or angle gear wheels rotate shafts in opposite directions, but sometimes it is desirable to rotate the shafts in the same direction. The accompanying illustration shows a means of securing this result by the use of three angle gears.



Bevel-gear Drive for Shafts running in the Same Direction

A and *B* are a pair of 24-tooth wheels mounted on the shafts *C* and *D* which do not mesh at *E* but are connected by the larger angle gear *F* having 36 teeth; this gear is supported by the stud *G* mounted in the plate which is bolted to the gear-case. Bushings *N* are provided in the frame, which can be removed and replaced when the bearings are worn, thus bringing the shafts back to their original alignment. If a closed gear-case is provided, it may be made to hold a supply of lubricant.

The balls *H* back up the gear *F* on stud *G* and take the thrust. It is evident that if shaft *C* and gear *A* rotate as indicated by the arrow, then by means of gear *F*, meshing with *A* and *B*, gear *B* and shaft *D* will rotate in the same direction as *A* and *C*.

This arrangement will be found to be a good substitute for the ordinary quarter-turn belt drive. A valuable feature is the possibility of locating one horizontal shaft above or below another. Thus the advantage of a skew bevel gear can be obtained by means of this combination. This drive when made and put up right, especially when mounted in a case containing a quantity of lubricant, will last for years in hard service with very little care.

Springfield, Mass. FRANCIS W. CLOUGH

AN ECCENTRIC TURNING FIXTURE

The turning fixture here illustrated was designed for the production of screws or small studs which are made with some portion eccentric to the remainder of the piece. Its use insures a very accurate throw of the eccentric, and the fixture is made adjustable through a wide range, thus accommodating a great variety of work.

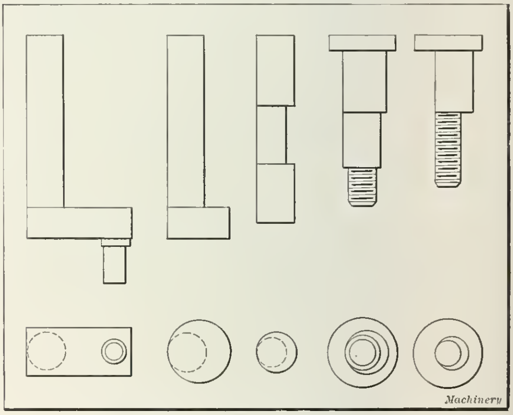


Fig. 2. Examples of Work for which the Fixture was designed

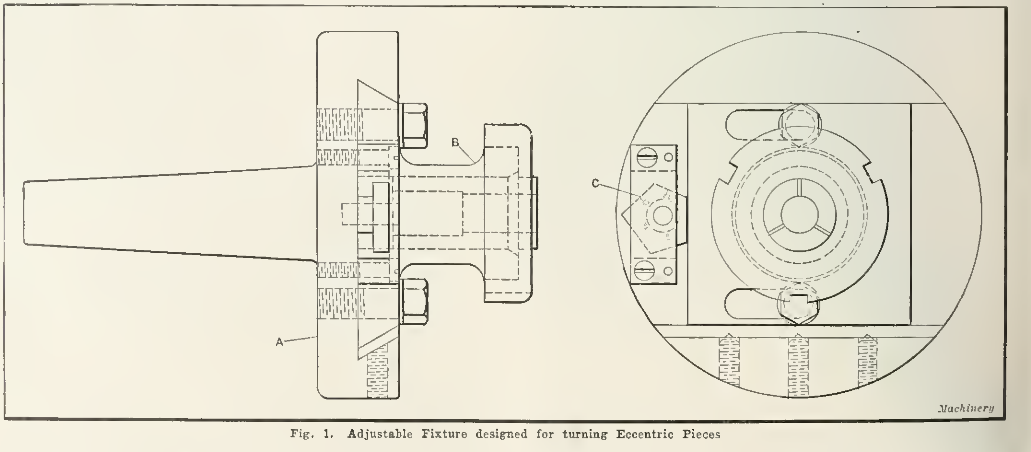


Fig. 1. Adjustable Fixture designed for turning Eccentric Pieces

The fixture consists of a body *A* which has a taper shank turned to fit the head center of the lathe, a collet holder *B*, accurately ground, and the eccentric indicating device *C*. *A* has a planed vee on the flange to which the collet holder *B* is fitted with a gib and to which it may be firmly clamped by means of two locking bolts, which are tapped into the body *A*, but which have elongated holes in *B*. The indicating device is interesting because of its simplicity. It consists of a five-sided plate, made so that the distances of its sides from the center are respectively, 0, 1/64, 1/32, 1/16, and ⅛ inch. This indicator is so fastened to the flange *A* that when the zero side of the plate is in contact with the side of slide *B*, the collet holder is central with the spindle, and as the various sides are placed in contact with *B*, the collet holder is set off center the amount marked on that side. For any throw that cannot be obtained from the plate, a standard set block may be inserted between the zero side and the side of the collet holder *B*, thus giving the required result.

It may be of interest to mention the way in which this fixture was made. The blank *A*, including the taper shank, was turned on the lathe, after which the V-slide was milled on the milling machine. Then the collet holder *B* was milled and fitted to *A*, and clamped in the zero position. The assembled fixture was then replaced in the lathe, and the hole for the collet or spring chucks was bored out, after which it was taken apart and *B* was hardened. The collet holder was then replaced and *B* ground to fit the spring chuck. The spring chucks are of standard make, and a set of them is used in connection with the fixture. The use of this fixture eliminates the slow method of measuring the eccentricity of a piece by means of an indicator or height gage, and it can be quickly changed from one setting to another. Duplicate work can be easily and quickly handled. A few of the pieces produced by this fixture, shown in Fig. 2, indicate the wide range of work which can be accommodated.

Beverly, Mass. EVERETT CHIPMAN

BUSHING A PROPELLER TAIL-SHAFT

The writer takes this opportunity of presenting the following reply to the inquiry of S. H. S. in the December issue of MACHINERY in regard to the proper method of bushing a propeller tail-shaft. A very satisfactory method of handling steel shafts is to cast a brass sleeve around them. An even better method, however, is that of shrinking on a brass sleeve and when this is properly done, the bushing should wear down to a quarter of an inch in thickness and still give satisfactory results. The objection to the use of this method is that it requires more time than is usually given to a job of this kind—especially in small shops—and a full day is not too much time to devote to boring and shrinking on the sleeve. A sleeve 2½ inches in diameter should not be over 12 inches in length and can be accurately bored on a lathe. Large sleeves of the type used on tug boats, where the length is from two to three feet, may be conveniently handled on a horizontal boring mill, although the bore will usually show a slight taper due to the springing of the bar or to inaccuracy of the fit of the yoke bushing. All of the work should be calipered and a parallel shaft used with a parallel sleeve; but if the sleeve shows a taper, a corresponding taper should be cut on the shaft. A shrinkage allowance of 0.001 inch per inch of diameter should be made. For a shaft 2½ inches in diameter, 0.003 inch shrinkage allowance will give excellent results. Hard brass should be used to resist the shrinkage strains and an alloy of 25 parts of copper, 2 parts of zinc and 4.5 parts of tin will meet average requirements. After shrinking the sleeve on the shaft, it should be pinned in position with brass studs screwed in as hard as possible. These studs are then headed over and smoothed off, after which the entire piece is finished.

C. R. C.

BORING A LARGE COMPRESSION COUPLING

At the plant where the writer is employed, there were a number of cast steel compression couplings to be machined. The principal difficulty met was in boring them, on account of their large size. The dimensions of one of the couplings are shown in Fig. 1. As there was no horizontal boring machine in the shops at that time, the use of a 36-inch lathe had to be resorted to. It will be noticed that the length of the work would not permit an ordinary boring-bar to be used, because it would not be rigid enough. Consequently, it was decided to make an attachment for the lathe that had the required rigidity, as the number of couplings to be bored was sufficient to warrant the expense involved.

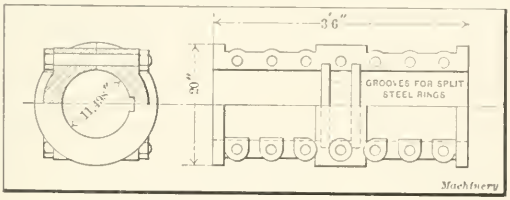


Fig. 1. Design of the Compression Coupling to be machined

Referring to Fig. 2, where the general arrangement of the attachment is shown, the method of procedure was as follows: Before starting to bore a coupling, a piece of rough iron was driven into one end, after which the coupling was hoisted to the lathe chuck, with the end toward the tail center that had the rough iron block driven into it. A center was drilled in this block and used to help steady the coupling while turning the end to receive the steadyrest *H*, as shown in Fig. 2. The tailstock and iron block were then removed and the bar, boring head, rests, etc., were set up on the lathe, after which the boring operation was started. The boring head *A* was fed along the steel bar *B* by means of a smaller steel bar *C*, which is fastened in a block *D* set in the compound rest of the lathe carriage. The steel bar *C* was fastened to the boring head by means of the two tap bolts *E*. The boring head carries two "Novo" tools which were held in place by set-screws. The steel bar *B* was supported at the forward end by a brass-lined steady bearing, and at the rear end by a support containing a set-screw to keep the bar from turning.

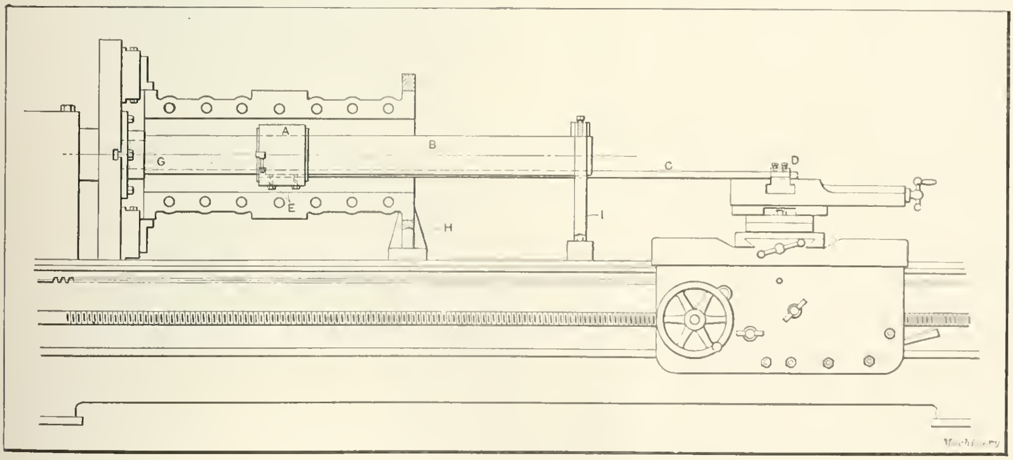


Fig. 2. Fixture used for boring Couplings on a 36-inch Lathe

The details of the various parts are shown in Fig. 3. The step bearing *G* was bolted to the faceplate of the lathe before the brass lining was bored out and was not removed until all the couplings were bored. The steadyrest *H* and bar support *I* were also bored out on the same lathe. The steel ring *J* has a beveled surface on the inside of the ring, so that when it was fastened to the boring head, there was space left for packing, which kept the dust and fine chips from getting under the head.

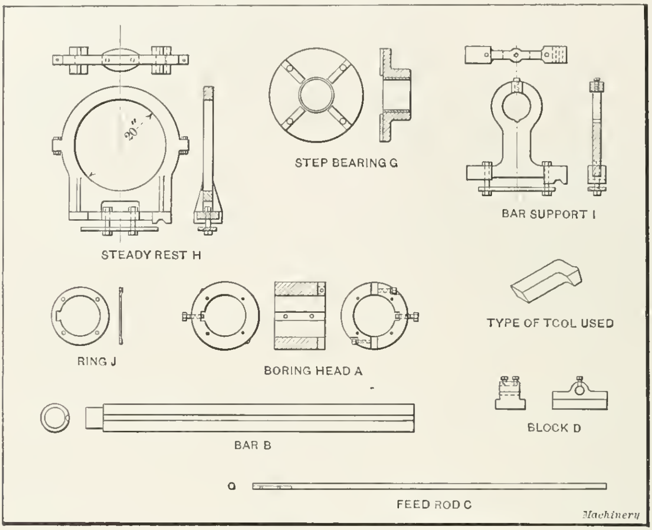


Fig. 3. Details of the Boring Fixture shown assembled in Fig. 2

In conclusion, it may be stated that the grooves shown for the split steel rings in Fig. 1 were not cut in the lathe, but instead, the work was taken to a vertical boring mill for this operation, as well as to machine the unfinished end of the coupling. Considering conditions, and the nature of the couplings, a good average time was made in machining them.

A. H. Myers

York, Pa.

BLANKING, FORMING AND PUNCHING DIE

The following is a description of a set of tools used for producing a brass cap of the form shown in detail in the illustration, between the punch and die. This cap is made of No. 22 gage sheet brass. A number of articles have been published in Machinery describing tools used for this kind of work, but the punch and die shown possess a number of interesting features. They were designed for use on a single-action press with an inclinable bed, and all parts were made interchangeable with the view of reducing the cost of repairs to a minimum.

Referring to the illustration, the punch-holder *A* is made of hardened tool steel and the lower end constitutes the blanking punch and forming die for drawing up the flange of the cap. A reamed hole *R* is provided in the punch-holder to receive the center-hole punch *G* which is a press fit in the holder. A 1/4-inch hole is drilled through the center of the shank to provide for knocking out the punch *G* when it is necessary to dismantle the punch and die for making repairs. The piercing punch retainer *E* is also made of tool steel and clamped to the punch-holder *A* by means of three small screws. Three slots *S* are cut in the punch-retainer *E* to enable it to clear the heads of the knock-out pins *C* which are made of cold-rolled steel. These knock-out pins are a press fit in the stripper *D* and slide up and down in the slots *T* which are cut in the punch-holder *A* for that purpose. The "kicker" *F* strips the work off the piercing punches *P* and the punch *G*. This kicker is operated by the pins *C*, the heads of which engage with its upper surface in the manner shown in the illustration. It will be seen that an off-set is provided at the top of this kicker to prevent it from falling out of the punch. The piercing punches *P* are made of hardened drill rod and are upset at the upper end to prevent them from dropping out of the holder; they are a sliding fit in the kicker *F*. The compression spring *B* operates the stripper *D*, which, in turn, operates the kicker *F*.

The method of assembling the punch is as follows: The spring *B* and stripper *D* are put in place around the punch-holder *A*, after which the pins *C* are inserted from the inside. Next, the retainer *E* is placed in the punch-holder and the three screws which are provided to keep it in place are tightened. Then the kicker *F* is inserted and the center hole punch *G* pressed into position.

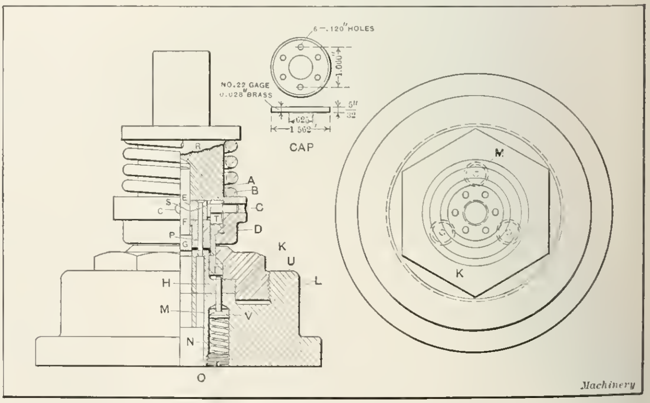
The die consists of a holder *L* which is a steel casting. The die-holder carries the blanking die *K* which is made of hardened tool steel and screwed into the die-holder at *U*. A clearance of 1/8 inch is allowed below the die *K* to provide for having it clamp the piercing die *H* in place in the die-holder. Two dowel pins, not shown, keep the die *H* from turning. A kicker *I*, which rests on three spring pins *M*, is made of machine steel and left soft; this kicker strips the work from the die *H*. Three holes are drilled through the die-holder from the under side to receive the springs *N* and pins *M* which operate the kicker *I*. Threaded plugs *O* are provided at the lower end of these holes and by adjusting their position, any required tension may be obtained in the springs *N*.

All of the hardened parts of the punch and die are ground to the required limit. The sheet brass used for the caps should be oiled in order to relieve the working parts of the tool. A trained operator running a press equipped with a punch and die of this type is able to produce from 18,000 to 20,000 caps in a ten-hour working day.

Buffalo, N. Y. J. Stanitz

SECTION DRAWINGS

In the April issue of Machinery, Mr. E. W. Tate refers to the method of indicating cast-iron sections which I described in the February number. Evidently, the method was not fully understood. It was not the intention to suggest this method for use on *all* classes of work, although it is capable of general application. The main use of tinting ink is on



Die for blanking, forming and punching Caps at One Operation all large full-sized sections, such as the beds of machines. In cases where time and money is of no consequence, the tinting ink method should not be used. Cross-hatching is not essential to the production of a good looking drawing, however, even where the drawing is used to sell a machine.

The tinting ink is not applied *all over* the cross-section, as the cloth would be rendered unfit for use by the shrinkage that would result from such a procedure. A border of ink, about ¾-inch in width, is painted around the outline of the section. The ink is easily applied, and the appearance of the blueprint produced from such a tracing is very satisfactory. It does not need an "artist" to apply it, as any "cub" can follow a line with a brush. One of the men in the drafting-room mentioned, not only uses the ink to show the sections, but shades all of his work with it. His drawings have always been used as a selling feature, and this shading certainly produces a very pleasing effect.

New Britain, Conn. J. M. Henry

BULLDOZER ATTACHMENT FOR BENDING AND PUNCHING FRICTION PLATES

The accompanying illustrations show a coupler friction plate used on freight cars and a bulldozer attachment designed by the writer for bending the plate and punching the holes in it; this attachment is in use at the B. & M. R. R. Shops, Concord, N. H. Both the bending and punching operations are performed at one stroke of the machine. These coupler friction plates are made from iron or steel stock ⅜ inch thick and have four 11/16-inch holes *A* as shown in Fig. 1. In the illustration of the attachment shown in Fig. 2, *A* is the punch-holder to be bolted to the bed of the machine, *B* the stripper and *C* the die to be attached to the ram. These parts were made from cast iron and the only machine work done on them was to plane the bottom of the punch-holder *A* and the back of the die *C*, except, of course, to drill and tap the holes that were required. The stripper *B* is operated by a spring *D* which is an old car spring picked from the scrap pile.

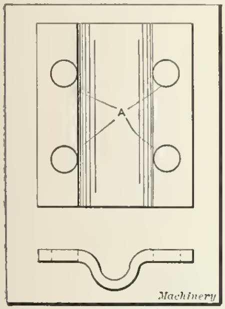


Fig. 1. Coupler Friction Plate bent to Shape and punched

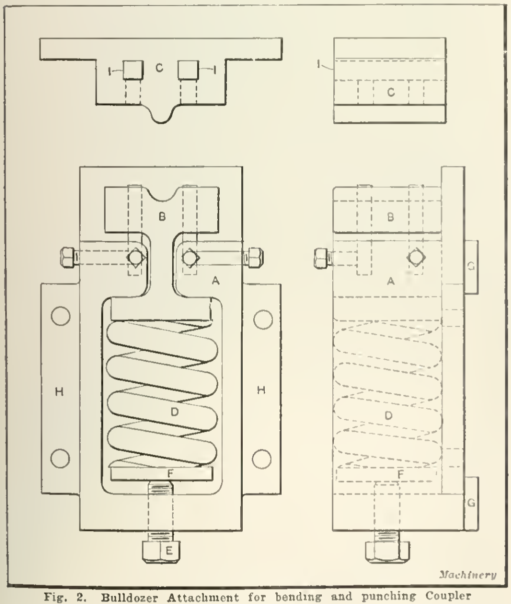


Fig. 2. Bulldozer Attachment for bending and punching Coupler Friction Plates

The tool operates as follows: A piece of stock, after having been cut to size and given the proper heat, is placed on edge in front of the stripper *B*. The die *C* then advances and forces the stock against the stripper *B* which bends it to shape and then forces it on to the punches as *B* moves back against the spring. The tension of the spring *D* should be strong enough to have the plate bent nearly to shape before the punching operation begins, and to strip the finished piece from the punches when the ram moves back to its idle stroke. The required tension of the spring can be regulated by means of the adjusting screw *E* acting against the block *F*.

It will greatly assist the operator in lining up the punch and die to unscrew *E* and remove the block *F*; this will allow the stripper *B* to slide back against the punch-holder *A*. In this position, the punches will extend through *B* for a sufficient distance to show if they are in line with the die. After the punch-holder *A* and die *C* are bolted in position, the block *F* is replaced and screw *E* adjusted. Two lugs *G* are cast on the bottom of the punch-holder *A* to fit into slots in the table of the machine. The projections *H* provide for bolting the punch-holder *A* in place. Stripper *B* acts as a support for the punches, and the holes through which the punches pass should not be more than 1/32 inch larger than the diameter of the punches, but they must be large enough so that the punches will not bind against the stripper. When iron stock is used, one set of punches will punch from 5000 to 10,000 holes if they are not allowed to become too hot. When the machine is running very fast, water should be used to keep the punches cool. The punches can be cut from 11/16-inch drill rod and the punchings drop out through the hole *I* in the die.

Concord, N. H. Ned D. Martin

MICROMETER HEIGHT GAGE

In designing the gage shown in Fig. 1, it was the object of the writer to devise a means of using a 1½- and 2-inch B. & S. inside micrometer for a height gage. This did not injure the tool in any way or detract from its usefulness as an inside "mike." It will be seen that a fixture is made to support the micrometer The base of this fixture is made of machine steel, casehardened, ground and lapped on the bottom. The bar and bracket of the fixture are of tool steel.

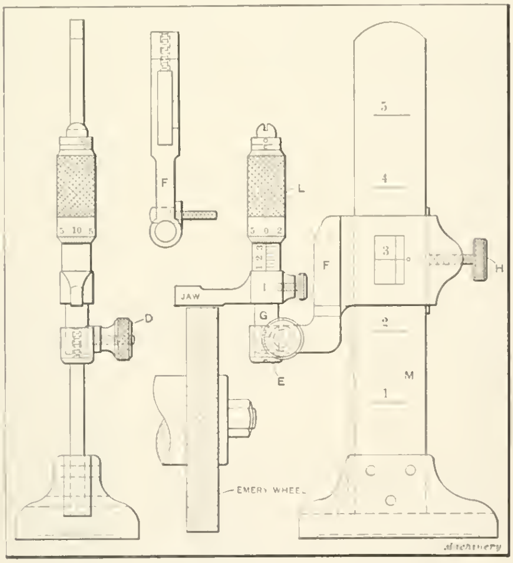


Fig. 1. Micrometer Height Gage made from B. & S. Inside Micrometer

Referring to Fig. 2, the scriber *A* is of hardened tool steel, and the two edges marked *a* are ground and lapped so that they are perfectly parallel with each other. The clamp *B* is a regular Brown & Sharpe height-gage clamp which can be purchased through the hardware dealers. The adapter block

C, which goes over the top of the jaw, is of tool steel and is for the clamp screw to bear against.

The bar *M* in Fig. 1 is graduated in inches or, if a metric "mike" is used, to twenty-five millimeters. The following method is used: After assembling the bar and base, the base is clamped lightly on an accurate surface plate and the divisions are then scribed from accurate size blocks or from a standard height gage. The lower jaw, thimble and screw are then removed from the micrometer, leaving the head jaw as at *I*; the hole *J* is plugged at both ends with a small cork to keep emery from falling on the threads. The head jaw *I* is next clamped lightly in a V-block and the clearance *K* is ground 0.010 inch below the jaw, a magnetic chuck grinder being used for this purpose. After demagnetizing and cleaning the work with gasoline, the head and thimble are reassembled and the end *G* is inserted in the bracket *F*, and clamped tight with the screw *D*. The assembled gage is now placed on the magnetic chuck grinder, and the under side of the jaw ground parallel with the bottom of the base.

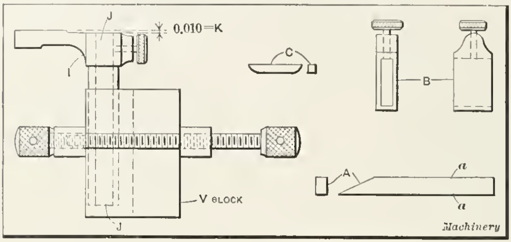


Fig. 2. Details of the Micrometer Height Gage

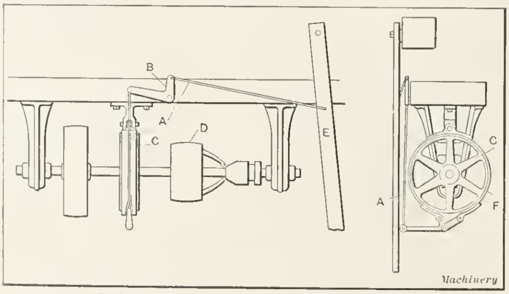
After thoroughly demagnetizing and cleaning, the gage is ready to set up, and this is done as follows: Set the zero line on the bracket to any division on the bar *M* and clamp the bracket tight with the screw *H*; then bring the thimble *L* to register zero at its lowest point, loosen the screw *D* and use a size block or height gage to set the jaw *I* to the height above the surface plate at which the bracket is set on the bar *M*. Now gage the distance between the jaw and the surface plate, adjusting the "mike" by means of the screw *E* until it just touches the gage used; retighten the screw *D*, and the gage is ready to use.

After the head is properly set in the bracket, it is only necessary to change the position of the bracket to coincide with any given line on the bar for the various inch or millimeter settings. The scriber *A* is used to scribe lines or to gage under projections.

New Britain, Conn. William C. Betz

BRAKE FOR HIGH-SPEED LATHE

The accompanying illustration shows a brake which was designed by the writer and recently tried out on a number of "Lo-Swing" lathes. The high speed of the driving pulleys on these machines was responsible for the loss of a considerable amount of time when it was required to stop them, or else the operator ran considerable risk of accident by attempting to use his hand for a brake. The use of the device illustrated herewith did away with all of these difficulties in a very satisfactory manner.



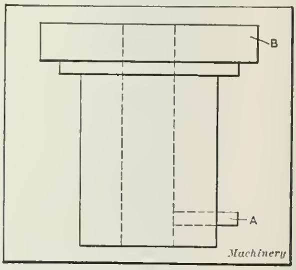
Design of Brake for stopping High-speed Lathes

Referring to the illustration, *C* is a 12-inch pulley, the face of which was turned flat. The pulley was mounted on the countershaft and the brake band *F* was hung from a beam overhead. This brake band embraces the pulley, and the material used in making it was obtained from some discarded automobile parts. Connection between the brake and shifter rod is made by the wires *A* and bell-rank *B*. The adjustment is so arranged that a slight movement of the shifter rod *E*, after the clutch is released, will tighten the band *F* on the pulley *C* and bring the countershaft to a stop. Four of these brakes have been in constant use in the shop for nearly a year and have never given any trouble. Their use enables the lathe to be stopped gradually or instantly if necessary.

Cleveland, Ohio. F. O. Smyth

SLIP DRILL BUSHING

In the April issue of Machinery, a description of a method of securing slip drill bushings was published. The following device is one which the writer believes is superior to that referred to. Here it will be seen that the pin *A* is put near the bottom of the bushing and a 7/32 or ¼-inch hole is drilled right through the jig so that it nearly breaks into the bushing hole. This hole is then cut or filed out so that it connects with the bushing hole. The cuttings force the bushing up somewhat, which is desirable as it makes it easier to remove. After the drill has entered an eighth or more, the bushing is not really needed. Thus bushings can be inserted from either side of the jig, the pin merely being used to prevent the bushing from rotating and wearing the hole out of alignment. It will be seen that a shoulder *B* is provided at the top of the bushing which makes it possible to use a screw-driver to pry it out when necessary.

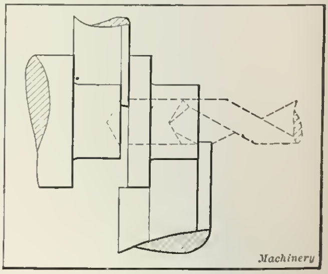


Pin for preventing Jig Bushing from turning

Galt, Ontario, Canada Cecil H. Smith

FORMING TOOLS FOR ROUGHING AND FINISHING

The illustration shows another method of producing ball bearing cones of the type referred to under this title by Corwin Lamoreaux and Elam Whitney in the January and April issues of Machinery. The writer has had considerable experience in designing tools of this type and believes that the present method would enable an increased production of work to be obtained. The advantage claimed for the separate roughing and finishing tools over the long forming tool is, of course, conceded, and this subject was very clearly dealt with by Mr. Whitney. The writer believes that the present method embodies all of the good points of the separate tools and, at the same time, allows the work to be drilled and reamed simultaneously with the forming operation.



Another Method of machining Ball Bearing Cones

Referring to the illustration, it will be seen that the work is roughed out and cut off with the "back tool" but a wall of sufficient strength is left on the side of the ⅜-inch hole (at the time the "front tool" finishes its work) to insure accurate results. The "front tool" can skim down the side of the large diameter at quite a fast feed—about 0.0015 inch per revolution—until it reaches the last thousandth when it can be slowed down to about 0.0005 inch per revolution to insure a good finish on the work. Operating under these conditions, the chip is light and the feed so slow that there is no danger of distorting the work. As the point of the forming tool which runs through the hole to a depth of 0.010 inch can be fitted into the flute of the reamer, there will be no interference.

The following is the order of operations:

	Rev.	Travel	Feed
Finish-forming	190	0.262	0.0005 0.0015
Drill	110	0.660	0.006
Index turret	20		
Ream	60	0.600	0.010
Cut off and rough forming	375	0.375	0.001
Total revolutions	375		

It will also be noted that the "front tool" reaches over the large diameter, thus removing the burr which is thrown up by the cut-off tool when it enters the work. In this way, the piece is dropped from the bar quite finished.

Providence, R. I. John J. McNiff

DRILLING HOLES IN GLASS

Mr. O. M. Hance describes a method of drilling holes in glass in the December number. I have found it much easier and quicker to drill glass by hand. Make a dam on the glass with putty or similar material around the spot where the hole is required to be drilled. Fill the dam with turpentine and use for a drill a three-cornered file having the end broken off at that point which will produce the size hole required. Sharpen the end to about 45 degrees making a sharp point. Use this drill in the hands, twisting it back and forth and apply plenty of turpentine. When the point of the drill punches through the opposite side, reverse the glass and finish the hole from the other side in order to prevent breaking out. I have drilled glass ⅜ inch thick in five minutes by this method.

South Bend, Ind. S. Queer

MEAT HOOK BENDING MACHINE

The manufacture of meat hooks for refrigerator cars is a side line in railway shop work which cannot be overlooked in developing efficient methods of operation. The machine illustrated in Fig. 1 is a labor-saving device for this purpose which has been the means of saving hundreds of dollars every year. The usual method of making all sizes of meat hooks is to bend them over a block by hand, or to use a hand or machine die for this purpose. In using either of these methods, the metal is worked hot and a separate operation is necessary for bending each end of the hooks. The machine which is to be described in this article enables the work to be bent cold and both ends of the hook are formed by a continuous operation of the machine.

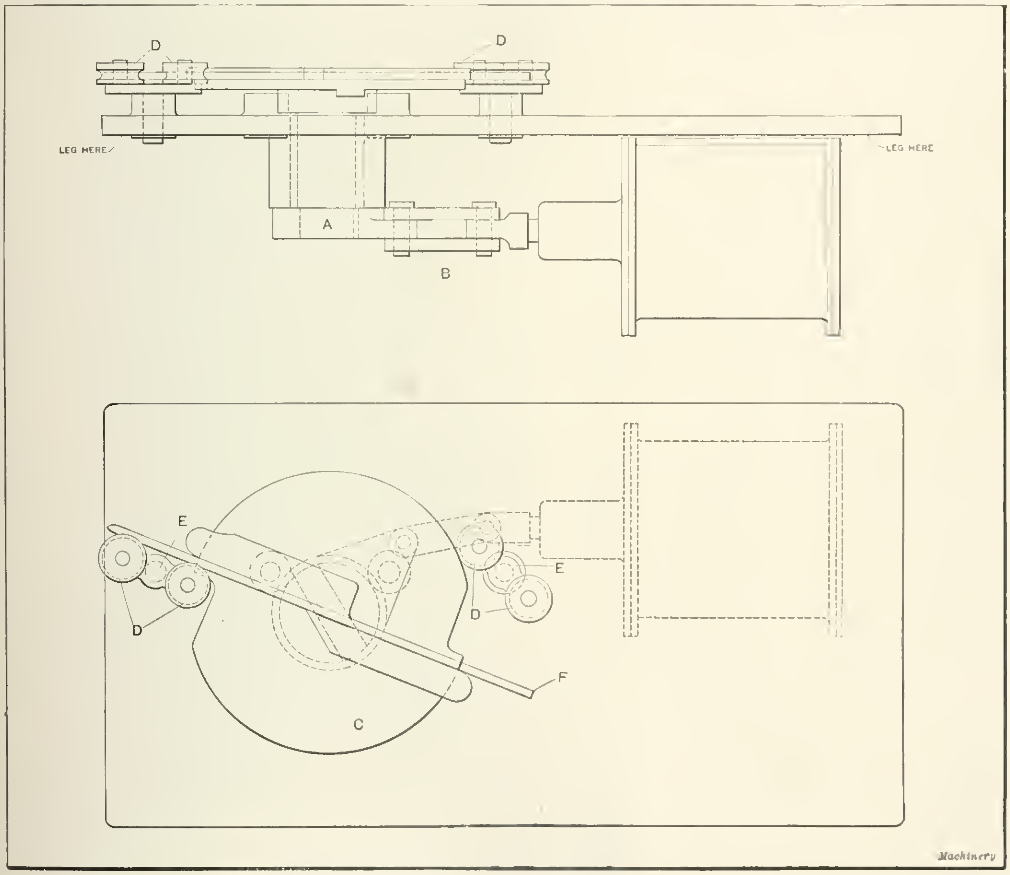


Fig. 1. Plan and Elevation of Meat Hook Bending Machine

This machine consists of an air cylinder and piston which rotates the mandrel *A* through an angle of 110 degrees by means of a suitable system of levers *B*. The top end of the mandrel is slotted to receive the head *C* which is so shaped that both ends of the hook can be formed around it. Two pairs of rollers *D* are mounted on stationary centers in the position shown. These rollers are maintained in a fixed relation to each other but are free to rotate on the stationary center *E*.

In operating the machine, a piece of ⅝-inch rod *F* of the proper length is placed in position, and the rotation of the head C causes the rollers to bend the rod around the die head, as shown in Figs. 2 to 5 which illustrate the successive operations in forming the two ends of the hook. In making larger sized meat hooks, the rollers are taken from the stationary centers and mounted on bosses provided for that purpose at a greater distance from the mandrels E. The operation is the same as that described for smaller sized hooks and the output of the machine is about 250 hooks per hour, regardless of the size.

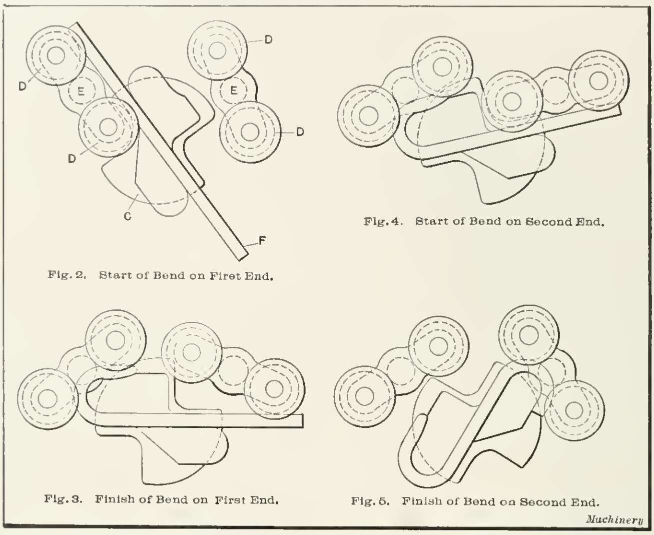


Fig. 2. Start of Bend on First End.

Fig. 4. Start of Bend on Second End.

Fig. 3. Finish of Bend on First End.

Fig. 5. Finish of Bend on Second End.

Figs. 2 to 5. Diagrams showing Successive Operations in bending Meat Hooks

West Winnipeg, Manitoba, Canada J. LEE

PROFESSORS OF MACHINE DESIGN—TWO EXTREMES AND THE AVERAGE

It is well that instructors in machine designing rarely feign supreme authority and versatility. If they did they would have hard positions to fill. A fool student, to say nothing of a wise one, can usually ask questions that nobody can answer; hence the frequent embarassment to the would-be authority where questions are asked that *can* be answered.

Occasionally iron-handed masters find their way into colleges, who may or may not be the authorities they pretend to be, yet they manage to retain the respect of their pupils by ignoring queries and continuing with lectures that are usually well emblazoned with intricate formulas. In fact, the writer was often present at lectures (not only in machine design) where neither he nor any other pupil present could have broached a sensible question bearing on the subject in hand because the lecturer did not make clear to us the points at which he was driving. To say one word would be an admission of ignorance and would spell "flunk" for the information seeker.

This type of "deep" lecturer commences his "one-hour-straight" in about this fashion: "The modulus of elasticity of cast iron being widely variable with different grades of the metal, we find it difficult to develop a precise rational formula for the curved beam we are designing to-day, which is subject both to tensional and bending stresses. In fact cast iron is not a strictly elastic metal anyway. However, by plotting the modulus figure, by noting the close approach of its outlines to the parabola, and by the application of a little simple calculus, we obtain this result * * *"

He would immediately cover the blackboard with figures, curves, unfathomable sketches of three dimensions (occasionally he would refer to the fourth dimension to further entangle us, but in justice to him I will say that he never attempted to plot that dimension), and with drawn features and wrinkled brow that forcefully portrayed the mathematical depths he had reached, the professor smote out his lecture while we, who were quickly disinterested, copied what he wrote on the blackboard and patiently waited for the hour to end. His method was to take us by surprise at the very beginning and snow us under with a carefully wrought sentence just as a football team in the early stages of a game plays the opposing team off its feet if possible. After that he seemed to be content and cared naught for himself or for us. When he saw that we were stupefied his face lit up. It would be difficult to conceive of lectures more droll.

Most minds, especially the minds of students, lag far behind the lecturer. Time is required to grasp the full meaning of a new subject. A slow lecturer who can produce a mind that leads, who can keep the majority of his class interested, who drives every argument home with simple, interesting illustrations, and who can thus clarify the most perplexing problems, is a rarity.

The superiority of the "slow" instructor in machine design was first brought to my attention a few years ago. I attended a well-known American university for the sole purpose of specializing in machine design. I frequently asked the professor in charge point-blank questions concerning problems over which I had often pondered. Except in the simplest cases I always received an indefinite reply and usually annoyed the professor. "The method developed by ——" he said at one time in answer to my query, "gives results for the design of crankshafts that are generally accepted in practice." I expressed a desire to have the theory of crankshafts explained, but the professor suddenly engaged himself busily elsewhere and I learned no more about crankshaft design than I knew before. The design of thick cylinders was this man's hobby and he kept us everlastingly at it. Later I went to a smaller Western college and had occasion to take some design work under a man who was slow but thorough. I brought up the crankshaft proposition and he admitted little knowledge of its niceties but immediately offered to assist me to the best of his ability. We dug into the theory, designed, redesigned, compared with common practice, and presently discovered why empirical and standardized processes are generally used. I was satisfied, and now feel that my knowledge of crankshafts is a little above the average. The slow teacher produced in me a leading mind. He was pleased to offer suggestions, to carefully explain the knotty places, and check my results. I noticed that in lectures before his classes this teacher would often make errors—purposely I believe in order to maintain the interest of his class. He required the men under him to check his figures constantly, and, more important still, he wanted them to *understand*. Teaching seemed to be his natural gift, but whether it is a fact to be deplored or not, he is still in the same small school, on the same small salary, and will perhaps spend the balance of his life there. His methods would be unsuccessful in a large college where more bluster and better presence are prerequisites.

Luckily for the student of engineering the average instructor usually confines himself and his class to problems that are tangible mathematically. Simple tensions, compressions, and bending moments in bolts, boiler plates, structural members, etc., constitute the principal course in design, and if the course is thorough in these basic principles, with an occasional careful wandering into something a little more involved such as sizes of pipe for steam, water and gas, intricate cam design, and a little precise gear designing, or some side line of which the teacher is a real master, the instructor may consider his work well done.

The college man who understands and can apply all that has been taught throughout his course, be those teachings ever so simple, has an obvious advantage over the man who has been taught nothing but intricacies and is not sure of any of them.

New York City. W. F. SCHAPHORST

CROSS-DRILLING ON A B. & S. AUTOMATIC WITHOUT STOPPING THE SPINDLE

The operation of cross-drilling the piece *B*, Fig. 1, on a B. & S. automatic is interesting because it must be accomplished without stopping the spindle, and since this piece is a screw, it will be understood that both pulleys of the screw machine are in use for threading, making it an impossibility to stop the spindle—hence the novelty. The writer has seen this fixture in operation in a shop where he was formerly employed, and will endeavor to explain the order of operations by means of the accompanying illustrations.

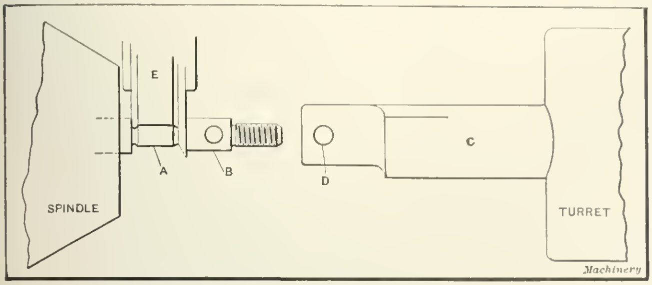


Fig. 1. Cut-off Tool in Operation and Supporting Fixture about to engage the Work

First, it will be noticed that for the particular job in question, a combination cut-off and forming tool *E* is used, as shown in Fig. 1. The only special fixture needed for this job is a sort of jig, which is held in the turret as shown at *C*. Fig. 2 shows two views of this fixture. By referring to Fig. 3, which shows the cams, it will be seen that just before the cut-off blade has severed the piece *B* from the bar stock, the fixture *C* is tripped and advances to the work. The hole *E*, Fig. 2, admits the head of the screw, and the turret is brought forward far enough so that plunger *G*, by the action of coil spring *H*, holds the piece *B* against the cut-off blade when entirely severed from the bar. It will be noticed that the cut-off tool remains in this position without advancing further, so that the cross-drilling attachment, *K*, Fig. 2, may advance to its working position, the drill being guided to the work by the hole *D*.

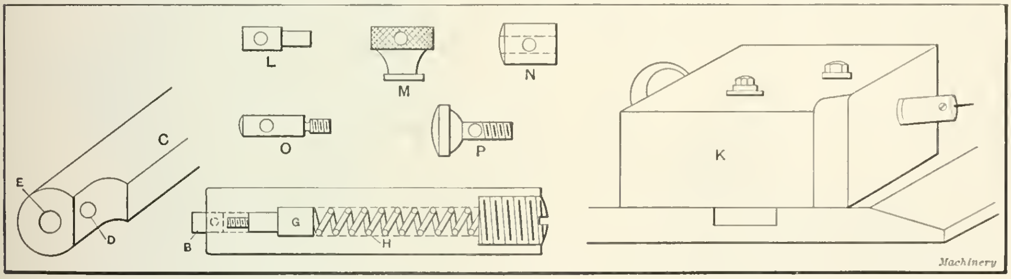


Fig. 2. Details of Supporting Fixture and Cross-drilling Attachment and Some Examples of Cross-drilled Pieces

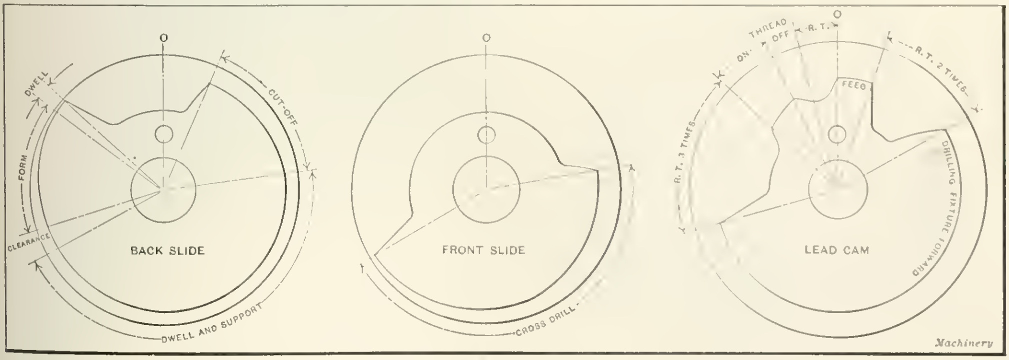


Fig. 3. Design of the Back-slide Cam, the Front-slide Cam and the Lead Cam

When the cross-drilling is accomplished the front slide recedes, and the jig is tripped away, allowing the cross-slide tool to advance again to form the shoulder *A* on the next piece ready for threading, which is done immediately on the return of the cross-slide tool to its idle position. The main object in using this method is the saving effected through not having to handle the work twice to complete the operations on it, and it also eliminates the cost of a drill jig on the drill press. In Fig. 2, the pieces *O* and *P* can be made with this set of cams, but a change of the drill fixture is necessary to accommodate the size of the work and position of the cross-drilled hole. The pieces *L*, *M* and *N* can be made on a screw machine, using only one pulley and a B. & S. spindle brake on the other pulley to stop the spindle while cross-drilling, but this would not be necessary, although for *M* and *N* a different set of cams would be used, because of drilling in the latter case and knurling in the former.

J. Harmon

CURTAIN FOR COVERING DRAWING-BOARD

Covering and uncovering a drawing-board with a cloth or newspaper is very little work, but most draftsmen and engineers will leave the board uncovered rather than to take this trouble. A better way is to provide an opaque roller shade, such as is used for windows, and attach it to the back of the board. The roller is fastened a little below the upper edge of the board so that it will be out of the way of the tee-square. If the engineer or draftsman is suddenly called away he usually does not take the time to cover up his board, leaving his work exposed to the dust, but with the roller shade attached to the back of the board it takes but a half second to cover up the work. In the morning or when the engineer returns to his work all that is necessary is to raise the shade and the work is as fresh and clean as before.

Chicago, Ill. O. M. Hance

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BOSTON GEAR HOBBING MACHINE

The gear hobbing machine illustrated herewith is being built by the Boston Gear Works, Norfolk Downs, Mass. This machine has a capacity for hobbing spur and spiral or helical gears up to 12 inches in diameter. Gears up to 6 pitch may be hobbed in steel and up to 5 pitch in cast iron. The machine can also be used for producing worm gears up to 12 inches in diameter, but in the case of worm gears, the feed is not automatic. Single-thread worms or screws up to 12 inches in diameter by 24 inches face can also be cut.

All of the gears on this machine are constructed to provide adjustment for wear, and in this way any backlash which would affect the accuracy of the cutting mechanism can be compensated for. The main work spindle and cutter spindle have taper bearings, thus providing an easy method of adjusting for wear. In designing this machine an effort was made to have it equally adaptable for cutting gearing as fine as 48 diametral pitch and less than 1 inch in diameter, and steel gears as heavy as 6 diametral pitch with the hob working up to its full capacity. Referring to the illustrations, it will be evident that much of the rigidity of this machine is due to the small amount of overhang of the cutter shaft. On the machine shown, the overhang does not exceed 4½ inches from the ways.

The design has also been simplified as far as possible, thus making the machine efficient and easy to operate. There are only two driving members in the cutter head. In the illustration Fig. 2, it will be seen that there is a screw arrangement on the back end of the shaft connected with the large bevel gear which provides for making adjustment toward the bevel pinion. This enables any backlash between these two gears to be compensated for. The arrangement of the other gears in the driving train has been worked out with the view of reducing backlash to a minimum. As a result, any tendency toward chatter in the gearing has been practically eliminated, thus increasing the accuracy and efficiency of the machine.

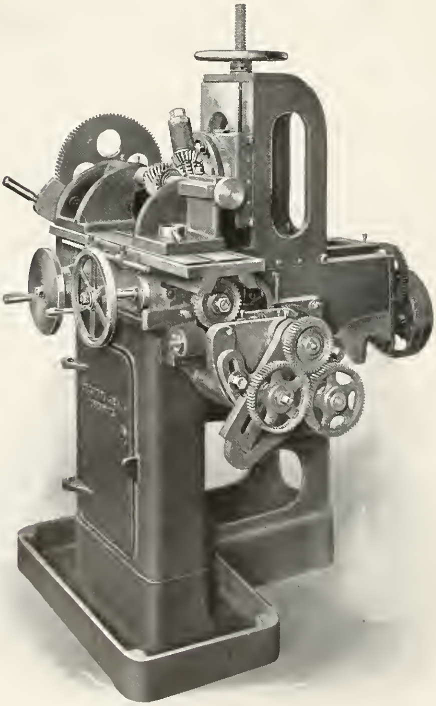


Fig. 1. The Boston Gear Generator

Another distinguishing feature is that the hob is held practically vertical when in the cutting position, and in cutting the ordinary type of gear this allows chips to clear themselves much better than they would if the hob was on top of the gear or the gear on top of the hob. An arrangement for taking care of the chips below the machine is provided, which enables the oil to be drained to the reservoir from which it is returned to the cutter by means of a suitable pump.

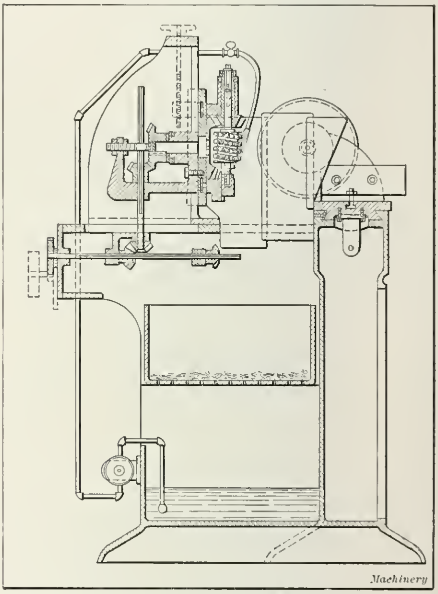


Fig. 2. Cross-sectional View of the Boston Gear Generator

The worm-gear index is accurately cut and all of the bearings in the machine are ground with oil grooves to provide for proper lubrication. All parts of the operating mechanism are conveniently located. The handwheel located at the left of the machine is provided with a micrometer dial for bringing the cutter head to the required position and securing the necessary depth of cut. The handwheel on the right-hand side of the machine is used for returning the cutter slide at the completion of the cutting operation. A quick return movement is provided for this purpose.

The machine is provided with a constant-speed, single pulley drive, the speed variations being obtained by a change gear device shown at the right-hand side of the machine. The change gears for both speed and indexing are conveniently located, gears being furnished to provide for cutting any number of teeth up to 100, and by compounding, even numbers can be obtained up to the usual requirements over 100. The driving pulley is 12 inches in diameter by 3 inches face and runs at a speed of 320 revolutions per minute. Ten changes of hob speeds are provided, which cover a range from 40 to 400 revolutions per minute. A special attachment can also be furnished which gives hob speeds up to 1200 revolutions per minute. The range of feed runs from 0.010 to 0.160 inch per revolution. The work spindle is provided with No. 10 B. & S. taper. The total height is 60 inches and the floor space occupied 40 by 50 inches. The net weight of the machine is approximately 1600 pounds.

WATERBURY FARREL WIRE SPOKE MACHINES

The machines illustrated and described in the following have been designed and built by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., for heading, bending and threading wire wheel spokes for automobiles, motor cycles and wagons. Fig. 1 shows an open-die, single-stroke header for heading and bending spokes. This machine is built in different sizes for heading and bending spokes up to and including ¼ inch in diameter. The bending attachment is mounted on the top of the machine and consists of suitable bending tools operated from the crankshaft.

The machines are driven by a flywheel mounted directly on the crankshaft, which is of ample size to furnish the required amount of power and runs in suitable bearings. Owing to the fact that these machines are hand fed and that the operator depresses and releases the treadle, causing the machine to make one revolution and come to a stop for each blank that is headed, the capacity in blanks per minute depends largely upon the skill of the operator. Some operators are able to run the machines almost continuously.

The heading slide is designed so that it is positively operated in the bed during its forward motion by a connection on the crankshaft, but so arranged that the gate is pulled back by a spring that brings it up against an adjustable stop-screw. To regulate the amount of stock in the upset, this adjustable stop-screw can be set so that the heading slide will stop with the punch at the required distance from the dies, thus acting as a feed stop for the wire and insuring the correct length of wire projecting from the dies to form the upset.

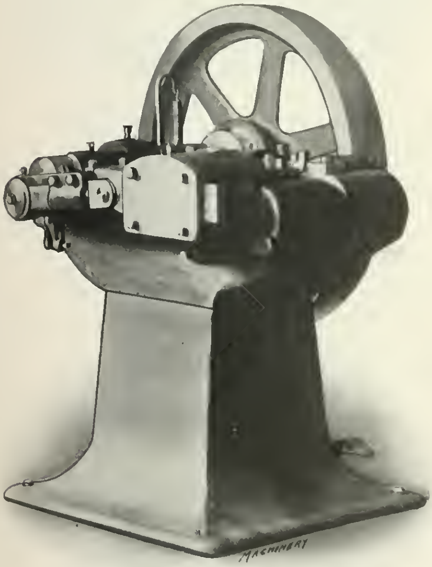


Fig. 1. Waterbury-Farrel Wire Spoke Heading and Bending Machine

The punch is held in an adjustable punch-holder in the end of the heading slide and may be adjusted up and down, from side to side, and also toward and away from the dies, which provides for having the punch centrally located with the dies. The gripping dies are made of hardened and ground tool steel; one die is held in a stationary die block, and the other in a sliding die block, which is operated by a toggle motion and connection from the crankshaft.

In operating the machine, the spoke to be headed is placed between the open dies and pushed forward until its end comes into contact with the punch, which acts as a feed stop, thus assuring the correct length of wire projecting from the dies to form the upset. The heading slide then advances the punch upsetting a head on the end of the spoke. The headed spoke is then taken from the top of the machine and inserted in the bending die at the left, where the bending tools operate, bending the spoke to the required shape.

Fig. 2 shows a reciprocating screw thread rolling machine of the side feed type, which is used for rolling the threads on the ends of the spokes. The machine is built in sizes suitable for threading spokes up to and including ⅜ inch in diameter. This machine is similar in design to the standard screw thread rolling machines built by this company, but as the work is too long to be handled in the standard machines, this machine was designed to receive the work from the side and is fed by hand.

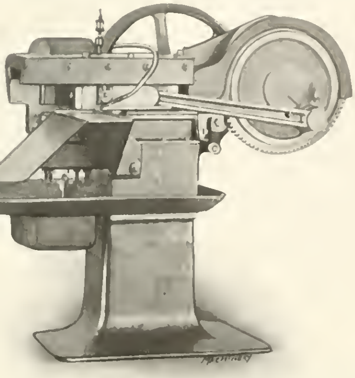


Fig. 2. Waterbury-Farrel Reciprocating Screw Thread Rolling Machine

The machine is driven by heavy pulleys and is back-geared to give a powerful drive. The gears, pitman and all parts are well protected by guards for the safety of the operator, as shown in the illustration. As the machine is fed by hand, the number of blanks that are threaded per minute depends largely upon the skill of the operator in feeding the work.

The dies are arranged so that the work is rolled in a horizontal position, thus allowing long work to be readily handled. The arrangement and adjustment of the dies is the same as on the standard type of thread rolling machines of this company's manufacture. The reciprocating or moving die is longer than the stationary die. The dies are held in position by clamps and may be easily removed when desired. The reciprocating gate or slide which carries the moving die is mounted in a dovetail slide and held in position by a cap, which has provision for taking up wear. The stationary die-holder is adjustable for any diameter of work within the limits of the machine.

In operating the machine, the blanks to be threaded are placed against a set edge on the table bracket which projects in front of the machine. As the gate is drawn back, the operator places the blank in position against a depth gage, which may be adjusted to give any length of thread that is desired within the limits of the machine. A "pusher" or starting slide automatically carries the blank to the dies at the correct time. The blank is then rolled and falls off the end of the die into a suitable receptacle placed on the floor to receive the finished work.

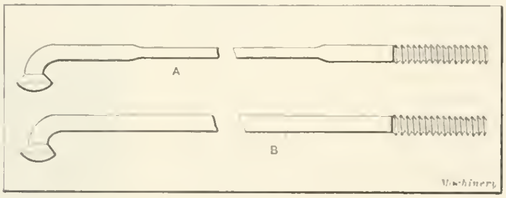
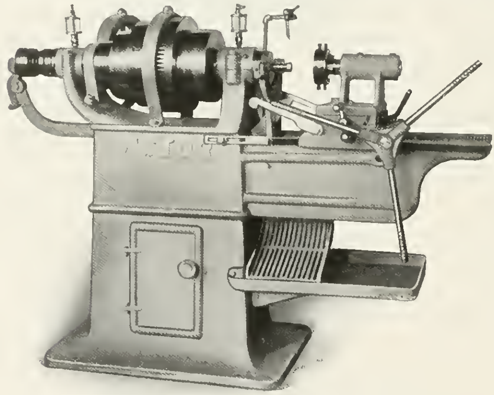


Fig. 3. Swaged Spoke A with Cut Thread; Spoke with Rolled Thread at B

An oil tank, pump and suitable piping are furnished with each machine, which provide an ample flow of oil or other lubricant for the work and dies, thus keeping the dies cool and clean. Fig. 3 shows two spokes which have been headed, bent and threaded. Rolling the thread increases the diameter of the wire at the threaded section. For rolled threads, a wire of the pitch diameter of the required thread is used. The spoke illustrated at *A* has been swaged and has a cut thread, while the spoke at *B* has a rolled thread, the increase of diameter of the threaded section being somewhat exaggerated in the illustration. Both spokes were headed and bent on the same machine. Where the spokes are to be swaged—that is, reduced in diameter between the ends—this is done on other machines.

VICTOR NUT FACING MACHINE

The improved nut facing machine which is shown in the accompanying illustration is a product of the Victor Tool Co., Waynesboro, Pa. This machine is designed for facing nuts which are screwed onto the end of the spindle ready to be operated upon by a tool carried by the tool-carriage. The operation of the machine is exceedingly simple and its design insures having a nut faced true with the thread. The operator feeds the machine with his left hand and uses his right hand for operating the tool-carriage. The method of procedure is as follows: Taking a nut in his left hand he places it on the revolving spindle of the machine, where it is engaged by the thread and screwed into place. The capstan handle is then turned to bring the facing tool into operation and the provision of suitable stops insures having each nut faced to the same thickness. After the facing operation has been completed, the capstan handle is turned to the right. This traverses the carriage to the right and engages a clutch on the spindle which rotates it in the opposite direction to back off the nut. The nut drops from the spindle and slides down the metal chute shown in the illustration, which discharges it into a box placed on the floor for that purpose. When the operator releases his grip on the capstan, the action of the spring at the left-hand end of the spindle draws the spindle back by means of the link which runs through the bed of the machine to the yoke at the right-hand end of the spindle. This engages a clutch which drives the spindle forward ready to have another nut screwed into place to be faced.



Victor No. 2 Nut Facing Machine

The machine is equipped with a pump, unless otherwise specified, and the use of a cutting compound is recommended. Referring to the illustration, it will be seen that the machine is driven by a three-step cone pulley and back-gears which provide six operating speeds. For facing 3/8- to 5/8-inch nuts, a speed of from 300 to 350 revolutions per minute is recommended, lower speeds being used in proportion to the size of the face. The principal dimensions of the machine are as follows: Height 48 inches; over-all length 64 inches; size of base 22 by 32 inches. The spindle bearings are bushed with babbitt and provided with means of adjusting for wear. The diameter of the front bearing is 3 inches and of the rear bearing, 2¼ inches. The cone pulley diameters are 11 inches, 8½ inches and 3¾ inches by 3-inch face. The net weight of the machine is 1400 pounds.

HJORTH BENCH LATHE ATTACHMENTS

The Hjorth Lathe & Tool Co., (Woburn), Boston, Mass., has developed a number of attachments for use on the bench lathes of its manufacture. These attachments are of material assistance in widening the scope of a bench lathe, and by referring to the illustrations, it will be evident that a great variety of work can be handled by a machine provided with all of these subsidiary equipments.

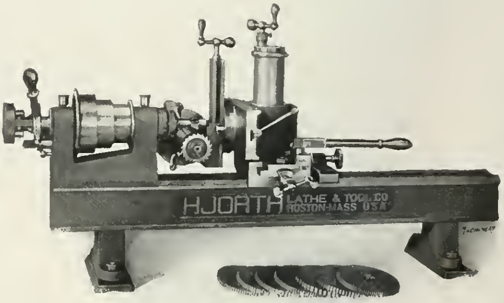


Fig. 1. Hjorth Bench Lathe equipped with Plain Milling Attachment

Fig. 1 illustrates a Hjorth bench lathe equipped with a plain milling attachment. This attachment is designed with combination lever and screw feed and is adapted for milling gears, milling cutters, reamers, taps, and similar classes of work. The attachment is adapted for using the same type of spring chucks that are used in the lathe headstocks and this makes the chucks of the lathe and milling attachment interchangeable. The cylindrical post provides a particularly rigid support and the vertical screw affords a means of setting the shoe-block at a suitable height for the class of work that is being handled. The shoe-block is graduated in degrees, so that it may be set to any required angle for cross or angular milling; this makes the shoe-block independent of the lower slide. A key, inserted through the shoe-block, is held on the cylindrical post by means of two taper-headed screws which enable the block to be raised or lowered without throwing it out of alignment with the lathe bed. When the attachment is to be used for angular milling, the key is loosened and the taper screws removed. The vertical movement of the attachment on the cylindrical post is 3½ inches and the cross movement, 3½ inches. A special slide is made to be fastened on the shoe-block by means of an eccentric binder. This slide provides a movement of 5½ inches. Both the swivel quill holder and the slide swivel are graduated in degrees and can be firmly tightened with two T-slot bolts. A swivel vise is made for use in connection with this milling attachment, which has been found to add materially to the efficiency of its operation.

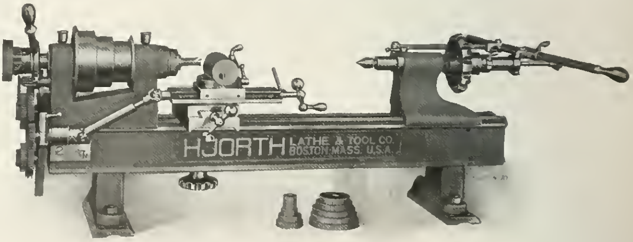


Fig. 2. Screw-cutting Attachment for Hjorth Bench Lathe

A lathe is shown in Fig. 2 equipped with a thread cutting attachment. Referring to the illustration, it will be seen that the screw of the compound rest is connected with the change-gears by means of a universal jointed driving rod. The change-gears supplied with the lathe give the attachment a range for cutting screws having from ten to eighty threads per inch.

Fig. 3 shows one of the Hjorth lathes equipped with a universal milling attachment, the machine being engaged in milling a rack. It will be seen from the illustration that the ball-crank at the top of the cylindrical post provides the vertical movement for the attachment. Longitudinal travel is secured through the threaded rod running parallel with the lathe bed, and transverse movement through the ball-crank which operates the slide. The work is held in a vise carried on the extension of the attachment, and the construction will be readily understood by reference to the illustration.

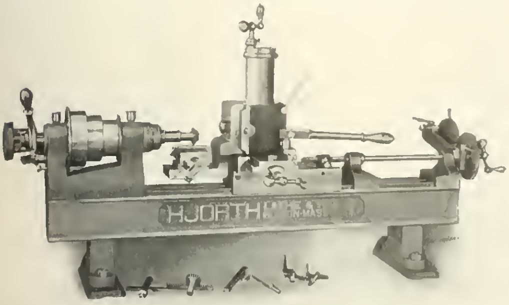


Fig. 3. Universal Milling Attachment for Hjorth Bench Lathe

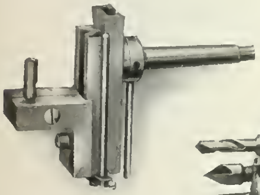


Fig. 4. Drilling, Centering and Tapping Attachment

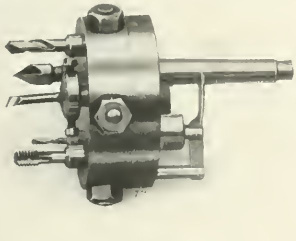


Fig. 5. Turret Attachment for Hjorth Bench Lathe

A combination drilling, reaming and centering attachment for the Hjorth bench lathe is illustrated in Fig. 6. The taper shank of this attachment is mounted in the lathe tailstock. This shank carries an off-set arm upon which the tool-holder attachment is pivoted. The illustration shows the tool in position for centering; after this operation has been performed, the tool is swung over to bring the drill into the line of centers when the drilling operation is performed. The same attachment can be used for a variety of classes of work where two operations must be performed.

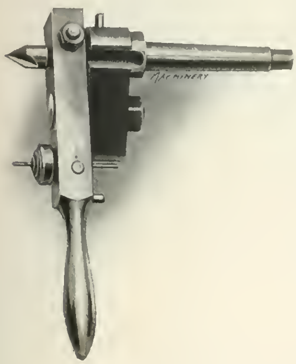


Fig. 6. Hjorth Combination Drilling, Reaming and Centering Attachment

A turret attachment having a capacity for five tools is illustrated in Fig. 5. Like the preceding attachment, this tool is fastened to the lathe by a taper shank fitting into the lathe tailstock. It will be seen from the illustration that a latch is provided which is controlled by a suitable lever. After each successive operation has been completed, the latch is released and the turret indexed into position for the next operation. It is then secured in this position by the latch.

Fig. 4 shows the adjustable V-block center, with an angle-iron attached, set up for drilling, a central stud being provided to hold and center the work. Referring to the illustration, it will be seen that the block has a cross-slide movement and that it can also be lowered and raised; when in the desired position, it is held in place by means of a T-slot and lock-nut on the shank. By removing the angle-iron, the stop rod on the side of the attachment can be placed in the groove of the V-block, adjusted and locked in place to serve as a means of locating successive pieces in the same position for drilling.

STOPS FOR HARDINGE BENCH LATHE TURRET HEAD

The accompanying illustration Fig. 1 shows a new form of independent stops for a bench lathe turret head which has been brought out by Hardinge Bros. Inc., 3133-3141 Lincoln Ave., Chicago, Ill. It will be seen that the turret has a capacity for six tools and that there are six stops—one for each tool. The advantage of such an arrangement will be readily apparent, as the length of the shank of each tool can be made entirely independent of that of the other tools in the turret.

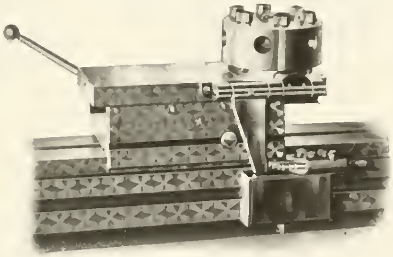


Fig. 1. Independent Stops for Hardinge Bench Lathe Turret Head

In operating a Hardinge bench lathe turret attachment provided with these independent stops, the part which engages with the stops is moved out each time that the turret is indexed for a new operation. In this way, the part is automatically brought into position to engage with the stop corresponding with the tool which is about to begin work.

Fig. 2 shows a No. 4 Hardinge bench lathe which is made with a 9-inch swing and provided with an off-set tailstock.

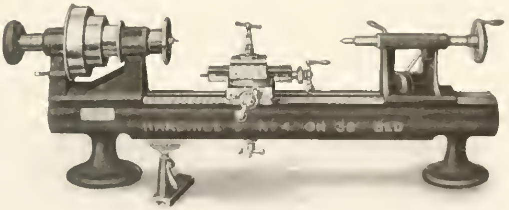


Fig. 2. Hardinge No. 4 Bench Lathe with 9-inch Swing

Hardinge Bros. have recently increased the swing of their Nos. 4 and 5 lathes from 7 to 9 inches to meet the demand for a heavy bench lathe equipment for use in manufacturing plants where work requiring machines of this size is being handled. A new compound slide rest of heavier design has also been brought out for use on these machines.

GRAHAM DRILL SPEEDERS

The Graham Mfg. Co., Providence, R. I., has brought out a new line of drill speeders or high-speed drilling attachments, which are for use on the larger sizes of drill presses where small holes are to be made. The general advantage of these speeders is that they convert a slow-running drill press into one of high speed, thus saving the cost as well as the space required for an extra high-speed machine. A large drill works at a disadvantage in making small holes for oil, dowel pins, etc., unless some speed increasing device of this nature is used. These attachments are intended for use on all drilling machines from the 20-inch size up to the largest radial. Few large machines are speeded sufficiently fast for drills under ⅝ inch, and radials naturally run still more slowly. The idea of trying to run machines of heavy design at the high speeds required is not good practice; the bearings are too large, the gears would make too much noise under such operating conditions, and too much vibration would be set up in the vicinity of the machine.

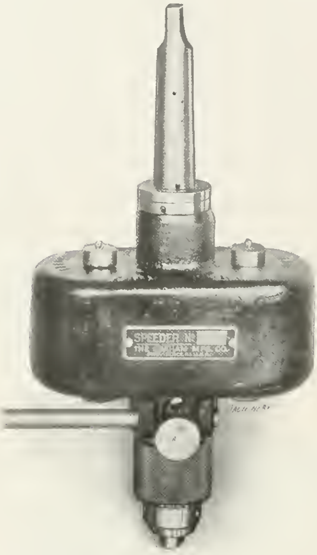


Fig. 1. Most commonly used Form of Graham Drill Speeder

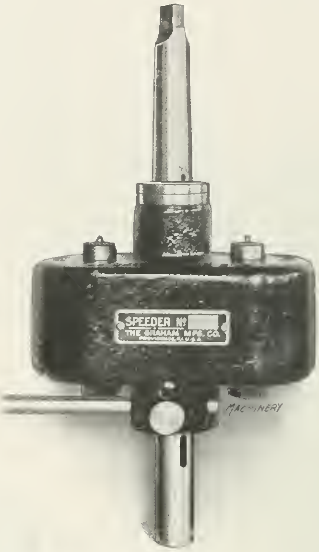


Fig. 2. Graham Drill Speeder designed for Taper Shank Drills

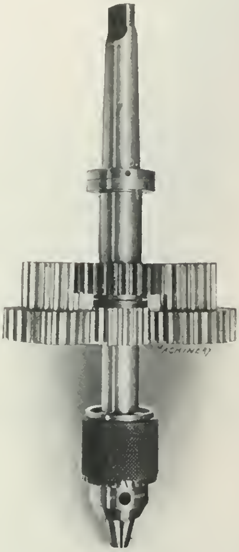


Fig. 3. Mechanism of Drill Speeder shown in Fig. 1

Referring to the illustrations, Fig. 1 shows the type of speeder most commonly used. It is made in three sizes, accommodating drills up to ¾ inch diameter. Fig. 4 shows a cross-sectional view and Fig. 3 the entire moving parts. It will be seen that the shank is of the regular taper type and has a casehardened gear fastened to it. This gear meshes with two pinions mounted on casehardened studs. A pair of gears are fastened to these pinions, which, in turn, mesh with the spindle pinion from opposite sides. The spindle and pinion are machined from a single piece of hardened tool steel. At the bottom, the spindle is fitted to a chuck, or it may be extended downward and a hole made in it to receive a taper shank drill, as shown in Fig. 2. The arrangement of the gearing balances practically all strain in the mechanism and there is no end-thrust transmitted through the case. A ball bearing is placed on a wide shoulder at the bottom of the shank, and the top of the spindle is below the ball bearing, so that there is nothing intervening but the ball bearing between the pressure applied to the shank from above and the pressure delivered to the spindle, chuck and drill below. This arrangement is clearly shown in the sectional view Fig. 4.

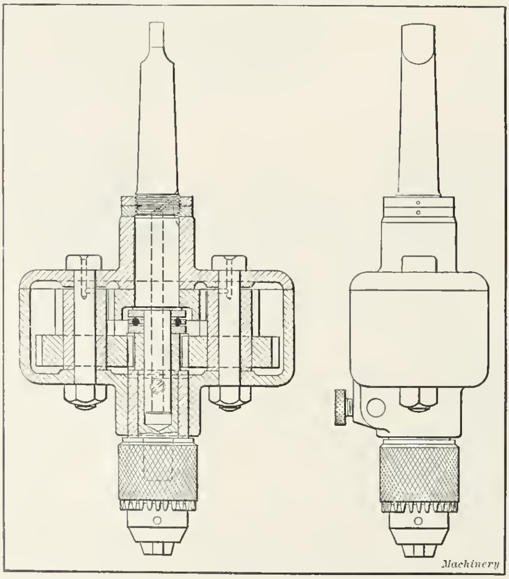


Fig. 4. Cross-sectional View and Outline of Speeder shown in Fig. 1

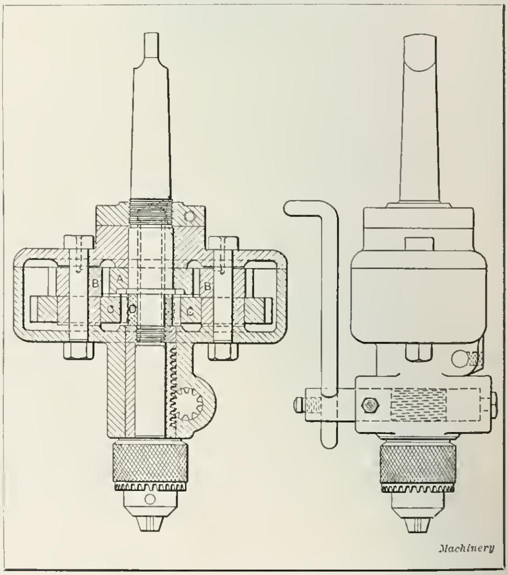


Fig. 5. Cross-sectional View and Outline of Speeder shown in Fig. 6

The matter of having perfect alignment is of great importance. This feature has been provided for by reducing the lower end of the shank and extending it downward until it is almost even with the top of the chuck. This extension, or tail, forms a long bearing inside the spindle. Further support is given to the spindle by a bushing on the outside; this bushing is also made to take up any end wear that may develop. The two studs upon which the intermediate gear clusters are mounted also serve to hold the case together. The case must not revolve, and a bar to keep it from doing so extends to the column of the machine, or some other rigid piece of a similar nature; or the bar may be held by hand.

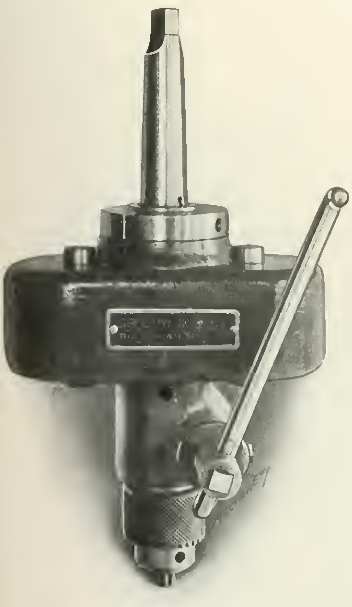


Fig. 6. Graham Drill Speeder provided with Sensitive Feed Mechanism

The device described in the foregoing is simply a speed increaser, and must be fed by the regular feed mechanism of the machine. It is made for hard service in regular manufacturing. Fig. 6 shows another type of speeder with a sensitive feed lever. This means that the main feed mechanism of the machine can be set at any desired point and locked, and that the actual feeding of the drill can be accomplished by a mechanism within the speeder. This style is not intended for heavy, constant or manufacturing service. It should be kept in the tool-room for use on all classes of fine drilling, such as making holes to lines, making templets, jig holes, lay-outs, dies, oil holes, pin holes, etc. The feed mechanism of the main machine is not usually sufficiently sensitive to the touch; hence the necessity of a spring return feed lever on the speeder itself.

In a general way, the driving mechanism is the same as that of the regular type of speeder which has been described. The speed is increased three times, and the gearing is arranged according to the previous description. The spindle is driven by a bronze gear, broached to suit splines on its upper end. It extends upward into the shank for alignment, as well as to provide the necessary length for the required end motion. In order to get vertical traverse, the spindle is mounted on a bronze racked sleeve. Into the rack there meshes a pinion, to which is fastened the return spring and the feed lever. This feature, as well as an entire section and outline is shown in Fig. 5.

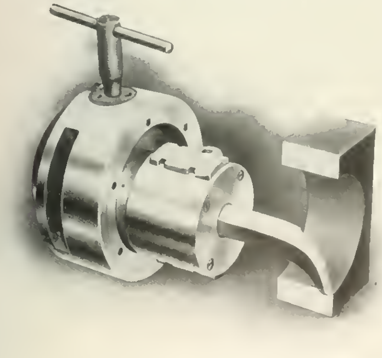


Fig. 1. Marvin & Casler Offset Boring Head

MARVIN & CASLER BORING BAR

In the March, 1909, issue of MACHINERY, the offset boring head made by Marvin & Casler Co., Canastota, N. Y., for use on milling machines, drill presses, boring mills and lathes, was illustrated and described. This company has recently brought out a new boring bar for use in connection with this head, the object being to adapt a milling machine for handling many classes of boring operations on jigs and irregular shaped machine parts which are usually performed on a lathe. The boring head is shown in Fig. 1, and Figs. 2 and 3 show an assembled boring bar and the parts of the bar, respectively.

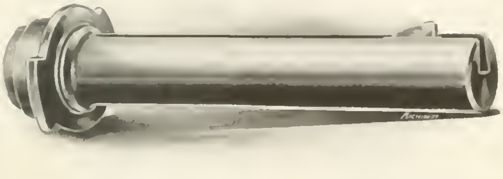


Fig. 2. Boring Bar for the Marvin & Casler Offset Boring Head

The boring head is usually arranged to be screwed onto the threaded nose of the milling machine spindle. Fig. 1 shows the head with the chuck set off center by means of the graduated screw, in order to enable the tool in the chuck to bore a hole of the required size. If desired, the chuck can be brought concentric with the head to enable an ordinary twist drill to be used for starting a hole.

Referring to the parts of the new boring bar which are shown in Fig. 3, it will be seen that *A* represents the bar, *B* the lock-nut for securing the bar in place, *C* the cutter which is made in various lengths to adapt the bar for a variety of classes of work; *D* the key which fits in the keyway in cutter *C*; and *E* a wedge which fits under the cutter. Both the key *D* and the cutter *C* are placed in the dovetail slot in the boring bar and secured in place by driving the wedge *E* under them. By this means, the cutter can be secured at any desired point along the bar. No adjustment of the cutter *C* is necessary as the depth of the cut is controlled by the adjusting screw in the head, which throws the bar the required distance off center. The application of this boring bar to the Marvin & Casler offset head, adapts the equipment for deep hole work.

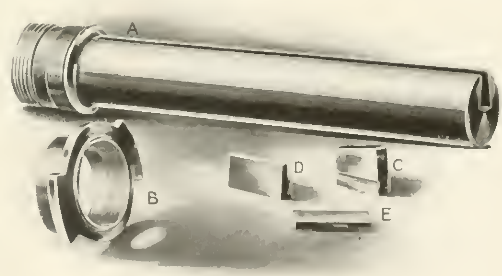


Fig. 3. Parts of the Marvin & Casler Boring Bar

GARVIN NO. 1-S DUPLEX DRILL

The illustrations show a horizontal duplex drill which has been placed on the market by the Garvin Machine Co., Spring and Varick Sts., New York City. The design of the machine has been worked out with the view of eliminating trouble from the chips interfering with the free sliding of the heads on the ways. Another feature of the design consists of the provision which has been made for adjusting each head to provide for the use of a short worn drill in one head and a long new drill in the opposite head. This arrangement affords a number of advantages in operating a machine of this type.

Where work is to be faced to shoulders—working from fixed points—either head can be adjusted with the nicety of snap gage work and as the tool is worn away by grinding, the adjustment allows the head to be reset to maintain the required dimensions.

Fig. 1 shows the machine and Figs. 2 and 3 show details of its construction. The ball handle rotates a nut which is released by an eccentric binder and reclamped after the necessary adjustments have been made. The heads are held to their bearings by taper gibs and are fed forward by a hardened screw which is cut right-hand at one end and left-hand at the other; the drive is effected through intermediate bevel gears from the power feed box. The worm-gear shaft is extended to receive the capstan shown in Fig. 1 and is provided with a handle for quick return. Fig. 2 shows a cross-section through the spindle, which is of special construction. Both front and rear bearings are of the taper type and in adjusting the spindle, the method of procedure is as follows: The nut lock *A* is loosened and the thrust screw *B* is then backed off, the nut *D* at the opposite end of the spindle also being loosened. The nut *E* is then tightened, drawing the front box and the spindle back to the rear bearing. After this has been done, the nut *D* is tightened and the nut *E* released until the spindle rotates freely when turned by the driving pulley. The thrust screw *B* is then screwed up until it just touches; the nut *C* is then jammed and the nut-lock *A* entered into the notched recess in the nut *E*.

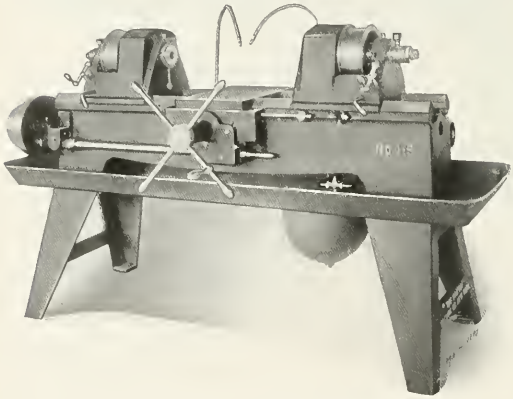


Fig. 1. Garvin No. 1-S Duplex Drill

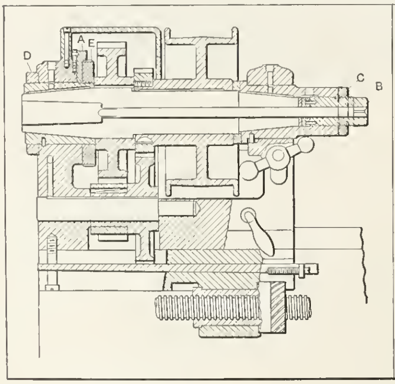


Fig. 2. Section through Spindle of Garvin Duplex Drill

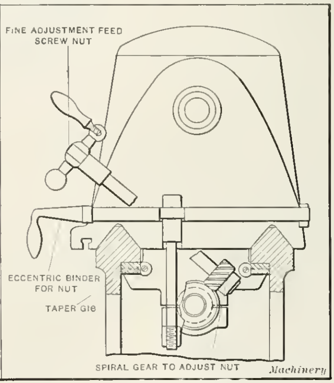


Fig. 3. Spiral Gear Arrangement for adjusting Binder Nut

It will be seen from the illustration that the back-gearing, which has a ratio of 3 to 1, is completely enclosed, thus affording protection for both the operator and the mechanism. The illustrations show a back-geared type of machine, but these machines are also made without back-gearing. The weight of the machine, including the countershaft, is about 2000 pounds.

WATSON-STILLMAN HYDRAULIC PIT JACK

The Watson-Stillman Co., 192 Fulton St., New York City, has recently made a change in the construction of its hydraulic pit jacks that has greatly improved these tools. The hand-operated pumps have been replaced by pumps driven by air engines that can be attached to any style or size of jack of this company's manufacture. The use of compressed air at about 90 pounds per square inch pressure has become so universal in roundhouses and railroad shops that the air-driven engine adapts itself admirably to modern shop equipment. To make the power connection, it is merely necessary to run a rubber hose or other flexible tubing from the shop air main to the pump engine, just as is done in the case of pneumatic riveters. The operating valves can be placed in any convenient position which will permit the foreman or man in charge to operate the lift in addition to directing the work of his men. The use of this air engine, therefore, eliminates one man—the pump operator—from the crew.

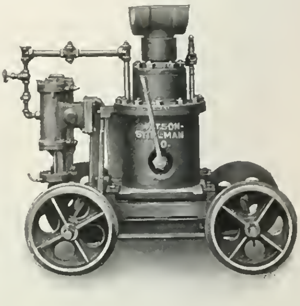


Fig. 1. Watson-Stillman Pit Jack with Ram down

To operate the machine, the straightway valve shown just over the air engine, is opened. This admits air on top of the water in the cistern, thus forcing the water into the ram cylinder and elevating the ram into the working position. The straightway valve is then closed and the globe valve shown at the extreme left is opened; this starts the engine, the function of which is to do the heavy lifting. To lower the ram—either loaded or unloaded—the relief valve shown near the center of the cistern is opened by means of the long lever. The arrangement of the valves is such that they are all within reach of the operator without requiring him to move. This machine is adapted for a track gage of 24 inches. The wheels are 14 inches in diameter and are carried by axles which run in ball bearings to eliminate starting friction. A side adjustment of 6 inches is provided; the distance from the track to the bottom of the cylinder is 1½ inch; and the distance from the pit track to the saddle with the ram down is 3 feet 4 inches. The telescopic ram does away with the necessity of a sub-pit cylinder. This jack has a lifting capacity of 15 tons and

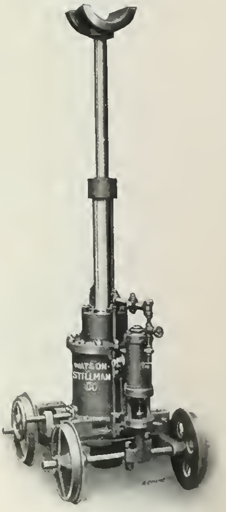


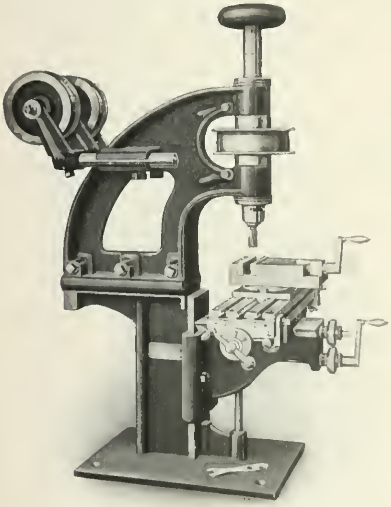
Fig. 2. Watson-Stillman Pit Jack with Ram extended

a total rise of 49½ inches. The telescopic ram is in two lengths of 3 and 4½ inches in diameter, respectively, and since it is equipped with an air power pump, it embodies the latest feature in these tools.

As most railroad men know, pit jacks are used for replacing wheels and axles on cars and locomotives. They are placed on a narrow gage track in a pit below and perpendicular to the main track. The ram rises, catches the axle in a saddle mounted on its end, and lowers it clear of the chassis; then carries it to an out-of-the-way position at one side of the main tracks. This same type of jack is used for removing and replacing heavy motors used on electric railway cars.

HARDINGE VERTICAL BENCH MILLING MACHINE

The bench milling machine illustrated herewith is a recent product of Hardinge Bros., Inc., 3133-3141 Lincoln Ave., Chicago, Ill. It will be seen that this machine is designed along the lines of a regular plain milling machine, the table being raised or lowered through miter gears operated at the end of the knee.



Hardinge Vertical Bench Milling Machine

This machine is adapted for using the Cataract No. 3 draw-in chucks. The advantage of this lies in the fact that a shop using No. 3 bench lathes can use the same chucks in either their lathes or milling machines. The use of draw-in chucks on this machine is particularly convenient in that it enables small cutters with straight shanks to be used. This machine is especially suitable for small die work and similar classes of milling.

ROCHESTER TABLE FOR BORING, MILLING, DRILLING AND TAPPING MACHINES

The universal table illustrated in this connection has been placed on the market by the Rochester Boring Machine Co., Rochester, N. Y., for use on the floor type of boring, milling, drilling and tapping machines of this company's manufacture. This table is universal in operation, having a rotary movement of 360 degrees and a tilting movement of 90 degrees, so that various machining operations may be performed on both the sides and top of the work and at any angle, without requiring re-setting. This results in a material saving of time, as well as in increased accuracy of the product by doing away with the necessity of resetting the work. It is generally easier and quicker to change the cutters or other tools than to reset the work.

The table is of box type construction, braced and cross-ribbed to give the necessary rigidity. It can be traversed to and from the column by a ratchet operating a pinion that engages with a rack in the floor plate. When traversed, the table is guided by a tongue engaging with a groove in the floor plate, thus providing for having the movement of the table parallel to the spindle. The rotary movement is obtained by a worm which runs in an oil bath and engages a worm-wheel of large diameter and coarse pitch. The table is elevated by a worm engaging with a worm-wheel connected to the pinion which is cut from the same piece as the shaft; this pinion meshes with the elevating gear.

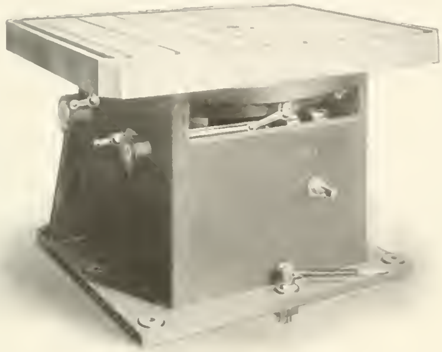


Fig. 1. Rochester Universal Table for Floor Type Boring, Drilling, Tapping and Milling Machine

Graduations are provided reading in degrees, and with the micrometer dial, readings can be obtained to 1/12 degree. The dials are also arranged with adjustable zero indicators. One turn of the crank rotates the table through 10 degrees, and the table is elevated through one degree for one turn of the elevating crank. A hole 4½ inches in diameter—containing a bushing—is provided at the center of the table to allow boring bars to be passed through. A locking device is furnished for clamping the bushing. This table can be quickly clamped in any position—either tilting or rotating, and at any angle.

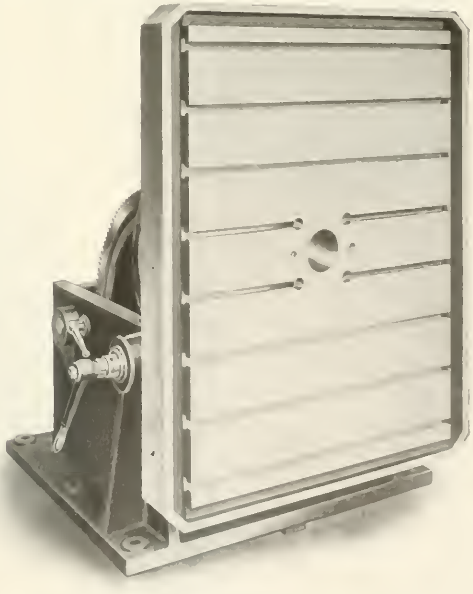


Fig. 2. Rochester Universal Table tilted to an Angle of nearly 90 Degrees

LANGELIER HOT SWAGING MACHINE WITH HEATING FURNACE

The swaging machine provided with a special holder and furnace shown in Figs. 1 and 2 was designed and built by the Langelier Mfg. Co., Providence, R. I., for swaging spinning spindles, straight and taper shank twist drill blanks, taper reamers, end mills, live axles for autos, round file blanks and many similar pieces that are customarily turned on screw machines or forged and ground. A large saving of stock can be effected by this method over other processes where metal is removed in reducing the profile of the piece, as there is absolutely no cutting away of the metal in swaging. In making high-speed steel drills and end mills, the saving of expense is considerable. In addition to this saving and the improvement which takes place in the stock as it is compressed, the machine swages the blanks so close to size that in most cases only a few thousandths have to be ground off to finish the piece completely.

The service required of this machine is particularly severe because the stock is fed into it at a forging heat, and to handle the work with ample reserve of power, the entire unit has been ruggedly constructed. The unit consists of an exceptionally heavy swager, a rack and pinion driven feed mechanism with pneumatic chucks, and a continuous rotary gas heating furnace. The swager head is cored out around the circumference and at the back to provide a chamber with wide ports through which a constant flow of cold water—either from city pressure or from a small pump—is maintained while the machine is running to prevent it from heating up. This construction enables the machine to be kept in continuous operation on hot stock, avoiding the necessity of shut-downs to cool it off. Simple means of controlling the inflow of water and the drainage of the head chamber are provided.

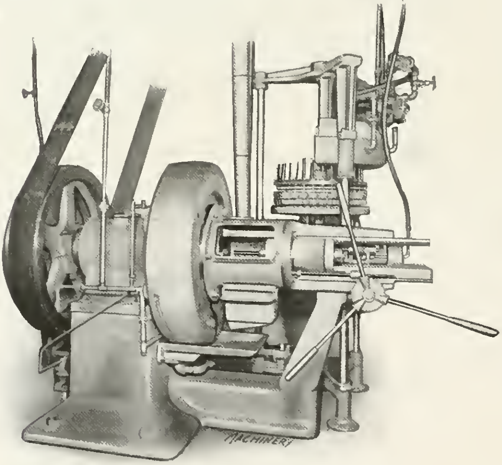


Fig. 1. Front View of Langelier Hot Swaging Machine

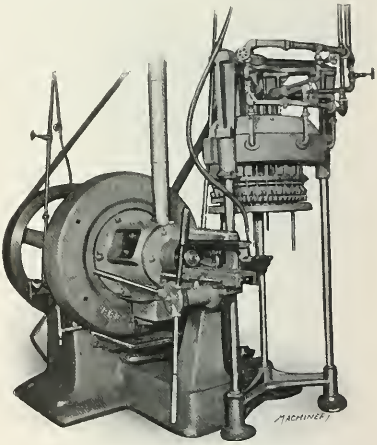


Fig. 2. Side View of Swaging Machine showing the Heating Furnace

The vital element of the machine—the spindle—is made of hammered steel, turned and ground to size, bored throughout its length and slotted diametrically across the enlarged head end. A circular steel ring, tongued and screwed into the spindle greatly strengthens this open end. All sides of the slot are lined with hardened steel plates that are riveted to the spindle. This construction practically encloses the dies and hammer-blocks in a hardened steel box and insures long life for the surfaces in contact. Surrounding the head of the spindle is a circular cage containing ten hardened steel rolls, the rolls being located equidistant from each other and kept in their relative positions by the cage lands. The cage is fitted freely into a heavy hardened steel ring that is accurately ground and forced into the head under heavy pressure. As a further precaution to prevent this ring from working loose from the continual hammering it receives, four cap-screws with washers bind it firmly to its seat. The cage is reinforced on both ends by circular steel plates, and is of as light design as is consistent with strength. To control the opening of the dies, two conical pointed screws are screwed into the front plate on the slotted end of the spindle and project into a corresponding hole in the end of the hammer-blocks just the amount necessary to give the required die opening. Washers of the required thickness are used under the heads of these screws to regulate the distance the conical points of the screws enter the hammer-blocks.

The spindle runs in loose, cast-iron bushings which creep slowly around with it, giving about 50 per cent more bearing surface. This makes it possible and inexpensive to replace the bushings when they are worn out, without requiring the entire head of the machine to be sent to the factory, as would be the case with stationary bushings or if the spindle revolved directly in the bearing in the machine head. The full power of the heavy flywheel is exerted on the dies and work through the spindle, which explains the ease and rapidity with which the machine produces considerable reductions and brings the work accurately to size. The circular opening through the spindle back of the dies permits pieces with a long parallel portion to pass beyond the dies, and serves as a duct to admit a blast of compressed air on the dies to keep them running cool. This arrangement also makes it possible to blow the scale out of the dies into a collecting receptacle, especially provided in the holder. A special connection is provided at the extreme end of the spindle for leading the air blast into the spindle.

The flywheel is 38 inches in diameter, with a rim 7½ inches thick, and carries a 7-inch belt. The hub of the wheel is split, and is clamped to the spindle with two ⅞-inch bolts; it is also keyed to the spindle. This arrangement has been found very effective in preventing the wheel from working loose. A clamping nut is provided on the rear of the spindle, that serves both as a means of taking up end play in the spindle and holding the flywheel in position. A large oil reservoir, immediately back of the machine, serves to collect the oil which is maintained in circulation through the automatic oil feed pump driven from the main spindle of the machine; the oil cools somewhat before being repumped to the working parts of the machine.

The holder is a one-piece steel casting of tubular design, bored out through its entire length to provide practically a perfect bearing for the holder piston. This piston, which carries the chucks for gripping the work, feeds the work into the dies and withdraws it through a steel pinion which meshes with a rack underneath the piston slide, the movement being operated by the capstan wheel shown in the illustrations. The piston and rack have stub form teeth to obtain the greatest possible strength and to resist the sudden shocks which attend swaging. The chucks are of the self-centering. spring type;

they are interchangeable, and are tightened and released by compressed air. When the holder piston reaches its rearmost position, it automatically shuts off the air pressure, thus opening the jaws of the chuck so that the blank to be swaged may be readily inserted or the swaged piece withdrawn from the chuck. As it leaves this position for the feeding stroke, the air valve opens, letting the full air pressure bind the chuck on the work. This form of chuck is very rapid in operation and requires almost no attention at all from the operator. A "mouth" is cast in the side of the holder to provide ready access to the chucks. This facilitates the insertion of blanks and the removal of swaged pieces, as well as allowing access to the dies of the machine for changing them.

The exact distance that the swaging takes place upon the stock may be easily adjusted to suit conditions. No further attention is then required from the operator until this setting is again changed. The fumes emitted by the burning of some of the lubricating oil which flows into the dies, are prevented from escaping into the room where the machine is installed by a small fume exhauster which is fastened to the ceiling. This exhauster carries the fumes outside the building. The holder is a vital part of the machine, and it has been designed with exceptional strength to absorb the recoil of the pieces from the dies as well as to make the machine easily operated by unskilled help. As a part of the unit, a continuous rotary gas heating furnace has been designed for heating the blanks to the proper temperature required for the stock that is being swaged.

Several changes of heating and feeding speeds are provided through crown gears, which permit of accelerating or retarding the speed in accordance with variations in the diameter and character of the stock, and the length to which it is to be heated, thus avoiding all loss of time between swaging passes. The furnace is made in two types, one for heating carbon steel and the other with more burners and with many modifications for heating high-speed steel. The proper temperature can be closely gaged by regulating the air and gas supply through suitable valves. About half of the dial may serve as loading stations while on the other half the pieces are being subjected to the heating blasts from the burners. Special fire-brick forms are used which almost entirely enclose the blanks, preventing any waste of heat. The exact length and time of heating may be closely gaged, and pieces of different lengths may be heated in the same furnaces by a suitable elevating and lowering dial on which the pieces rest. The dial is kept in motion through pulleys at the base of the furnace, belted from the main countershaft overhead. The machine weighs approximately 11,000 pounds including the holder, and the flywheel runs at from 250 to 280 R.P.M. The floor space occupied is 8 feet by 5 feet.

NEWTON MULTIPLE-SPINDLE MILLING MACHINE

A motor-driven four-spindle milling machine which has been added to the line of the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., is illustrated in Figs. 1, 2 and 3. This machine is equipped with two motors. The motor mounted on the floor drives the two side heads—each of which is independently clutched—and also controls the fast power traverse, the feed of the table, and the cross feed of the vertical spindles on the rail. The drive for the vertical spindles is provided by the motor which will be seen mounted on the rail. This arrangement permits of a wide speed variation for the vertical spindles without introducing mechanical complications. Each of the heads is of the same dimensions and design.

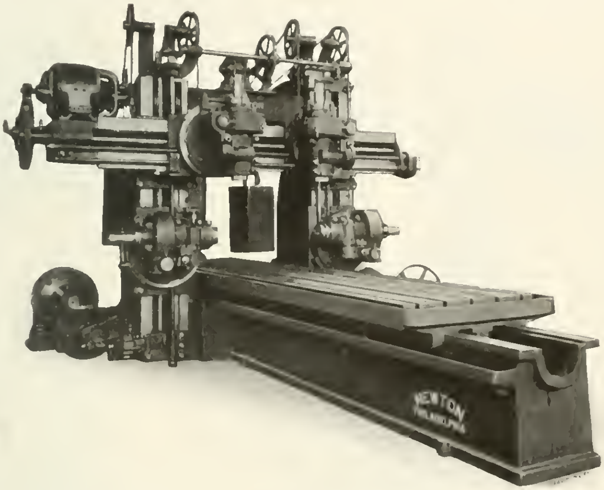


Fig. 1. Left-hand Side of Newton Multiple Spindle Milling Machine showing Motor Drive

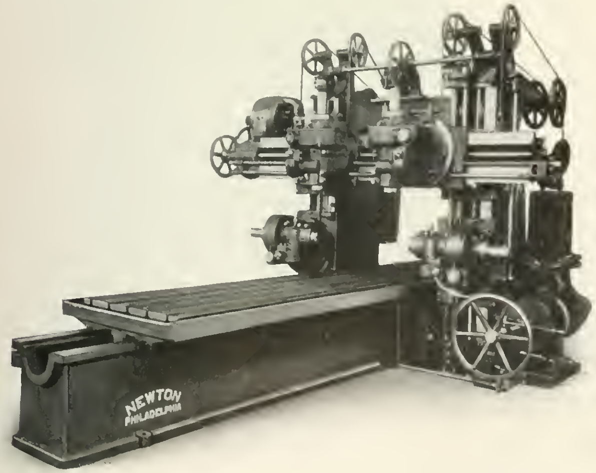


Fig. 2. Right-hand Side of Newton Multiple Spindle Milling Machine

The drive is taken from vertical spline shafts through bevel and spur gears which transmit the power to a steel worm which engages with a bronze worm-wheel. The worm and worm-wheel are both encased and kept flooded with oil. The diameter of the spindle is 4 inches and there is a straight and taper bronze bushed bearing in the sleeve, the largest diameter of which is $6\frac{1}{2}$ inches. The spindles are arranged to drive the cutters by means of a broad faced slot, and the cutters are held in place by means of a retaining bolt. Adjusting screws provide for adjusting the spindle sleeves and each of the spindles may be swiveled through 45 degrees by means of a worm and worm-wheel arrangement which is clearly shown in the illustrations. In the end view, Fig. 3, the spindles are shown set at an angle.

The motor equipment of this milling machine is best shown in Fig. 1. It has already been stated that the motor mounted on the floor is used to drive the side heads and to provide for the feed of the table and the traverse of the vertical heads. Power is transmitted to both of the side heads by a single horizontal shaft, and the drive for each of the side heads is clutched by means of the hand levers shown near the floor at each side of the machine. Each side head is counterweighted and provided with means for vertical elevation by hand; the left-hand head may be attached to the finished base of the cross-rail, as shown in Fig. 1, to provide for power elevation. The right-hand head has a fast reversing power elevation and the work table is provided with nine changes of geared feed with reversing fast power traverse and hand adjustment. The cross-rail is independently counterweighted and is provided with power elevation through the motor on the rail, which was previously referred to. Each of the vertical heads is provided with hand adjustment in addition to the reversing feed and fast power traverse across the rail. The motion is transmitted through the gear-box mechanism that controls the table movement.

The principal dimensions of the machine are as follows: Size of working surface of table, 16 feet long by 42 inches wide; minimum distance between ends of horizontal spindles, 16 inches; maximum distance between ends of horizontal spindles, 48 inches; and maximum height from table to under side of vertical spindles, 36 inches.

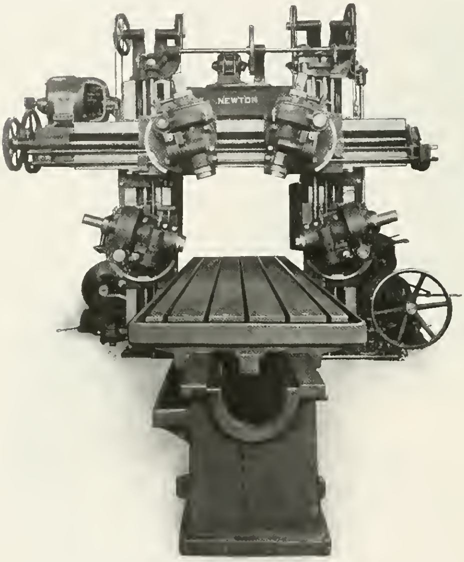
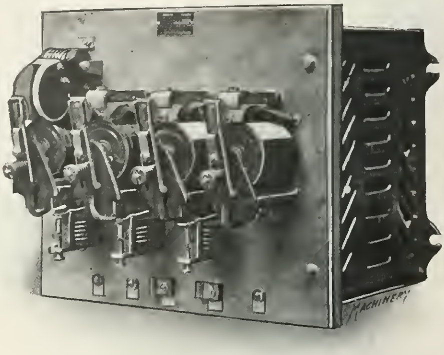


Fig. 3. End View of Newton Milling Machine with Heads set at an Angle

CUTLER-HAMMER MOTOR CONTROLLER

The present-day tendency in manufacturing is to offer the workman every opportunity to specialize in the work for which he has been trained. With this object in view, the design of manufacturing equipment is being worked out with a view of relieving the workman as far as possible from routine duties, so that he may concentrate upon work which requires the attention of the skilled mechanic. This means a high-grade product and increased production. Among such devices for relieving the workman of responsibility, automatic control of motor-driven machine tools is an important item, and the accompanying illustration shows a new type of automatic series-relay motor controller for motor-driven machine tools, which has been placed upon the market by the Cutler-Hammer Mfg. Co., Milwaukee, Wis. With a machine equipped with one of these controllers, all that the workman is required to do is to throw in the switch—regardless of whether the load is light or heavy, at the time of starting—and the motor will be automatically brought to the required operating speed without an undesirable inrush of current or other trouble. Proper acceleration is assured, time is saved and damage to the motor or machine, due to possible carelessness on the part of the operator, is avoided.

With this class of controller, the resistance is cut out of the circuit, and the motor accelerated automatically. The magnetic switches close in succession, the speed of closing successive switches depending upon the motor current which acts through the relays to close the switches or hold them open. These relays are positive in action and respond to the variations in motor load, so that when the motor is started under light load, it is accelerated more quickly than if it is heavily loaded. In the latter case, the switches are not closed so quickly as a result of which, the resistance is left in the main circuit for a longer time and prevents the current from exceeding a predetermined maximum value. A smaller controller of this type is made in capacities up to 15 horsepower for use on 110, 220 and 500 volt circuits. Another type of heavy main-line magnetic switch is made in larger capacities. With this form of motor control, the automatic controller can be placed out of reach, which is desirable in some cases.



Cutler-Hammer Automatic Controller for Motor-driven Machine Tools

DAVIS-BOURNONVILLE MECHANICALLY-GUIDED METAL-CUTTING TORCHES

A recent addition to the line of apparatus developed by the Davis-Bournonville Co., 30 Church St., New York City, for mechanically guiding cutting apparatus, is shown in Figs. 1 and 2 of the accompanying illustrations. This new machine is known as the "radiagraph." It is a motor-driven device especially adapted to straight or circular cutting. The construction is very simple, the principal parts of the machine being a three-wheeled carriage for supporting the cutting torch, which is propelled along the surface of the work at the most efficient rate of speed by a small motor.

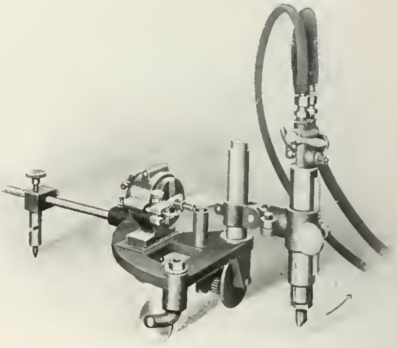


Fig. 1. Davis-Bournonville Radiagraph for Straight or Circular Cutting

As will be seen by referring to Fig. 1, this motor connects with a vertical shaft through worm-gearing. At the lower end of this vertical shaft, there is a second set of worm-gearing which transmits motion to a horizontal shaft, which, in turn, drives the front tractor wheels through spur gearing. When it is desired to cut a circular opening, the conical center seen to the left is turned down into engagement with the surface of the work, which lifts the carriage slightly so that the weight is supported by the two outer wheels. The motor is started and the carriage then moves in a circle about the central pivot, and an opening is cut by the torch, the diameter of which depends, of course, upon the distance from the torch tip to the central pivot. The machine has a capacity for holes six inches in diameter and upwards. The driving motor is equipped with a small friction brake for regulating the speed in accordance with the thickness of the metal being cut. The rate of speed is shown by an indicator, not in place in this particular view.

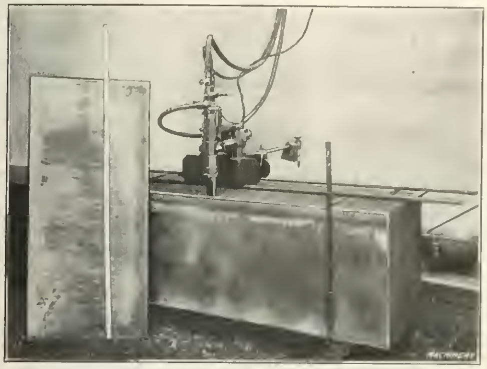


Fig. 2. Application of Radiagraph for cutting 16-inch Armor Plate

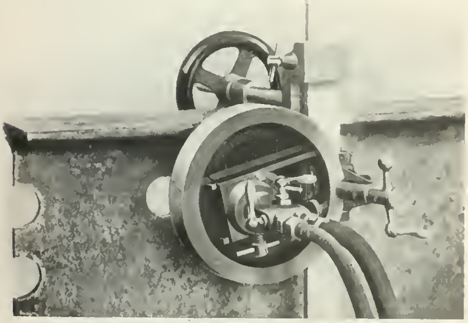


Fig. 3. The Holograph for cutting Holes in Webs of Rails or Structural Parts

Fig. 2 shows the application of the radiagraph to straight cutting, the work in this instance being a piece of armor plate 16 inches thick. The machine is caused to move in a straight line by mounting it upon parallel tracks having V-shaped grooves for the wheels. This track is notched at the ends so that two sections can be joined readily. For ordinary work one section is sufficient, but when taking long cuts, two sections are employed, thus making it possible to prolong the cut indefinitely by placing the rear section to the front as soon as the machine has passed it. The rate of traverse for cutting 16-inch armor plate is about four inches per minute and, as the illustration shows, the kerf left by the flame is remarkably smooth, considering the depth of the cut. For this particular work, the oxygen pressure was 125 pounds per square inch. In case it is not convenient to connect the motor with a lighting circuit, small batteries can be used, so that the machine is adapted for yard use as well as in the factory.

Another recent development of the Davis-Bournonville Co. is shown in Fig. 3. This machine is known as a holograph and it was designed for cutting holes in the webs of rails or in structural material not more than ¾ inch thick. This machine has a circular member for holding the torch, which is rotated through bevel gearing by the handle seen to the right, thus causing the torch tip to move in a circle. The web of a rail can be pierced without any previous drilling and the machine will cut smooth round holes varying from ½ to 2 inches in diameter, in from 30 to 60 seconds. The diameter of the hole cut, is varied by simply shifting the torch holder to or from the center of the rotating disk. The torch rotating mechanism is held in position by a vertical bar which, in turn, is clamped to the rail by the screw or handle shown. The holograph is especially adapted for railroad work and for enlarging or cutting holes in structural steel.

BIGNALL & KEELER PIPE THREAD GAGE

A detailed drawing showing the parts of a new pipe thread length gage which has been brought out by the Bignall & Keeler Mfg. Co., Edwardsville, Ill., is shown in Fig. 2. Fig. 1 shows one of the machines of this company's manufacture equipped with this type of thread gage. Referring to the details of the gage shown in Fig. 2, *A* is a scale which is bolted to the carriage of the pipe threading machine. It will be seen that this scale has a slot which is covered by the plate *B*. The pointer *C* is carried by the member *D* which is clamped to the rod *E*. This rod *E* is secured to the machine by means of two brackets, *F*.

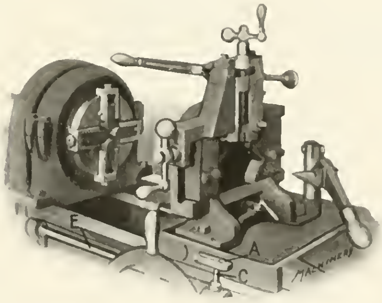


Fig. 1. Bignall & Keeler Pipe Threading Machine equipped with Length Gage

When the carriage is moved, the indicating finger remains stationary until it comes into contact with the end of the slot in the scale member *A*. In operating a machine equipped with this gage, the carriage is run forward until the dies touch the end of the pipe; the indicating finger is then pushed along the rod *E* until it comes up against the forward end of the scale. This brings the indicator opposite the zero mark. The indicating finger then remains stationary while the carriage and scale travel past it. When the desired length of thread has been cut, as indicated by the position of the pointer

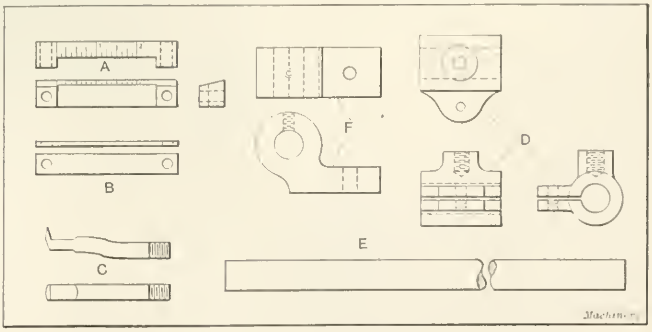


Fig. 2. Details of Bignall & Keeler Pipe Thread Length Gage

over the scale, the machine is stopped. The scale is graduated in eighths of an inch and its face is set at an angle of 15 degrees with the horizontal, to make it easily read. All of the "P. D. Q. C." and "Peerless" 2 and 3 inch pipe threading machines of this company's manufacture are now being equipped with gages of this kind.

NIAGARA DOUBLE-SEAMING MACHINE

A double-seaming machine for use in the manufacture of cylindrical metal packages, which has been placed upon the market by the Niagara Machine & Tool Works, Buffalo, N. Y., is illustrated in Fig. 1. This machine is designed for comparatively large sized work, such as oil and asphalt barrels, garbage cans, ash cans, etc. It will handle work up to 26 inches in diameter by 36 inches in height, in material up to No. 24 gage soft steel. The machine will double-seam two ends of a drum or barrel at the same time, or double-seam one end and lay over the other edge of the body simultaneously, as shown in positions *B* and *C*, of Fig. 2. The heads and body of the work must be previously prepared, as shown at *A*, in this diagram.

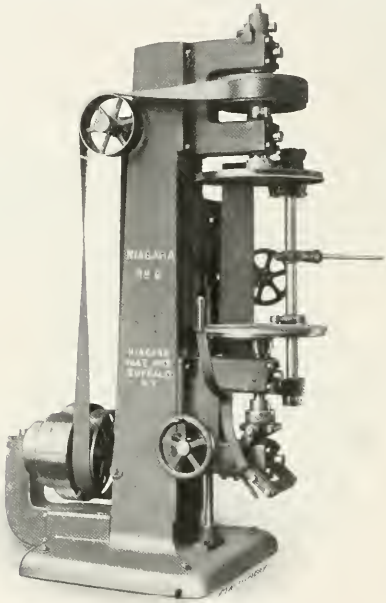


Fig. 1. Niagara Double-seaming Machine

The frame of this machine is of box-section. The upper spindle is mounted in stationary bearings, while the lower spindle is adjustable vertically by means of a screw and hand-wheel. This enables the machine to be regulated to adapt it for different heights of work. The vertical chuck spindles are carried in ball-thrust bearings. The barrel to be seamed is clamped between the two chucks by means of a lever on the left-hand side of the machine. The seaming roll levers are mounted on a vertical shaft at the right of the machine and are made adjustable to suit the height of the work. The machine is arranged for three different speeds to permit running faster on small work, and slower on large work. As this machine operates on both ends of the work simultaneously, a greatly increased production is secured.

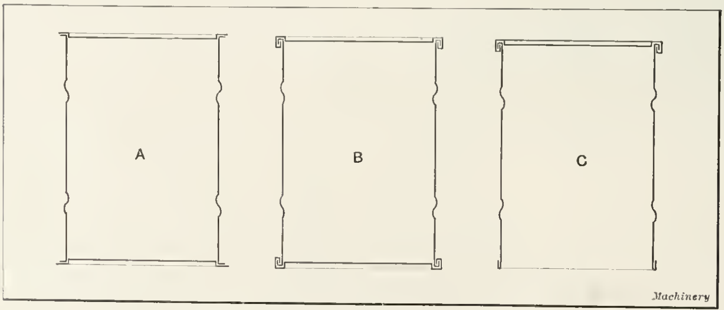


Fig. 2. Diagram illustrating Operations performed on Niagara Double-seaming Machine

STOCKBRIDGE TWENTY-INCH SHAPER

The Stockbridge Machine Co., Worcester, Mass., has brought out a 20-inch cone-drive, back-geared shaper which combines several new features in its design. Most important among these is the arrangement of the cross-feed mechanism. This design has been worked out in such a way that it is impossible for a shiftless mechanic to operate his machine so that it takes the feed against the cut. Fig. 1 shows the new shaper; Fig. 2 gives a cross-sectional view of the cone pulley; and Fig. 3 shows the design of the cross-feed mechanism.

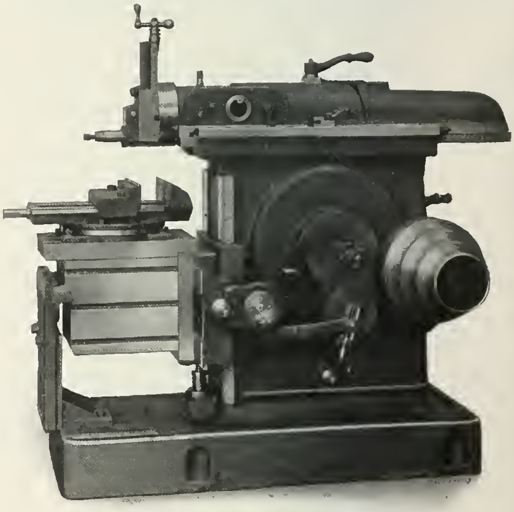


Fig. 1. Stockbridge 20-inch Shaper with Improved Feed Mechanism

Referring to Figs. 1 and 3, the design of the cross-feed mechanism may be briefly described as follows: The two rods which actuate the feed are shown in Fig. 1, where it will be seen that an adjustment is provided for regulating the feed which the machine takes at each stroke, the range being from zero up to ¼ inch. These rods lead over to the feed mechanism, which is clearly shown in Fig. 1, and also in more detail in Fig. 3. The feed rods actuate a feed pawl *A* which engages with ratchet teeth on the inside of gear *B*. The number of teeth which are "picked" at each stroke of the ram is regulated by the adjusting screw, previously referred to. The feed-screw *C* carries a pinion *D* and motion is transmitted to the feed-screw from gear *B*, either directly through gear *E* or indirectly through gears *E* and *F* to gear *D*. The small lever *H* controls the method of driving to give the feed in the required direction. With the lever in the position shown in Fig. 3, it will be seen that the gear *E* is in mesh with gear *D*. If the lever *H* is thrown over to the opposite position, the rocker member *G*, which carries the gears, is lifted in such a way that the gear *E* is thrown out of mesh with gear *D* and drives through the gear *F* which is brought into mesh with gear *D*. With this mechanism it is only possible for the machine to take the cross-feed on the return or idle stroke. If it is desired to feed by hand, the power feed can be disengaged by lifting the pawl *A* into the neutral position, where it does not engage with the teeth of the ratchet wheel.

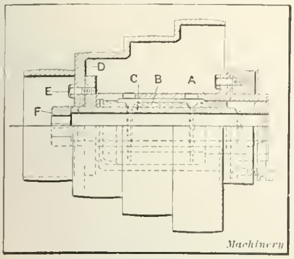


Fig. 2. Cross-sectional View of Cone Pulley of Stockbridge Shaper

Fig. 2 shows a cross-sectional view of the cone pulley on the drive shaft. It will be seen from this illustration that the shaft is supported by a type of cone bearing which relieves it from practically all of the belt pull. The bearings are of the ring oiling type, the construction being clearly shown. Referring to the illustration, the cone bearing *A* is bolted to the column of the machine and the bushing *B* slips into the bearing. The cone hub *C* fits inside the bushing and the cone *D* is bolted to the cone hub by means of four bolts *E*. The two-jaw clutch *F* engages with the clutch on the cone hub, the clutch being keyed to the driving shaft.

The table construction is similar to that of the standard construction which has been adopted by this company. The table is mounted on the knee and overhangs the saddle in such a way that part of the pressure is taken on the saddle. When the machine is to be used for larger work, it is also possible to supply larger tables. The crank motion is of the familiar two-piece crank type used by the Stockbridge Machine Co., and the main bearing is ring-oiled.

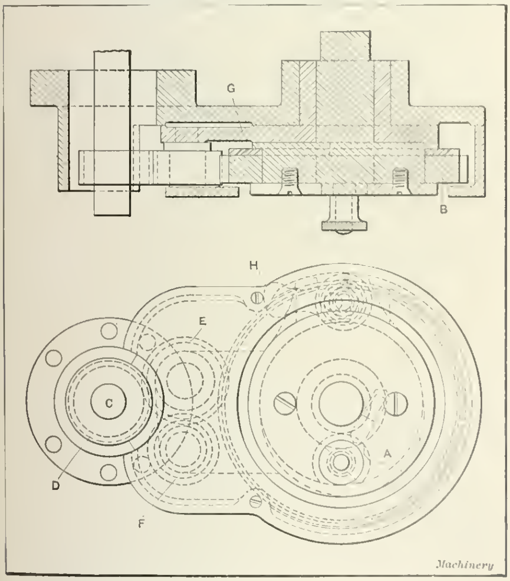


Fig. 3. Detail of Feed Mechanism of Stockbridge Shaper

DODGE CAPILLARY BEARING

A form of self-oiling bearing in which the oil is lifted from the reservoir by capillary attraction has been placed upon the market by the Dodge Mfg. Co., Mishawaka, Ind. Fig. 1 shows a sectional view of the bearing. Referring to this illustration, it will be seen that there is an opening at the bottom of the bearing, and a wooden block—the lower part of which dips into the oil—is held against the shaft by a spring. A top view of this block is shown at the left-hand side of Fig. 3. It will be seen from this illustration that a series of slots is sawed in this block, these slots coming to a sharp angle at one end. The tendency of the oil to rise, due to capillary action, is dependent upon the distance between the surfaces. As a result, the oil rises highest in the narrow portion of the slots and comes in contact with the shaft over these points. A constant film of oil is maintained on the shaft in this way, and oil grooves are cut in the sides of the bearing, as shown in Fig. 1, these grooves being kept full of oil which is carried up by the shaft. The right-hand illustration in Fig. 3 shows the way in which the oil is carried up in the narrow ends of the slots in the wooden block, the shaded and dotted sections showing the oil in the narrow ends of the slots at each side of the block.

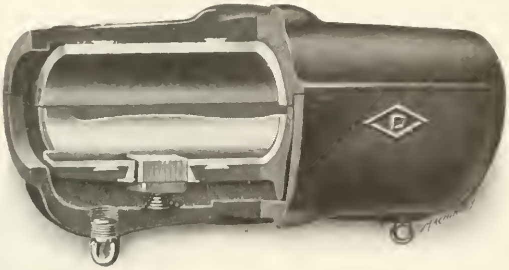


Fig. 1. Sectional View of Dodge Capillary Bearing showing Oil Grooves

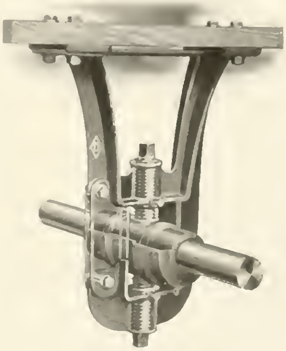


Fig. 2. Dodge Hanger equipped with Capillary Bearing

As there is no mechanical agitation of the oil in the reservoir, any foreign matter which is present in the oil is allowed to settle to the bottom. As a result, only pure oil is admitted to the bearing and there is no trouble due to friction and wear caused by admitting gritty matter into the bearing. The reservoir has a capacity for enough oil to last the bearing for about six months, and with the exception of an inspection at intervals of about three months, the only attention which the bearing requires is to be cleaned and refilled twice a year. Bearings of this type are applied to the various forms of hangers made by the Dodge Mfg. Co. Fig. 2 shows a hanger provided with one of these bearings, and by referring to this illustration it will be seen that the provision of adjusting screws enables the alignment on the shafting to be accurately regulated.

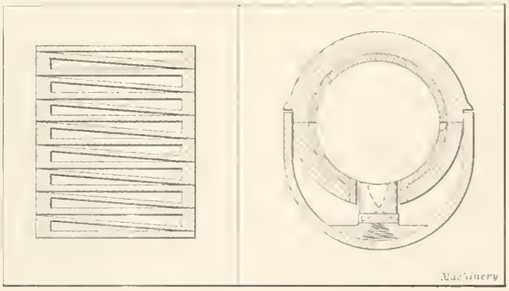


Fig. 3. Top View of Block and Diagram illustrating Rise of the Oil

REED 20-INCH GEARED-HEAD LATHE

The 20-inch geared-head lathe illustrated herewith is a recent product of the Reed-Prentice Co., Worcester, Mass.

This machine is of the heavy-duty type, and is provided with thirteen gears in the headstock which give eighteen changes of spindle speed ranging from 7 to 533 revolutions per minute. All of the speeds are selective, and any speed can be obtained almost instantly, the changes being made while the machine is running. As the gears are always in mesh, it is impossible to damage them in making changes, and a suitable friction clutch is provided, which takes up any shock. The control of the lathe spindle is provided by a lever at the right-hand side of the apron; this lever travels with the apron and is within easy reach of the operator. The spindle reversing mechanism in the head consists of spur gears and a double friction clutch. These gears are not used to drive the lathe, being merely intended for reversing the spindle. The control is very sensitive, enabling the operator to start, stop or reverse the spindle almost instantly. To secure a given spindle speed, it is merely necessary to set a lever opposite the required speed on the index-plate. The changes of feed are also obtained by a simple lever movement. The ease with which these changes are made will insure having the operator run his machine under the most favorable conditions of speed and feed for the work on which it is engaged.

It will be seen that this lathe is equipped with a single-pulley drive, the pulley being of large diameter and wide face, so that ample power is provided to utilize the full capacity of high-speed steel. Ball bearings support the driving pulley, thus saving a considerable amount of power. The pulley runs at 400 revolutions per minute and provides a constant amount of power at the tool for any given spindle speed.

The quick-change gear device provides sixty changes for both the lead-screw and feed-rod. The lead-screw is cut from a special grade of steel, the method being one which provides extreme accuracy. The feed-rod drives the apron mechanism so that the lead-screw can be reserved exclusively for screw cutting. Graduated dials reading in thousandths of an inch are furnished on both the cross-feed and compound-rest screws. The rest has long bearings and is securely gibbed to the bed. The feed reverse lever at the front of the apron operates a double bevel pinion and may be set to feed in either direction, or in the neutral position where the gearing is disengaged. An automatic lockout connected with the reverse lever prevents the half-nuts from engaging with the lead-screw while the feeds are engaged, thus making it impossible to engage the lead-screw and feed-rod at the same time. The headstock and tailstock spindles are made of high-carbon crucible steel forgings and the tailstock is clamped to the bed by four heavy bolts. The spindle bearings are of bronze, securely fastened to the head and provided with efficient oiling facilities. The bed and large gears are made of semi-steel which gives close-grain castings, hard and tough. The lathe can be arranged for motor drive, in which case the motor is mounted on a bracket on the cabinet leg.

NEW MACHINERY AND TOOLS NOTES

Cone Clutch: Sterling Elliott, Newton, Mass. A two-piece clutch intended for application on a variety of classes of machines.

Test Indicator: C. E. Robinson Co., 96 W. River St., Orange, Mass. This tool is equipped with a reversible dial which is graduated on both sides, one side giving readings in inches and the other in millimeters.

Bench Drilling Machine: G. R. Mellon, 14 East 17th St., Kansas City, Mo. A bench drilling machine equipped with a special form of rest which may be rapidly adjusted to accommodate different shapes of work.

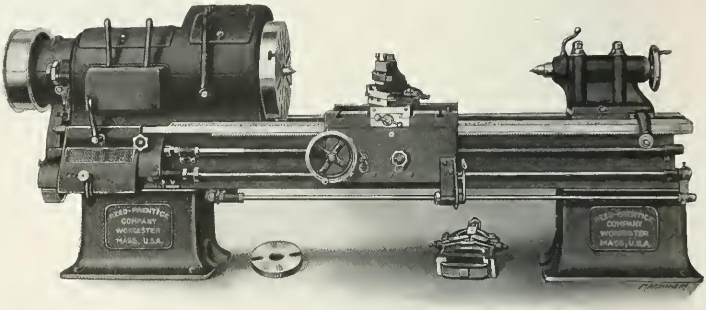
Square and Hexagon Milling Fixtures: Garvin Machine Co., Spring and Varick Sts., New York City. A fixture designed for use on milling machines to meet the requirements of square or hexagon straddle milling.

High-duty Milling Machine: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. A new line of heavy-duty milling machines, equipped with single pulley drive. All changes are made by gearing. These machines are made in both the plain and universal types.

Traveling Crane Trolley: Whiting Foundry Equipment Co., Harvey, Ill. A new design of trolley for an electric traveling crane which has all of the gearing enclosed. The gears are placed inside the main bearings and only two reduction gears are used.

Sharpener for Vixen Files: Vixen Tool Co., 5001 Lancaster Ave., Philadelphia, Pa. A sharpening device which consists of a swivel grinding head carrying a fine grinding wheel of suitable shape and a sliding table on which the file, which is to be sharpened, is held.

Drafting-room Vertical File: Yawman & Erbe Mfg. Co., Rochester, N. Y. A vertical file designed for holding blueprints, drawings, and tracings in the drafting-room. This file keeps the sheets flat, and also enables them to be indexed so that any sheet may be readily located when it is required.


REED-PRENTICE COMPANY WORCESTER MASS. U.S.A.
REED-PRENTICE COMPANY WORCESTER MASS. U.S.A.
MACHINERY

Reed 20-inch, Heavy-duty, Geared-head Lathe

Portable Electric Grinders: The Van Dorn & Dutton Co., Cleveland, Ohio. A new line of electric grinding machines comprising the following types: a bench grinder, toolpost grinder, and an aerial grinder. The last type of tool is made in several styles, one of which is provided with a 12-inch extension.

Five-spindle Drilling Machine: Grant Automatic Machine Co., Detroit, Mich. This machine is provided with five horizontal spindles which are fed to the work by cams, and so timed that they enable one operator to handle all of the spindles. The camshaft is driven by a three-step cone and planetary gears.

Broaching Machine: The Lapointe Machine Tool Co., Hudson, Mass. A direct-connected motor-driven broaching machine with a stroke of 50 inches. The driving screw is 3¾ inches in diameter. The machine is adapted for operating at a rate of 54 inches per minute, and the geared return stroke is made at the rate of 240 inches per minute.

Electric Riveter: Eveland Engineering & Mfg. Co., Philadelphia, Pa. An electric riveting machine in which the rivet or rivet rod is heated by electric current and the head of the rivet shaped and pressed into place by a ram operated by a rack and pinion. The machine is adapted for working with rivets of any metal and of various diameters and lengths.

Large Motor-driven Lathe: Bridgeford Machine Tool Works, Rochester, N. Y. A 48-inch motor-driven lathe for use in the Gary plant of the American Bridge Co. The general design and construction of this machine is the same as the regular machines of this company's manufacture, with the exception of the increased length of the bed which adapts the machine for handling work up to 35 feet in length.

Universal Ball Vise: Adolph Muehlmatt, Cincinnati, Ohio. The "Rex" universal ball vise, as it is known, is mounted on a turntable revolving on a ball bearing. If desired, this bearing may be removed and the turntable locked to the base. The vise may be tilted to any desired angle in the ring pad upon which it rests, and the turntable, with the jaws, may be revolved to bring the work into the most convenient position for the mechanic.

Pipe Threading Machine: Pipe Machinery Co., 4907 Mead Ave., Cleveland, Ohio. A pipe threading machine designed for pipe mill work. One of the features of this machine is the complete enclosure of the gripping mechanism and all gearing. In this way, the machine is protected from damage and the safety of the operator is also provided for. The machine is driven by 3½-horsepower variable-speed motor supported on a bed bolted to the main bed of the machine at the rear.

Drilling and Tapping Machine: Kern Machine Tool Co., Hamilton, Ohio. A combination high-speed, ball-bearing, sensitive drilling and tapping machine adapted for use in factories engaged in the manufacture of such products as meters, cash registers, and other light classes of work. The general construction is the same as that of this company's standard line of ball-bearing machines. The distinctive feature lies in the fact that the right-hand head pulleys are fitted with expanding ring frictions instead of with the positive clutch which is used on the drill for speed changing only.

Improvements on the "Lo-Swing" Lathe: Fitchburg Machine Works, Fitchburg, Mass. The improvements which this company has made on the "Lo-Swing" lathe of its manufacture comprise the following: tool-holders, a taper attachment of new design, a simpler and easier control of the gear-box mechanism, a roller bearing thrust collar on the spindle, swivel drive with a double-tail dog for high-speed work on heavy cuts, and an automatic measuring device which prevents errors being made in the length of stock for depth of centers, thus facilitating the production of duplicate parts.

Float Type Recording Differential Pressure Gage: The Bristol Co., Waterbury, Conn. A description of a new Bristol recording differential pressure gage was published in the April issue of MACHINERY. This company has also brought out a new float type of recording differential gage. This instrument has been developed to meet the requirements of classes of service for which the spring pressure tube type of differential gage is not adapted; *i. e.*, for very low ranges of differential pressure, in air, gases, liquids or steam. The use of this gage provides a continuous record of the rate of flow of the fluid, the differential pressure of which is being measured.

Press for Forming Automobile Side Frames: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine was built for one of the largest manufacturers of automobile parts in France, and is capable of forming side frames of ¼-inch chrome-nickel steel up to 18 feet in length. The moving table is raised by four connecting-rods which are fitted to the crankshaft, the connecting-rods being equally spaced. The machine is twin-driven, that is to say, it is provided with a gear on each end of the crankshaft. These gears are driven through triple reduction gearing, and the driving gear which transmits power to the main gears is placed centrally to overcome all torsional strain on the main backshaft. The control of the machine is effected by a double friction clutch which is operated by hand, thus giving the operator complete control of the moving parts at any point on the upward or downward movement of the press.

* * *

DISKS FOR ACCURATE ANGLE MEASUREMENTS*

BY GUY H. GARDNER†

For setting up a piece of work on which a surface is to be planed or milled at an exact angle to a surface already finished, the sine protractor, as shown in Fig. 1, with the height gage or with standard disks as shown in Fig. 2, furnishes easy and accurate means of adjustment. But many mechanics who occasionally have to do work of this sort lack sine protractors and height gages, and many shops have no sets of standard disks. The object of this article is to suggest a ready means of attaining equal accuracy without these convenient but somewhat costly tools.

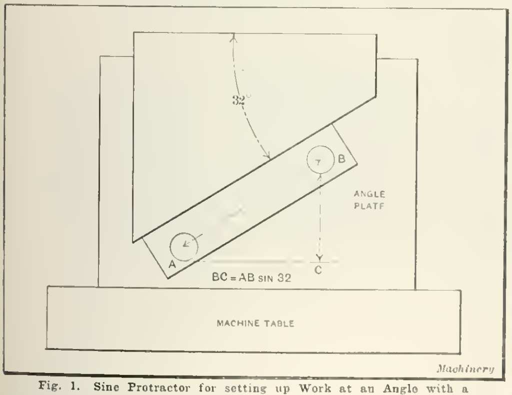


Fig. 1. Sine Protractor for setting up Work at an Angle with a Finished Surface

The one-inch disk, used for setting a two-inch micrometer, is within every mechanic's reach, and by making another disk of suitable size to be used in contact with the one-inch disk any angle up, to say about forty degrees, can be obtained with almost any desired limit of accuracy.

The formulas for disks in contact are:

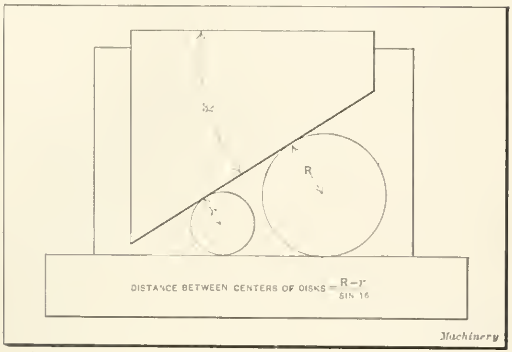


Fig. 2. Method of setting up Work at an Angle with Standard Disks

$$x = \frac{2\,r \sin \beta}{1 - \sin \beta}$$

and

$$x = \frac{2\,R \sin \beta}{1 + \sin \beta}$$

in which R = radius of larger disk.
r = radius of smaller disk.
$x = R - r$
β = one-half the desired angle.

Fig. 3 illustrates the method of use.

The accompanying table gives the sizes of the larger disks to the nearest ten-thousandth inch for whole degrees ranging from five degrees to forty degrees inclusive. For other angles D can be found by simple arithmetical calculation, thus for an angle of 17 degrees, 26 minutes

$$D = 1 + \frac{2 \sin 8 \text{ deg. } 43 \text{ min.}}{1 - \sin 8 \text{ deg. } 43 \text{ min.}} = 1 + \frac{0.3031}{0.84845} = 1.3572 \text{ inch.}$$

DISK DIAMETERS FOR ANGLE MEASUREMENT

Deg.	Inch	Deg.	Inch	Deg.	Inch	Deg.	Inch
5	1.0912	14	1.2775	23	1.4980	32	1.7610
6	1.1104	15	1.3002	24	1.5249	33	1.7934
7	1.1300	16	1.3234	25	1.5524	34	1.8262
8	1.1499	17	1.3468	26	1.5805	35	1.8600
9	1.1702	18	1.3708	27	1.6090	36	1.8944
10	1.1909	19	1.3953	28	1.6382	37	1.9295
11	1.2120	20	1.4203	29	1.6680	38	1.9654
12	1.2334	21	1.4457	30	1.6983	39	2.0021
13	1.2553	22	1.4716	31	1.7294	40	2.0396

Machinery

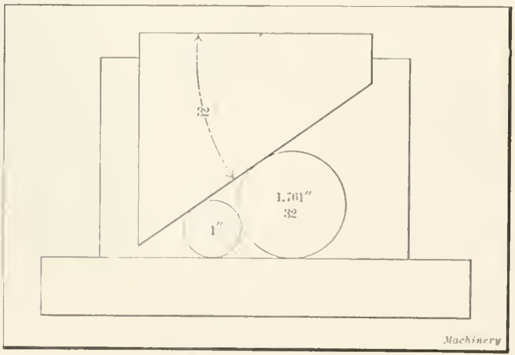


Fig. 3. Diagram showing Method of Angle Measurements with Disks in Contact

The usefulness of these disks can be increased by stamping on each, its diameter and also the angle which it subtends when in contact with the one-inch disk.

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* For previous information on the use of sine bars for angular work, see "Use of Sine Bar for Measuring Angles," January, 1912.
† Address: New London, N. H.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The semi-annual convention of the National Machine Tool Builders' Association was held May 15 and 16 at the Hotel Astor, New York City, Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Co., presiding. The program of the convention included comparatively little of public interest, the work being done chiefly in committees and executive session. C. Wood Walter, of the Cincinnati Milling Machine Co., gave an interesting talk on his efforts in behalf of the present tariff on machine tools at Washington. Two new members were added to the association, *viz.*, the Cincinnati Electrical Tool Co., Cincinnati, Ohio, and Wickes Bros., Saginaw, Mich.

The association's differentiation of machine tool builders into classes, worked out under the direction of Mr. James H. Herron, general manager of the association, is given in the following list of committees. It will be noted that the committee of each main division is designated by a capital letter and the sub-divisions are indicated by lower case letters. Thus, Ba means the horizontal boring machine division of the boring machine committee:

(A) Bolt Threading Machine.
(B) Boring Machine. (a) Horizontal. (b) Vertical.
(C) Drilling Machine. (a) Electrical Portable. (b) Heavy Duty Box Column Type. (c) Radial. (d) Sensitive. (e) Vertical.
(D) Gear Cutting Machine.
(E) Grinding Machine. (a) Cylindrical. (b) Cutter and Tool. (c) Disk. (d) Drill. (e) Floor and Bench. (f) Internal. (g) Surface.
(F) Hammer.
(G) Lathe. (a) Plain. (b) Turret.
(H) Metal Sawing Machine.
(I) Milling Machine.
(J) Miscellaneous.
(K) Planing Machine.
(L) Press.
(M) Punching and Shearing Machine.
(N) Screw Machine. (a) Automatic. (b) Hand.
(O) Shaping Machine.
(P) Slotting Machine.

The matter of establishing a mechanical section was discussed and finally dismissed as being inadvisable. The association was originally organized for commercial purposes, and many of the members were of the opinion that a mechanical section would divert attention from the main object. The thought was expressed that the proper place for the presentation of mechanical papers is before the American Society of Mechanical Engineers, especially as that society has an organized committee on machine shop practice. Some expressions on the advisability of holding spring meetings in the future were voiced. A sentiment prevails that the association could do all the necessary business at the annual fall meetings, and by correspondence.

* * *

High-speed steel drawn accurately to size and coppered to prevent rust is one of the improved steel products that has come into use for tool making within the last few years. It can be ordered in many sizes, and being very close to specified dimensions requires little machining.

MAKING THE MARK COLD-DRAWN STEEL PIPE UNION

The Mark Mfg. Co., of Chicago, Ill., has just placed on the market a cold-drawn steel pipe union which is radically different from any other union heretofore produced. This union, as shown in Fig. 1, is made entirely from cold-drawn steel by a series of punch-press operations, and consists of the usual three main parts—male and female ends joined together by a coupling nut—the two ends being separated by a soft brass ring. These parts are completed, with the exception of threading, in powerful punch presses

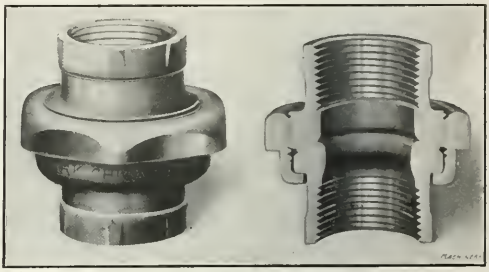

Fig. 1. Exterior and Sectional Views of the Mark Cold-drawn Steel Pipe Union

Fig. 2 illustrates the sequence of operations performed on the male member shown in Fig. 1. The first operation consists in cutting out the blank from ⅛-inch sheet steel; this blank is then drawn cup shaped and the bottom pierced out in the toggle drawing and deep stamping press with double roll-feeding attachment shown in Fig. 3. The appearance of the male part of the union after this operation is shown in Fig. 2. The next operation consists in folding over about one-quarter of the length of this cup, forming it into the shape shown. This is a very difficult operation, and is accomplished in a heavy Toledo punch press, equipped with a double-action toggle motion. The work when being formed into the shape shown is held in the lower die, and is first expanded by a taper-ended punch. Following this punch, and operated by the toggle action of the press is a sleeve which carries down the partially bent mouth of the shell and folds it over the body into the shape shown.

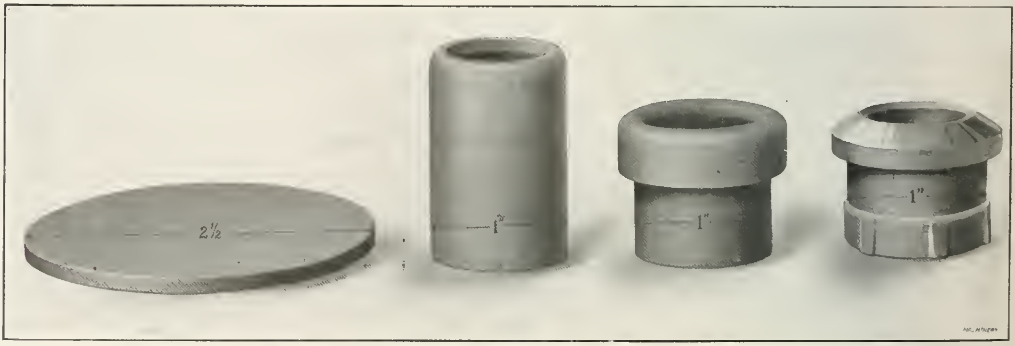

Fig. 2. Sequence of Punch Press Operations in the Formation of the Male Member of the Pipe Union shown in Fig. 1

After folding over the top part of the shell, the next operation consists in forming the top part and embossing the lower end. This operation is accomplished in the special Toledo press, with two auxiliary slides, shown in Fig. 4. The two horizontal side members of this press carry the halves of an opening die in which impressions are made for forming the projections on the lower portion of the male member of the union. The upper part which has been folded over in the previous operation is formed to the desired shape by a suitably shaped die held in the ram of the press. This die, in addition to forming the top of the work, forces the metal down and expands it into the dies held in the side working members of the press.

The other parts of this union are carried through the forming operations in practically the same manner as the male member, and after being completed in the punch press they are taken to a threading machine and threaded. After threading, all the parts of the union pass through what is known as a sherardizing process. This consists in placing the articles to be sherardized in a drum or retort carrying zinc dust. The retort is then rolled into a furnace where the members are brought to the desired temperature. Subjecting the parts to this process causes the zinc to penetrate a short distance into the metal, and also leaves a coating on its outer surface, thus making it rust-proof.

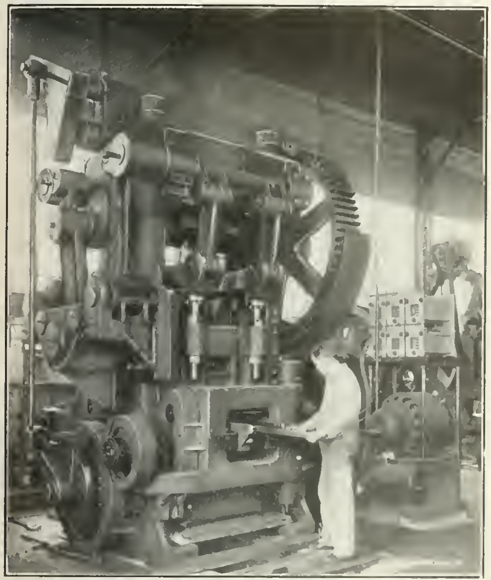
Fig. 3. Punch Press used for First Operation on Pipe Union Parts

There are several superior qualities claimed for this type of seamless cold-drawn pipe union over those made by any other process, particularly casting. In the first place, the cold-drawn seamless union is free from sand holes and other structural defects; and as it is made from steel instead of malleable or cast iron, it is much stronger and hence can be subjected to greater pressures. In testing different makes of unions it was found that no two unions stood an equal pressure before leaking, thus showing a great lack of uniformity. It was also found that this lack of uniformity in most unions was due to the seats being imperfect, caused by shrinkage and flaws in the metal, and to irregularities inherent in the methods of manufacture. This uncertainty is practically eliminated in the Mark type of cold-drawn steel union, as the seat is formed by a very soft brass ring that makes the union leak-proof. As all the parts are passed through a sherardizing process, they are rust-proof. Another advantage obtained by using the Mark union is that it is made from the same material as is used in the manufacture of the pipe, and consequently its coefficient of expansion is the same. This is not the case with unions made from malleable iron or brass. It will therefore be seen that a pipe subjected to different temperatures has no tendency to shrink away from one of these cold-drawn steel unions, and, therefore, obviates the possibility of leakage. The contact surfaces of the members of the union against the brass ring are also considerably harder than the other portions of the body, which, of course, is due to the great pressure to which these parts are subjected when formed in the punch press.

The manufacturing plant in which these unions are produced is a little out of the ordinary, and is worthy of mention. It will be seen in Figs. 3 and 4 that the punch presses shown are equipped with electrical controllers, this being a further development of the electrical method of driving punch presses. The operation of the punch press is controlled entirely by the electrical rheostat, which in Fig. 3 is placed at the side of the press with the motor, and in Fig. 4 at the top of the press. The electric control is operated by the handwheel shown in Fig. 4, and governs the operation of the press, enabling the ram to be stopped at any point of its travel.

* * *

While there is yet much to be done before the aeroplane will become a practical and, generally speaking, useful machine, it must be admitted that it has fully passed its experimental stage, when it has now become possible to cover over five hundred miles in a cross-country flight without a stop. This was accomplished on May 1, by a French aviator, Gilbert, who flew continually for 8½ hours from Paris to Vittoria, Spain, a distance of 513 miles. Another remarkable flight was made by a Frenchman, Guillaux, who on April 27 and 28 covered over one thousand miles in less than 24 hours, descending twice on this trip. Another Frenchman, Daucourt, recently flew from Paris to Berlin, a distance of 555 miles with only two stops, one at Liege and one at Hanover, the actual flying time being less than 9 hours. The 211 miles between Paris and Liege were covered in 2½ hours, or at an average speed of 85 miles per hour.

* * *

Among the interesting collection of fixed ammunition shown by the Union Metallic Cartridge Co. at its Bridgeport factory, are some metallic cartridges of the style used by Chinese Gordon in his defense of Khartum which ended in the annihilation of the British forces in 1885. These cartridge cases were reduced at the mouth to bottle-neck form, but the reducing operation was so poorly done that the metal was crushed into deep folds and wrinkles, the appearance being very crude as compared to the smooth work now done by cartridge makers. The failure of the British cartridge makers to produce smoothly reduced shells is said to have been directly responsible for the disaster to the British forces when the wild fanatical Mahdists charged. Sand from the desert lodged between the rough cartridge cases and the chamber walls of the barrel was so firmly imbedded in the shell and barrel after firing that the soldiers could not extract the empty shells. Hundreds of muskets were found after the battle in a useless condition because of stuck shells in the chambers.

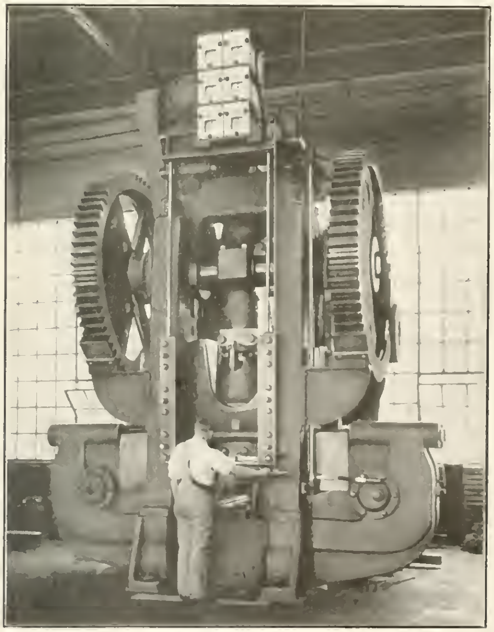
Fig. 4. Large Special Toledo Press used in performing the Final Forming Operations on the Pipe Unions

FIXTURE FOR GRINDING VALVE PUSH-RODS

The grinding of valve push-rods to the proper length is an operation which is not usually handled at a very rapid rate, owing to the accuracy required and also to the fact that they must be ground on both ends. Several methods are employed for this work, one of which is shown in the accompanying illustrations. Fig. 3 shows how this operation is handled in the plant of the Ford Motor Co., Detroit, Mich., where a Blanchard vertical surface grinder, provided with two fixtures *A* and *B*, is used. Each of these fixtures is designed for holding 104 rods (shown in detail in Fig. 1), and both ends of the push-rods are ground without removing the rods from the fixture after they have been clamped in place. The Blanchard vertical surface grinder shown is provided with a magnetic chuck for holding the fixtures carrying the work.

For the first operation, which is shown in Fig. 3, and at *A* in Fig. 2, the tops or largest diameters of the push-rods are ground—about 0.010 inch being removed—and when this operation is being accomplished, a blocking ring of the inverted T-section, as shown at *C* in Fig. 2, is placed under the fixture. This raises the fixture from the magnetic chuck and prevents the push-rods from touching. For the second operation—the grinding of the small end of the rods—the blocking ring *C* is removed and the fixture is located on the table as indicated at *B* in Fig. 2, the previously ground faces of the rods resting on the magnetic chuck. This feature is worth calling attention to, as it enables greater accuracy to be obtained, owing to the fact that the fixture does not intercept the rods and the surface of the magnetic chuck.

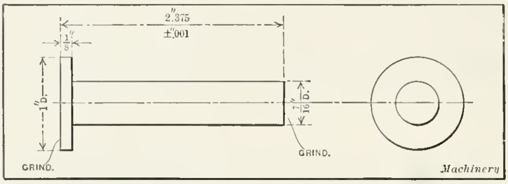

Fig. 1. Valve Push-rod ground to Exact Length in Fixture shown in Figs. 2 and 3

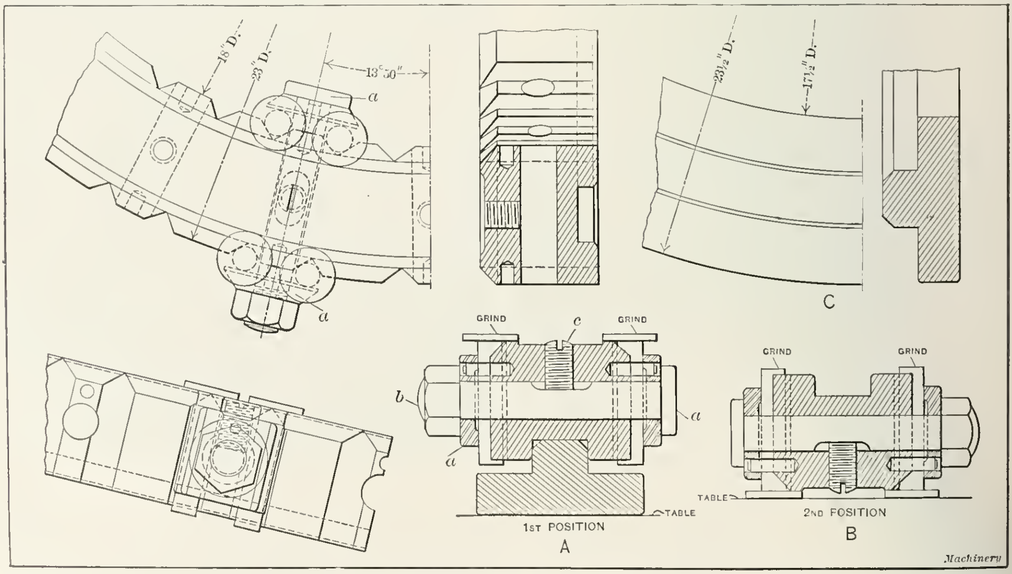

Fig. 2. Details of Fixture used on Blanchard Vertical Surface Grinder for grinding Valve Push-rods

Referring to Fig. 2, where the details of this interesting valve push-rod fixture are shown, it will be seen that the method of clamping is simple and consists of two blocks *a* through which passes a shouldered binding stud *b*. This stud, in connection with the two clamps, holds four push-rods in place. The studs are prevented from turning by headless screws *c* resting on a flat provided on the studs. The rods are held in V-grooves in the body of the fixture and are located when being placed in the fixture by the under surface of the heads which rests on the finished top face of the fixture. Two of these fixtures, as shown in Fig. 3, are provided so that when one is on the machine, the other fixture is being loaded by the operator. This enables the grinding operation to be carried on practically continuously and makes possible the enormous production of 720 rods per hour. The fixture shown in Figs. 2 and 3 was designed and built by the Blanchard Machine Co., Cambridge, Mass.
D. T. H.

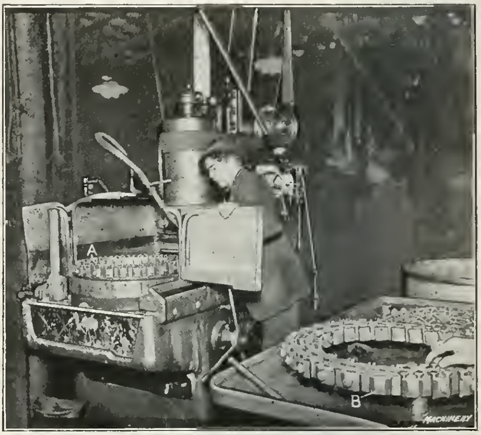

Fig. 3. Grinding Valve Push-rods on a Blanchard Vertical Surface Grinder at the Rate of 720 per Hour

* * *

The New York, New Haven & Hartford Railroad Co. a short time ago offered a prize of $10,000 for an automatic stop device to meet certain requirements laid down by the railroad. In response to this offer, 1574 automatic stop devices were submitted to the company. Of these, two devices have been selected for experiment on the railroad. The engineers of the company have stated that neither of these devices can be considered perfect in themselves, but that they are worthy of trial installation.

SPRING MEETING OF THE A. S. M. E.

The spring meeting of the A. S. M. E., was held in Baltimore, Md., May 20-23, at the Hotel Belvedere. The meeting was in charge of Dr. W. F. M. Goss, president, and Calvin W. Rice, secretary. The technical program comprised the following papers and reports:

Reports of special committees on myriawatt, involute gears and code of ethics.

"Test of a Hydraulic Buffer," by Carl Schwartz.

"The Present Condition of the Patent Law," by Edwin J. Prindle.

"Shading in Mechanical Drawing," by Theodore W. Johnson.

"Cost of Upkeep of Horse-drawn Vehicles against Electric Vehicles," by W. R. Metz.

"Present Operation of Gas Engines using Blast-furnace Gas as Fuel," by Charles C. Sampson.

"The Baltimore High-pressure Fire Service," by James B. Scott.

"National Standard Hose Couplings and Hydrant Fittings for Public Fire Service," by F. M. Griswold.

"Debarment of City Conflagrations," by Albert Blauvelt.

"Allowable Height and Area in Factory Buildings," by Ira H. Woolson.

"The Protection of Main Belt Drives with Fire Retardant Partitions," by C. H. Smith.

"The Life Hazard in Crowded Buildings due to Inadequate Exits," by H. F. J. Porter.

An informal reception was held Tuesday evening by the officers of the Engineers' Club of Baltimore, and on Wednesday afternoon a demonstration of the high-pressure fire system was made on the City Hall plaza. This was followed by an inspection of the pumping station on South St. A trip was made around the harbor on the municipal steamer *F. C. Latrobe*, and Wednesday evening a lecture, illustrated by lantern views entitled "Around the World in Eighty Minutes," was given by the Hon. O. P. Austin, secretary of the National Geographic Society.

On Thursday, the members made an inspection of the Jones' Falls conduits, the sewage pumping plant in Baltimore, and the sewage disposal plant at Back River. In the evening a reception and dance was tendered the members of the society by the Engineers' Club of Baltimore in the ball room of the Hotel Belvedere.

On Friday, an excursion was made to Annapolis, the capital of Maryland, and the U. S. Naval Academy. The party was met at the State House by Governor Goldsborough, who delivered an address of welcome. Flights of the two Wright and three Curtiss hydro-aeroplanes were made, and members of the visiting party were taken up for short flights. At the Naval Experiment Station, investigations were in progress on the corrosion of metals, boiler compounds, lubricants, metals, strength of materials, endurance of metals, etc.

* * *

"FIGURING OUT GEARS FOR SPEED BOXES"

Formula (5) in the article "Figuring Out Gears for Speed Boxes," published in the April number, reads

$$B = \frac{J - C}{\sqrt{\frac{JG}{C}} - 1}$$

The formula should be corrected to read thus:

$$B = \frac{J - C}{\sqrt{\frac{JG}{C} - 1}}$$

* * *

Work has begun on a hydro-electric power plant in Switzerland which will use a water head of 5412 feet. The plant will be located near Martigny in the Canton of Wallis. The pipe line at the lower end must be constructed to withstand a pressure of 2400 pounds per square inch. The length of the line will be 2¾ miles, and its inside diameter will vary from 20 to 24 inches, while the thickness of the walls will vary from ¼ to 1¾ inch. The upper sections of the pipe will be of the lap-welded type, while the pipes at the lower part will be seamless. Each of the turbines used will be 15,000 horsepower capacity.

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A feature of milling machine practice that often receives scant attention is making the mills of a gang as large as possible in order to reduce the disproportion of diameters. When a three-inch mill is working in the same gang with a six-inch mill, the peripheral speed has to be kept within the maximum speed capacity of the six-inch mill, which means that the three-inch mill is running far below its maximum peripheral speed. On the other hand the feed is limited to the capacity of the three-inch mill. Thus one cutter is working at one-half its peripheral cutting speed and the other at one-half its feed capacity. Now, if the diameter of the small mill is made six inches and that of the larger one nine inches the same form will be produced and the production capacity may be increased fully fifty per cent. The force of this is evident. The same condition has been observed in the use of dovetail cutters when the width of the dovetail affords plenty of room for a large diameter cutter. Examples of dovetail cutters have been noted having a small diameter of 1¼ inch and a large diameter of three inches. In this case the loss of efficiency is even greater than in the first mentioned case.

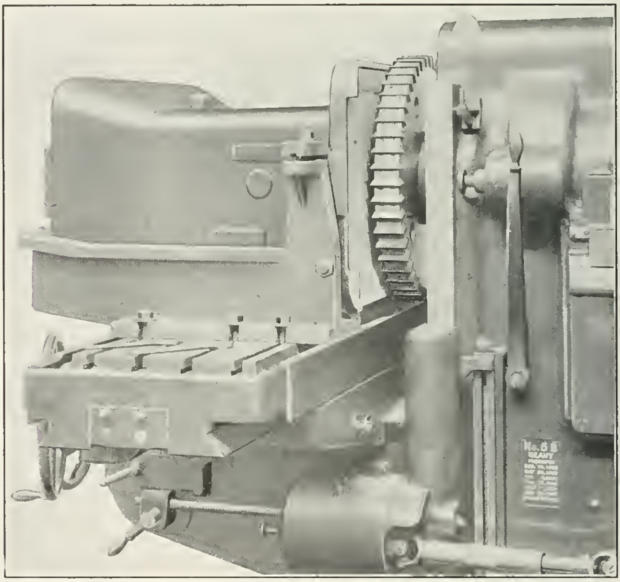
* * *

PERSONALS

F. E. Gardner, vice-president of the Gardner Machine Co., Beloit, Wis., who has been seriously ill, has greatly improved, and will fully recover.

John J. Hannigan has joined the Bath Grinder Co., Fitchburg, Mass., to take charge of the company's advertising, succeeding Mr. S. W. Mathias, resigned.

1000 lbs. on the Table of the No.



Milling Base of Automatic Screw Machine Bed

Casting, as it is fastened on machine, is 25" high and extends 35" out from cutter. Work and fixture combined weigh about 1000 lbs. The B. & S. Inserted Tooth Face Mill is 26" in diameter.

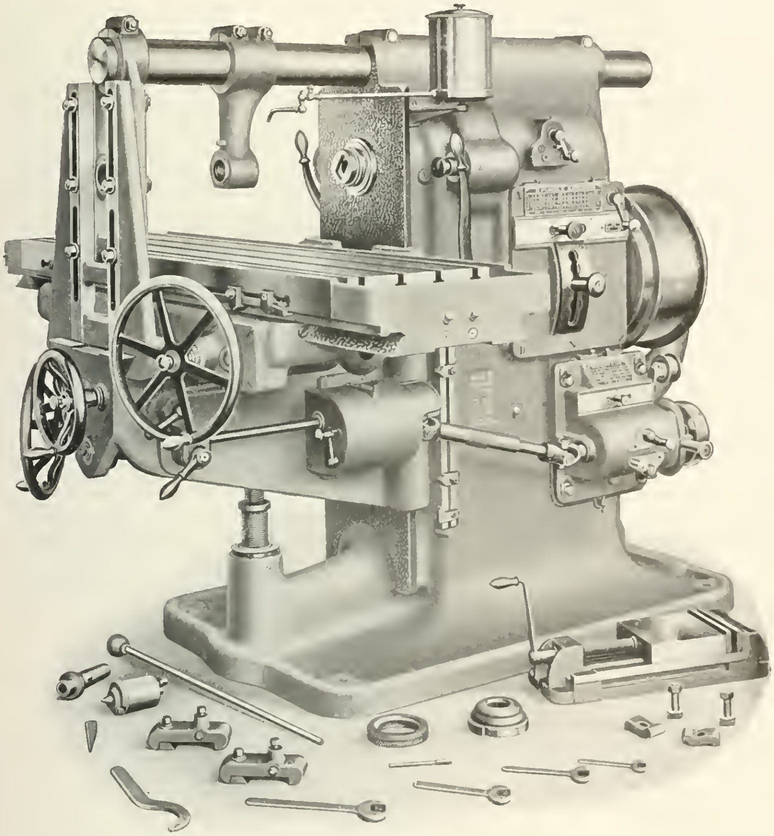
Put Your Big Jobs on this Machine.
It is Built for Heavy Service.

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.: Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco,Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

5 B Heavy Plain Milling Machine



The machine has the requisite power, strength and rigidity to pull deep cuts and support heavy loads.

Capacity 50" x 12" x 21".

Driving pulley 20" diameter, runs 320 R.P.M., 7" belt.

PROVIDENCE, R. I., U. S. A.

Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfurt, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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H. L. Babcock, formerly of the H. H. Franklin Mfg. Co., Syracuse, N. Y., is now representing the E. B. Van Wagner Mfg. Co., of Syracuse, in the Middle West.

R. K. LeBlond, president of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, will sail for Europe June 10, on the *Victoria-Louise*, for a three months' business and pleasure trip.

George C. Bardons, of Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes, sailed for Europe May 10, on the *Friedrich Wilhelm*. Mr. Bardons will spend six weeks in England, Scotland and Wales.

C. C. Gressle has been made superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Gressle has held high positions in the factory organization of the company since its inception, about fifteen years ago.

Dyer Smith, at one time associate editor of MACHINERY, has removed his office from 2 Rector St., New York City, to the Woolworth Building, where he will continue his practice as heretofore in connection with patents, patent cost, trademarks and copyrights.

Frank Horsburgh, president and general manager of the Horsburgh & Scott Co., Cleveland, Ohio, will sail, accompanied by his wife, on the *Saxonia*, June 12, for a three to four months' tour in Europe, landing at Italy, and also visiting France, Germany, Switzerland, Holland, Belgium and England.

Arthur Williams, president of the American Museum of Safety, New York, was decorated May 2 with the Cross of Isabela de Catolica in recognition of his work as a promoter of industrial safety. The presentation of the decoration was made the occasion of a testimonial banquet at Sherry's, New York City.

A. W. Morris, formerly of the Morris Mfg. Co. and the Wetherill Finished Castings Co., has joined the Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y., maker of die-castings, etc., as factory manager. The Wetherill Finished Castings Co. and the Morris Mfg. Co., have discontinued business and dissolved.

G. E. Stoy has resigned his position as general foreman of the Trinity & Brazos Valley shops, at Galveston, Texas, to take charge of the locomotive department of the Vandaveer Clay Products Co., of Houston, Texas. Mr. Stoy will have charge of all installations of this company's patent locomotive firebox liners and oil burners.

William Newell, mechanical engineer of the New York State Department of Labor and author of the specifications on exhaust systems published in the May number, will act in an editorial capacity with *Safety Engineering*, having charge of the accident prevention department. Mr. Newell will be assisted by Mr. David Van Schaack, director of the Bureau of Inspection and Accident Prevention of the Aetna Life Insurance Co.

E. T. Enlow has resigned as manager of the Stark Rolling Mill Co., Canton, Ohio, and become associated with the Pedlar People, Oshawa, Ontario, Canada. Mr. Enlow has been active in the sheet metal trade of the United States for the past twenty years. While with the Stark Rolling Mill Co., he was closely identified with the sale of "Toncan" metal and will continue in that relation with the Pedlar People who are large sheet metal factors in Canada.

H. T. Latto, who has for several years been connected with the sales department of the National-Acme Mfg. Co., Cleveland, Ohio, has been appointed Eastern sales manager of the company to succeed Mr. L. M. Waite. Mr. Latto will have charge of the Eastern office and warehouse at 77 White St., New York City, after the middle of May, and will direct the work of the company's sales organization in Eastern Pennsylvania, Eastern New York, New Jersey, Maryland, Delaware and Virginia.

S. W. Hartley has been appointed sales manager of the Standard Welding Co., Cleveland, Ohio, succeeding J. C. Manternach, who has been promoted to the position of general manager. Mr. Hartley was assistant sales manager of the Standard Welding Co., for over two years. He has been prominently identified with the engineering of the motor car industry in the United States from its beginning. He was formerly with the Peerless Co., of Cleveland, Ohio, the Garford Co., of Elyria, Ohio, and the A. O. Smith Co., of Milwaukee, Wis.

R. S. Bryant has been made consulting engineer of the Standard Welding Co., Cleveland, Ohio. He is the designer of the first quick-detachable rim in America and has been in the employ of the company about two years. He is the originator of the types of rims now being made and sold by the company, and the designer of many other styles that have had notable success. He also built and perfected the first specialized machines for the manufacture of automobile rims. Mr. Bryant was the founder of the Bryant Rim Co., Columbus, Ohio, which was purchased by the Diamond Rubber interests several years ago.

F. N. Gardner

J. C. Manternach, formerly sales manager of the Standard Welding Co., has been appointed general manager of the company, succeeding Tracy W. Guthrie, resigned. Mr. Manternach was appointed sales manager of the Standard Welding Co., by the late W. S. Gorton, and his present advancement is the result of his efficient efforts in behalf of the company. He has been identified with the American steel tube industry practically from its infancy. He began with the Pope Mfg. Co., Hartford, Conn., in 1897 and later was with the Shelby Steel Tube Co., and the National Tube Co. He is widely known among those connected with the bicycle, motorcycle, automobile and steel tube industries.

OBITUARIES

J. L. A. Wheeler, superintendent of the Frick Co., Waynesboro, Pa., died April 19.

James R. Huber, western sales representative of the Lumen Bearing Co., Buffalo, died from pneumonia at his home in Detroit, May 8.

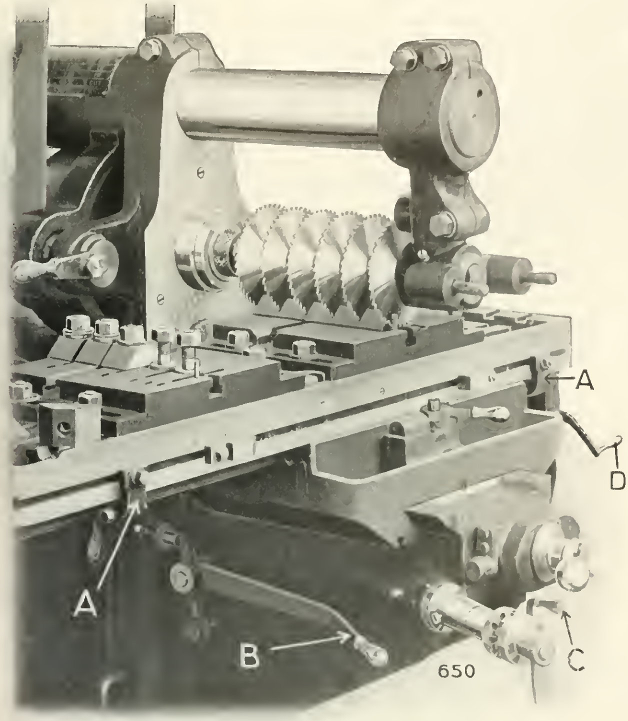
Francis M. Rites, inventor of the inertia governor for steam engines, and a well-known mechanical engineer, was found dead in his home, near Ithaca, N. Y., May 9.

DANIEL SIMONDS

Daniel Simonds, president of the Simonds Mfg. Co., Fitchburg, Mass., died May 4 at his summer home at Larchmont, L. I., at the age of sixty-five years. He was born in Fitchburg, 1847, and attended the public schools and the Comer's Commercial College of Boston. After leaving college, he went to work for his father in West Fitchburg, making scythes and edge-tools. In 1868 the Simonds Mfg. Co. was incorporated. This company took over the business organized by Abel Simonds, Mr. Daniel Simonds' father, and the latter held various positions with the new company until in the early eighties he was made superintendent and vice-president, and in 1888 president of the concern. The business has steadily grown under Mr. Simond's leadership. In 1900, the company built a steel plant and began the manufacture of steel in Chicago. In 1905 the Fitchburg File Works was bought, and in 1906 the firm acquired four plants in Montreal. Mr. Simonds was the moving spirit in the cooperative industrial system of education at the high school, which has widely advertised Fitchburg throughout the country. He was a director of the Fitchburg National Bank and Fitchburg Mutual Fire Insurance Co., and a member of several business associations and clubs. He is survived by a widow and three sons, A. T. Simonds, of Lockport, N. Y., and G. K. Simonds and H. K. Simonds, of Fitchburg, Mass.

F. N. GARDNER

F. N. Gardner, president of the Gardner Machine Co., Beloit, Wis., died of pneumonia at the Beloit Hospital, May 11, aged sixty-four years. Mr. Gardner was sick only a few days, and his death caused a great shock to the business community of Beloit and to his many friends throughout the country. He was born at Ashfield, Mass., September 4, 1848. At the age of fifteen he began to learn the trades of machinist and toolmaker in the Wiley & Russell Shops at Greenfield, Mass. Later he continued his apprenticeship with John J. Grant in Northampton, Mass. After having completed a total of seven years apprenticeship, he went to Hartford, Conn., where he was employed for many years by the Pratt & Whitney Co. During the last years that he was connected with this company he had charge of what is now known as the "small tool department." Mr. Gardner also was connected with the Hartford Tool Co. In 1888 he came to Chicago for the purpose of selling the Pratt & Whitney Co.'s products for C. H. Besly & Co., who then represented the former



Continuous Milling

The desired section is machined in economical manufacturing lengths, and then sawed to finished size in 7/10 minutes, each piece.

When your work permits, it's often a good plan to keep a number of the pieces joined together for the earlier machining operations and to separate them afterwards with a gang of saws.

There's no idle travel on the first milling operations because there is no space between pieces.

Only one clamping needed for several pieces. The drilling can be handled on a multi-spindle machine.

Then on the last operation of sawing apart you get CONTINUOUS MILLING—PROVIDED ALWAYS—that your machine has sufficient power to pull the gang of saws as fast as the operator can chuck the pieces.

AND that the vertical feed engaging and reversing levers are operated from the front of the knee.

The No. 2 CONE TYPE CINCINNATI MILLING MACHINE illustrated above is sawing up a bar from which we make 5 gibs.

The bar is milled to section and drilled before this operation. It is clamped to one of two plates and is located under the saws by the hand stop A on the front of the table. The vertical feed is engaged through lever B.

At the conclusion of the cut the trip dog throws out the feed which is then reversed through lever C. During this time the operator has removed the separated pieces and clamped a new bar in the other fixture.

With the quick return handle D he brings the table over to the second hand stop A and repeats the process.

The "Cincinnati" control makes this cycle of movements simple.

Note how all the levers are grouped at, and can be operated from, the front of the knee.

Speed 60 R. P. M.
Feed .013 in. per rev.
Width of each cut 1/8 x 3½.

Depth of cut 1¼ in.
Metal removed 1.8 cu. in. per min.
Time 7/10 minutes.

Doesn't this apply to some of your work?

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

company in the West. In 1890 he became superintendent and general manager of the works of C. H. Besly & Co., of Beloit, and remained for several years with this firm, during which period he developed the disk grinder, forged taps, and other specialties. Mr. Gardner was the inventor of the disk grinder which has become recognized the world over as a machine tool of extraordinary capacity for roughing and finishing metal work. While with C. H. Besly & Co., the disk grinder part of the business became an important part of the manufactured product. In 1905, Mr. Gardner organized the Gardner Machine Co., having interested local capital in his enterprise, and built a factory in Beloit for building disk grinders and other machines.

Mr. Gardner was an expert toolmaker. While with the Hartford Tool Co.—an association of E. G. Parkhurst, M. D. Pratt, J. E. Woodbridge and Mr. Gardner—he developed a method of making knife-edge straightedges and produced straightedges that had never been equalled before for accuracy. He is credited with being the inventor of the deep hole drill of the type having oil ducts or tubes in the body of the drill for carrying lubricant under pressure to the point of the drill, where it not only lubricates the cutting edge, but forces out the chips as rapidly as they are formed. This important improvement in drills was made about 1886, while employed by the Pratt & Whitney Co., under Mr. Heyer on the "reamer job." This tool made possible the rapid drilling of deep holes of small diameter very straight. The deep hole drill of the forced lubrication type is used for gun barrel drilling generally in the armories of the world.

Mr. Gardner was a man of pleasing personality and had many friends. He was closely identified with the local activities of Beloit, belonging to various fraternal societies and other organizations. He was greatly interested in improving conditions in and around Beloit, and was active in the movement for deepening the channel of Rock River, so as to make it navigable by steamers the year round. Mr. Gardner is survived by Mrs. Gardner, two daughters and five sons—Fred E., John M., Charles E., Edward B., and Ralph Gardner.

COMING EVENTS

June 5-7.—Semi-annual meeting of the Society of Automobile Engineers and Joint meeting of the Institution of Automobile Engineers (of England) and the Society of Automobile Engineers (of America) to be held on board the steamship "City of Detroit III" cruising on the great lakes. The steamer leaves Detroit, Mich. on the afternoon of June 4. Coker F. Clarkson, secretary of General Committee of Arrangements, 1451 Broadway, New York City.

June 10.—Departure from New York City of American Society of Mechanical Engineers' party to attend joint meeting with Verein deutscher Ingenieure in Leipzig, Germany, beginning June 23.

June 11-13.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

June 16-18.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago, Ill.

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

September 17-23.—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, J. F. Nickersoo, 431 South Dearborn St., Chicago, Ill.

October 10-17.—Eighth Annual Foundry and Machine Exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. Forty-five concerns were represented in the exhibition held in Buffalo last year. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

February 20—December 4, 1915.—Panama-Pacific International Exposition, San Francisco, Cal. Charles C. Moore, president; Rudolph J. Taussig, secretary.

SOCIETIES, SCHOOLS AND COLLEGES

University of Nebraska, Lincoln, Neb. Annual catalogue of the College of Engineering for the year 1913-14.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the College of Engineering for the year 1913-14.

American Museum of Safety, 29 West 39th St., New York City, issues a publication regularly called "Safety," devoted to accident prevention, hygiene, mutuality and the cause of the better industrial working conditions generally.

Louisiana State University, Baton Rouge, La. Catalogue of the university for the year 1913, giving information concerning the courses of study offered, the various student organizations and other matters of timely interest to both students of the university and those who intend entering upon courses of study.

Pratt Institute, Brooklyn, N. Y., will make its annual exhibit of the work of day students June 12-14. The exhibit is open to the public and affords those who are interested in industrial and technical education an opportunity not only of viewing the work of students in various courses, but of inspecting the methods as well as the equipment of the school and its general facilities for giving technical training. The school provides instruction in applied mechanics, applied electricity, applied chemistry and tanning, machine work and toolmaking, carpentry and building and patternmaking; besides a great variety of vocational subjects for young men and women.

NEW BOOKS AND PAMPHLETS

Road Models of the Office of Public Roads. 45 pages, 6 by 9 inches. Illustrated. Published by the U. S. Department of Agriculture, Washington, D. C., as Bulletin No. 47.

Entropy-Temperature and Transmission Diagrams for Air. By C. H. Richards. 20 pages, 6 by 9 inches, three folding plates. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 63. Price 25 cents.

Past and Present Metal Markets. By W. E. Figgla. Part I. 46 pages, 5 by 8½ inches. Part II, Charts A and B. Published by Critchley Parker, Melbourne, Australia. Price 15 shillings net.

The booklet reviews the fluctuation of prices of copper, tin, zinc, lead and silver. Chart A shows the price fluctuations of copper and tin from the year 1890 up to the present and chart B the fluctuations of zinc, lead and silver for the same period.

Steel: Its Selection, Annealing, Hardening and Tempering. By E. R. Markham. 367 pages, 7½ by 5⅜ inches. 168 illustrations. Published by the Norman W. Henley Publishing Co., 132 Nassau St., New York City. Price $2.50.

The present is the fourth edition of this work, which was formerly known as "The American Steel Worker." The present edition has been thoroughly revised and, as the title implies, it constitutes a comprehensive text on the selection of tool steel and methods of heat-treatment.

Practical Geometry and Graphics for Technical Students. By Edward L. Bates and Frederick Charlesworth. 621 pages, 4¾ by 7¼ inches. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price $2.00 net.

This work, which is intended to be a text-book for students in technical and trade schools, evening classes, etc., treats of plane geometry, graphics and descriptive geometry, giving numerous illustrations and examples for practice. The ground covered comprises a two or three years' course of instruction, according to the ability of the student.

Descriptive Geometry. By Adam V. Millar and Edward S. Maclin. 131 pages, 5 by 7½ inches. Published by McGraw-Hill Book Co., New York City. Price $1.50 net.

The work treats of projection, orthographic projection, picturing magnitudes in space, points, lines, planes, revolution and counter-revolution, line conventions, the elementary principles of the point, straight line, and plane; applications of the elementary principles of the point, straight line, and plane; curved lines and surfaces, plane sections and developments of curved surfaces, intersections of curved surfaces.

Characteristics and Limitations of the Series Transformer. By A. R. Anderson and H. R. Woodrow. 45 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill. Price 25 cents.

The bulletin treats of the characteristics of the series transformer and the theory of the transformer based on instantaneous current values. It is the purpose of the bulletin to show the imperfections of the transformer and to determine how and to what extent certain constants influence its operation. A comparison of results obtained and a general summary are given in conclusion.

Wastes in the Production and Utilization of Natural Gas and Means for Their Prevention. By Ralph Arnold and Frederick S. Clapp. 29 pages, 9 by 6 inches. Published by Bureau of Mines, Department of the Interior, Washington, D. C., as "Technical Paper No. 38—Petroleum Technology 6."

A general treatise on the distribution and utilization of natural gas. Information is given on the districts in which natural gas occurs, the methods used in distributing it, and means of eliminating the wastes which have occurred in the past through unscientific methods of handling this valuable natural product.

Practical Mathematics. By Claude Irwin Palmer. 147 pages, 7 by 4¾ inches. 68 illustrations. Published by McGraw-Hill Book Co., 239 West 39th St., New York City. Price 75 cents.

This is the fourth part of a treatise, "Practical Mathematics," and deals with the subjects of trigonometry and logarithms. Like the preceding parts of the series dealing with arithmetic, geometry and algebra (which have already been reviewed in MACHINERY) the present part has been developed to meet the requirements of practical men. Each step is illustrated by problems so that the method of applying mathematical knowledge in the shop is clearly explained.

The Motor and the Dynamo. By James Loring Arnold. 178 pages, 9 by 6 inches. 166 illustrations. Published by the Chemical Publishing Co., Easton, Pa. Price $1.50.

The text is divided into seven chapters and covers the fundamental principles of direct and alternating current electricity and the design and construction of direct and alternating current dynamos and motors. Taken by chapters, the subject matter may be briefly outlined as follows: "Introduction," "Mathematical Principles," "The Dynamo Machine," "Operation and Characteristics of the Direct Current Dynamo," "The Direct Current Motor," "The Alternating Current and Its Measurement," "Alternating Current Machinery."

Practical Mathematics for Technical Students. By Edward L. Bates and Frederick Charlesworth. 513 pages, 4¾ by 7¼ inches. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price $1.50 net.

The work contains an introduction to algebra and fractions, measurements, use of squared paper, operations with fractions, duo-decimals, algebraic operations, geometrical definitions, measurements of angles, ratio and proportion, logarithms, geometry of rectilinear figures and right-angle triangles, mensuration of regular figures, simultaneous simple equations, quadratic and cubic equations, factors, binomial theorem, vectors, trigonometry, rates of increase, differentiation, integration, etc.

Air Compression and Transmission. By H. J. Thorkelson. 207 pages, 9⅜ by 6⅜ inches. 143 illustrations. Published by McGraw-Hill Book Co., 239 West 39th St., New York City. Price $2.00 net.

The work deals with the properties of compressed air, the purposes for which it is used and the machines and equipment for its generation and transmission to different units in the factory. The opening chapters are devoted to a discussion of the fundamental properties of compressed air and the formulas presented in this section are those which appear in most of the standard textbooks on thermodynamics. After this treatment has been covered, a description of different forms of equipment and the purpose for which they are used, is taken up in some detail.

Manual of Wireless Telegraphy and Telephony. By A. F. Collins. 300 pages, 5 by 7¼ inches. 129 illustrations. Published by John Wiley & Sons, New York City. Price $1.50 net.

This work has passed into the third edition. The improvements made in wireless telegraphy during the past decade have necessitated a thorough revision of the book first published in 1906. The alternating-current transformer has largely taken the place of the induction coil, and the auto receptor has practically superseded the coherer receptor. The contents of the work by chapter heads are: "A Simple Wireless Telegraph System," "Elementary Theory," "Apparatus of a Commercial Station," "Apparatus of a Commercial Station" (Continued), "The Aerial Wire System," "Wiring Diagrams for Transmitters," "Wiring Diagrams for Receptors," "The Apparatus in Action," "Adjusting and Operating the Instruments," "Different Makes of Equipment," "Suggestions to Operators," "Wireless Telephony," "Glossary of Wireless Words, Terms and Phrases."

The New Steam Tables, Together With Their Derivation and Application. By C. A. M. Smith and A. G. Warren. 101 pages, 5½ by 8 1/5 inches. Published by D. Van Nostrand Co., 25 Park Place, New York City. Price $1.25 net.

The work is based on the researches of Prof. H. L. Callendar, being calculated originally from Callendar's equations and checked with Mollier's steam tables where possible. The tables comprise "Properties of Saturated Steam on Pressure Base" (Pound Centigrade Units), "Properties of Saturated Steam on Centigrade Temperature Base," "Specific Heats of Superheated Steam at Various Temperatures (Centigrade) and Pressures," "Average Specific Heats of Superheated Steam from Saturation to Tabulated Temperatures (Centigrade) at Various Pressures," "Properties of Saturated Steam on Pressure Base" (Pound-Fahrenheit Units), "Properties of Saturated Steam on Fahrenheit Temperature Base," "Specific Heats of Superheated Steam at Various Temperatures (Fahrenheit) and Pressures," "Average Specific Heats of Superheated Steam from Saturation to Tabulated Temperatures (Fahrenheit) at Various Pressures." A folder is included showing Mollier's chart for total heat and entropy as coordinates.

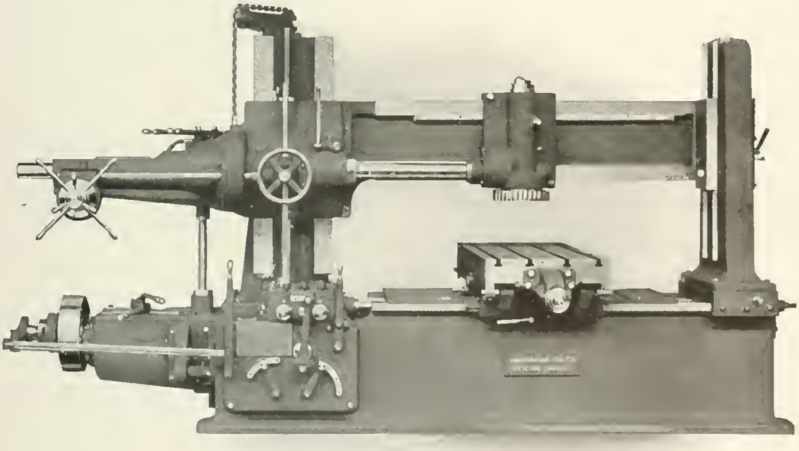
Safety Valve Rating. By Alfred B. Carhart. 105 pages, 9 by 6¼ inches. 8 illustrations. Published by Press of George H. Ellis Co., Boston, Mass.

This text presents a new method of rating safety valves and is intended as an elementary discussion of the subject. There are really three new rules proposed which have been developed from one another in sequence, and any one of these rules could form a satisfactory basis for an acceptable rule or table. All calculations have been given in detail so that each step will be clear to readers who are interested in this subject. Besides the descrip-

A Trip to Atlantic City

is DOUBLY ENJOYABLE about this time because there you can see in SPACES 104 and 106, Young's Million Dollar Pier, June 11-18, 1913, the

LATEST
"PRECISION"
Boring, Drilling and Milling Machine with Vertical Milling Attachment



It is so simple that you can see ALL of it ALMOST at a GLANCE and you DON'T HAVE TO LEARN TO RUN IT.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

tions and mathematical derivation of the different rules the following suggestions have been made: (1) Any rule of valve rating should give the valve diameter instead of valve area. (2) Valve lifts should not increase in direct proportion to diameters as this gives too low a lift in small sized valves and too great a lift in large valves. (3) Large valves should lift less than small valves. (4) Any valve should lift less at high pressures and more at low pressures. (5) The calculation of the discharge rating of a safety valve to determine the maximum emergency boiler protection should be taken at a rate greater than that indicated by the nominal working pressure usually assumed.

NEW CATALOGUES AND CIRCULARS

Producers Supply Co., Franklin, Pa. Circular of the "Producers" gas engine built in sizes of 10 to 30 H.P.

Armstrong Cork Co., Pittsburg, Pa. Folder advertising Nonpareil steam pipe covering for steam lines and boilers.

Ohio Valley Pulley Works, Inc., Maysville, Ky. Card advertising the "Limestone" wood split pulleys for all classes of service.

Von Wyck Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing new sixteen-inch engine lathe with apron geared feed.

Reading Iron Co., Reading, Pa. Bulletin No. 10 on the Illmer gas engine, an improved engine of the double-cutting, two-stroke cycle type.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Catalogue No. 42 on the Boyer speed recorder for application to locomotives and cars.

Oswego Tool Co., Oswego, N. Y. Circular of the Oswego-Dickson improved "Stillson" wrench, made in sizes from six inches to forty-eight inches, inclusive.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins Nos. 1032 and 1035 on Type H cast grid resistance and Type B limit stops for direct current motors, respectively.

Phoenix Mfg. Co., Eau Claire, Wis. Circular of the Conradson turret toolpost for use on engine lathes, illustrating tools and applications to typical engine lathe work.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of conductor pipe and eave trough machinery, paint rolls, drop presses, melting outfits and dies for ceilings, sidings, cornices, etc.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet on the use of "Cling-Surface" for canvas belts illustrating a number of canvas belting installations where "Cling-Surface" has been used with marked success.

Albany Lubricating Co., 708-710 Washington St., New York City, has begun the publication of a house organ known as "The Bearing." It will be devoted to lubrication in general and the use of Cook's lubricants in particular.

Panama-Pacific International Exposition, San Francisco, Cal. Rules and regulations for the information and guidance of intending participants and bulletin on the official classification of exhibit departments for the information of exhibitors.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins 1000, 1033, 1034 on Dinkey ventilated controllers for direct-current motors, E. C. & M. automatic pressure regulators for direct-current, type U controllers for direct-current motors, respectively.

General Electric Co., Schenectady, N. Y. Bulletins Nos. A4061, A4084, A4102, A4113 on electric arc headlights, centrifugal air compressors, sewing machine motors, oil switches for small capacity industrial application, respectively.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheet No. 93, Class V, on pulley mounting for rope drive or hoisting sheave, showing the application of ball bearings; data sheet No. 94, Class IX, on ball-bearing arbor for heavy-duty wood shaper.

Dodge Mfg. Co., Mishawaka, Ind. Pamphlet entitled "Main Engine Drives," illustrating the making of large rope driving wheels and installations of same; also containing numerous testimonial letters from large plants in which the Dodge system has been installed.

Mesta Machine Co., Pittsburg, Pa. Pamphlet on the Mesta blowing engines, illustrating the new Iversen air valve, which requires no valve gear, gives great volumetric and mechanical efficiency, requires no lubrication and operates efficiently up to 100 revolutions per minute.

Briatol Co., Waterbury, Conn. Bulletin No. 169 on counters which automatically count and register revolutions or strokes. These counters are made to count 10,000, 100,000 or 1,000,000, and one style is furnished with set-back by which all numbers can be turned back to zero with one turn of the key.

General Electric Co., Schenectady, N. Y. Bulletin No. A4116 describing isolated and small plant alternating current switchboard panels, both generator and feeder, for three-phase, 25 to 60-cycle circuit. Bulletin No. A4119, devoted to the application of electricity to the operation of packing establishments.

Firth-Sterling Steel Co. (Wheelock, Lovejoy & Co.), 23 Cliff St., New York City. Circulars on Firth-Sterling steel for punches, dies, chipping chisels, twist drills, reamers, counterbores, threading dies, screw drivers, etc.; also pamphlet entitled "The Relation of Tool Steel Prices to Manufacturing Costs."

Stark Rolling Mill Co., Canton, Ohio. Booklet on "Toncan" metal and corrosion. "Toncan" metal is claimed to be far less affected by corrosion than ordinary commercial steel. Many buildings covered with "Toncan" metal are illustrated and other structures are shown in which this metal plays an important part.

E. M. Dart Mfg. Co., Providence, R. I. Folder illustrating and giving dimensions of Dart unions and flanges. These are provided with two bronze seats which prevent corrosion, and with malleable pipe ends and nut, insuring strength and durability. A number of different types of straight, elbow and tee-unions are shown.

Metal Treating and Equipment Co., Inc., 1784 Broadway, New York City. Pamphlet entitled "Protection of Iron and Steel against Corrosion," treating of corrosion, galvanizing, hot galvanizing, sherardizing, electro-galvanizing and describing the "Standard" galvanizing process for which certain advantages are claimed.

National Tube Co., Frick Bldg., Pittsburg, Pa., has issued a book of forty pages on the Matheson joint pipe, showing scenes where it is being installed. Some of the advantages of Matheson joint pipe enumerated are: Reduced weight compared to cast iron, saving in lead used per mile, ability to lay pipe on a vertical curve, etc.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet entitled "Graphite for the Boiler" recommending the use of fine flake graphite in steam boilers to minimize the time and power lost while cleaning, to increase efficiency of heating surfaces, to reduce fuel consumption, to minimize repairs and to improve the operation of feed pumps, etc.

Rugen-Maschinen-Fundament Co., Ltd., Bismarck-Strasse 97-98, Charlottenburg, Berlin, Germany. Pamphlets on the Rugen machine foundation, consisting of rubber mats placed between the machine and floor. These mats eliminate the necessity of bolts or other fastenings. They also insulate machinery which is often desirable when electrically operated.

General Electric Co., Schenectady, N. Y. Bulletin No. A4110 on cloth pinions for use where the noise of metallic gears is objectionable. Cloth pinions are offered as a substitute for rawhide, paper and other materials for deadening gear sounds. Data are included on the horsepower capacity of pinions, which will be found helpful when ordering them for installations.

H. W. Johns-Manvilla Co., Madison Ave., & 41st St., New York City. List of J-M asbestos, magnesia and electrical products for roofing and building materials, non-conducting coverings, steam packings, "Vulcabeston," fireproof cements, asbestos fabrics and specialties, asbestos household articles, electrical supplies, cold storage insulation and specialties.

Sleaper & Hartley, Worcester, Mass., designers and builders of automatic machinery. Bulletin No. 252 on plain spring coiling machine; Nos. 254, 260 and 261 on universal coiling machines; No. 264 on spring setting machines; No. 268 on helical cutting and hooking machines; No. 270 on torsion spring machines. These bulletins give illustrations of the machines described and specifications of the product for which each is adapted.

General Electric Co., Schenectady, N. Y. Bulletin No. A4071 on lamp brackets and suspension fixtures for incandescent street lighting; Bulletin No. A4087 on direct current motor starting panels for heavy service; Bulletin No. A4097 on General Electric ventilated railway motors; Bulletin No. A4095 on direct current switchboards; Bulletin No. A4947 on Edison Mazda lamps for railway service.

South Band Machine Tool Co., South Bend, Ind. Booklet entitled "How to Care for, Erect and Operate a Screw Cutting Engine Lathe," containing practical instructions for the guidance of buyers and users of engine lathes. Directions are given for setting up, leveling and belting lathes, for finding speeds and sizes of tools, preparing work for turning, setting the tool, gearing for thread cutting, turning tapers, use of center rests, cutting speeds, etc.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa. Second bulletin of "Blacksmithing and Drop Forging" handbook treating of the hammer, the press, effect of the press compared with the hammer, large heating furnaces, modern tendency in forge shops, the band saw in forge shops, hollow shafts, working temperatures, finishing temperatures, working and finishing colors for steel, necessity for annealing, annealing temperatures, annealing furnaces, alloy steels, etc.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. The "Cleveland" handbook No. 5, showing dimensions of punches and dies for different classes of work, couplings, rivet sets, chisel blanks, flue beading tools, cold chisels, rivet busters, hand rivet sets, drift pins, wrenches, reamers and high-speed drills, hand punches, punching machines, angle shears, bar shears, bending rolls, multiple punch or gate shear, rotary planers, wall radial drills, planers and shapers.

Haine Safety Boiler Co., St. Louis, Mo. Pamphlet on the Heine safety boiler, containing a number of advertisements of well-known manufacturing concerns in whose power plants the Heine safety boilers are installed. The pamphlet also contains advertisements of the Heine superheaters, pointing out important advantages of this type of superheater, such as the close temperature regulation, absence of necessity of flooding, impossibility of danger from excessive superheating, etc.

New Process Gear Corporation, Syracuse, N. Y. Treatise on noiseless gear driving and catalogue of "New Process" gears and pinions. The disturbing effect of gear noises upon the workmen is discussed. Installations are illustrated of machines equipped with rawhide pinions in order to minimize gear noises. The construction of spur and bevel rawhide gears is illustrated. The price list comprises blanks and pinions from one inch face and two inches outside diameter to ten inches face and fifteen inches outside diameter, inclusive.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich. Bulletin No. 3 on Hoskins thermo-electric pyrometers, treating of temperature measurements, the thermo-electric pyrometer, Hoskins thermocouples, Hoskins meters, resistance of pyrometer leads, Hoskins cold-end regulation, protecting tubes, permanent pyrometer installations, high resistance thermo-electric pyrometers, applications of thermo-electric pyrometers and calibration of pyrometers. The bulletin is of general interest to all concerned with the heat-treatment of metals and other work requiring exact temperature measurements.

Cincinnati Shaper Co., Cincinnati, Ohio. Catalogue H on traverse shapers, open side shapers and crank planers. The traverse shapers are made with one or two heads and of 18, 22 and 26-inch strokes with even length beds from 8 to 20 feet. The open-side shapers are made to plane 15, 20, 25, 30 and 40 inches width and from 30 inches to 102 inches length. The crank shaper sizes are 17 by 17 by 12 inches and 24 by 24 inches, respectively. The catalogue also shows the Cincinnati heavy duty 32-inch railroad and manufacturing shaper, designed with the view of machining locomotive driving boxes and similar heavy parts.

Jones & Lamson Machine Co., Springfield, Vt. Publication entitled "The Fay Automatic Lathe," describing a machine developed especially for the automatic turning of work held on centers or on centered arbors. The book, which contains 45 pages and is handsomely illustrated, printed and bound, discusses the field for the Fay automatic lathe in the machine shop and deals with some of the problems met with in selecting the proper machines for certain work. It gives a detailed description of the design and construction of the machine, pointing out its advantages and showing examples, illustrated by line engravings, of work that can be done on the machine.

Davis-Bournonville Co., Hudson Terminal Bldg., 30 Church St., New York City. Catalogue of oxy-acetylene welding and cutting apparatus for welding iron, steel, cast iron, aluminum, brass, copper, platinum and other metals, and for cutting iron and steel. The oxy-acetylene flame has a temperature of about 6300 degrees F. and is the hottest of all gas flames. The catalogue illustrates various styles of acetylene generators, both stationary and portable types, and includes diagrams showing the lay out of plants for generating and compressing acetylene and oxygen. The various forms of Davis-Bournonville torches are illustrated; also the mechanical apparatus for guiding cutting torches for cutting steel plates, beams, etc. A number of new machines are shown, including the "radiagraph" and the "holograph."

TRADE NOTES

Electric Specialty Co., Stamford, Conn., successor to the Engineering Electric Mfg. Co., Inc., is a manufacturer of electric motors, both alternating and direct current types, motor generators, dynamos and electrical specialties.

American Blower Co., Detroit, Mich., announces that the Hon. William C. Redfield having been appointed a member of President Wilson's Cabinet, has deemed it advisable to terminate his business connections and has resigned as vice-president and director.

Munning-Loab Co., Matawan, N. J., announces that it has obtained exclusive rights for the manufacture and sale of the "None-Such" single cylinder and double cylinder, rotating plating barrels covered by a patent of S. D. Catlin, and formerly sold by the firm of Rockhill & Victor.

Bardons & Oliver, Cleveland, Ohio, manufacturers of turret lathes, have just completed a six-story addition to their factory which will greatly increase their capacity and make it possible to take care of their rapidly increasing business. The new shop contains many unique features and is thoroughly modern in its construction.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y., announces that the sales of its products will hereafter be in charge of the general manager, Mr. Andrew Thompson, with offices at Niagara Falls, N. Y. Mr. A. C. Hawley will represent the company in the Pittsburg district, in the Oliver Bldg., Pittsburg, Pa.

Taft-Peirce Mfg. Co., Woonsocket, R. I., has moved its New York City office from the City Investing Bldg., to the Woolworth Bldg., where one-half the thirty-fourth floor will be occupied. The new offices of seven rooms will provide quarters for the president, vice-president, general manager, treasurer, two sales representatives, etc.

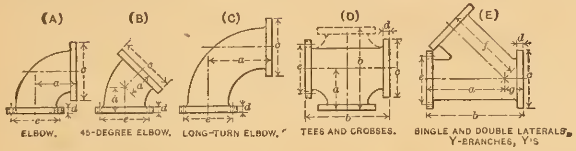
Bridgeport Mechanical Co., Bridgeport, Conn., has been incorporated with a capital of $50,000 to promote American inventions, to do first-class mechanical work and efficiency engineering and to systematize manufacturing, etc. The officers are: L. G. Wagner, president and treasurer; T. B. Lasher, vice-president; W. G. Lohmeyer, secretary.

Niagara Machine & Tool Works, Buffalo, N. Y., is offering $200 in prizes consisting of a first prize of $100; second prize, $40; third and fourth prizes, $20 each, and fifth and sixth prizes, $10 each, for new ideas and methods for sheet metal working. The ideas offered will be submitted to a committee and the names of the prize winners will be published January, 1914.

Taft-Peirce Mfg. Co., Woonsocket, R. I., is building an addition to its factory in the shape of a four-story tower, which will provide an entrance to the new offices on the fourth floor just completed. The tower will be fireproof, having a concrete shaft lined with glazed tile. Fireproof vaults and tool cribs will be provided on the second and third floors.

J. M. Voith Co., Inc., 200 Fifth Avenue, New York City, has been incorporated to sell in the United States and Canada the water wheels, gov-

STANDARD WEIGHT U. S. STANDARD FLANGED FITTINGS—II



Type of Fitting	1-inch					
	Diam. Bolts, 7/16. No. Holes 4; Diam., 9/16					
	a	b	e	d	e	f
A	3½	..	4	7/16	3	..
B	2	..	4	7/16	3	..
C	5½	..	4	7/16	3	..
D	3½	7	4	7/16	3	..
E	6†	8	4	7/16	3	6

Type	1¼-inch					
	Diam. Bolts, 7/16. No. Holes, 4; Diam., 9/16					
A	3¾	..	4½	½	3⅜	..
B	2	..	4½	½	3⅜	..
C	6	..	4½	½	3⅜	..
D	3¾	7½	4½	½	3⅜	..
E	6¼†	8½	4½	½	3⅜	6¼

Type	1½-inch					
	Diam. Bolts, ½. No. Holes, 4; Diam., ⅝					
A	4	..	5	9/16	3⅞	..
B	2¼	..	5	9/16	3⅞	..
C	6½	..	5	9/16	3⅞	..
D	4	8	5	9/16	3⅞	..
E	6⅞†	9¼	5	9/16	3⅞	6⅞

Type	2-inch					
	Diam. Bolts, ⅝. No. Holes, 4; Diam., ¾					
A	4½	..	6	⅝	4¾	..
B	2½	..	6	⅝	4¾	..
C	7	..	6	⅝	4¾	..
D	4½	9	6	⅝	4¾	..
E	8†	10½	6	⅝	4¾	8

Type of Fitting	2½-inch					
	Diam. Bolts, ⅝. No. Holes, 4; Diam., ¾					
	a	b	c	d	e	f
A	5	..	7	11/16	5½	..
B	2¾	..	7	11/16	5½	..
C	7½	..	7	11/16	5½	..
D	5	10	7	11/16	5½	..
E	9½†	12	7	11/16	5½	9½

Type	3-inch					
	Diam. Bolts, ⅝. No. Holes, 4; Diam., ¾					
A	5½	..	7½	¾	6	..
B	3	..	7½	¾	6	..
C	8	..	7½	¾	6	.
D	5½	11	7½	¾	6	..
E	10†	13	7½	¾	6	10

Type	3½-inch					
	Diam. Bolts, ⅝. No. Holes, 4; Diam., ¾					
A	6	..	8½	13/16	7	..
B	3½	..	8½	13/16	7	..
C	9	..	8½	13/16	7	..
D	6	12	8½	13/16	7	..
E	11½†	14½	8½	13/16	7	11½

Type	4-inch					
	Diam. Bolts, ¾. No. Holes, 8; Diam., ⅞					
A	6½	..	9	15/16	7½	.
B	4	..	9	15/16	7½	.
C	10	..	9	15/16	7½	.
D	6½	13	9	15/16	7½	..
E	12†	15	9	15/16	7½	12

Sign (†) indicates center-to-face dimensions of run on laterals, or double laterals, each way. Dimension g (see illustration E) is also the center-to-face dimension of a Y on the short end. All other dimensions on Y's are the same as for elbows of the same size. A reducing Y carries same dimensions as a straight size Y of the size of the largest opening in the fitting in question.

1912 U. S. STANDARD FLANGED FITTINGS AND FLANGES—I

EXPLANATORY NOTES FOR "THE 1912 U. S. STANDARD"

Adopted by a Committee of the National Association of Master Steam and
Hot Water Fitters and the American Society
of Mechanical Engineers

Schedule of Standard Weight and Extra-Heavy Flanged Fittings.

1. Standard or extra-heavy-reducing elbows have same dimensions from center-to-face as regular elbows of largest straight size.

2. Standard or extra-heavy tees, crosses and laterals, reducing on run, have the same dimensions face-to-face as largest straight size.

3. If flanged fittings are made for lower working pressures than 125 pounds, they shall conform in all dimensions, except thickness of shell, to this standard, and shall have the guaranteed working pressure cast on each fitting. Flanges for these fittings must be standard dimensions.

4. Where long-turn fittings are specified, it has reference only to elbows, which are made in two center-to-face dimensions, to be known as "elbows" and "long-turn elbows," the latter being used only when so specified.

5. All standard weight fittings must be guaranteed for 125 pounds working pressure and extra-heavy fittings for 250 pounds pressure, and each fitting must have some mark cast on it indicating the maker and guaranteed working steam pressure.

6. All extra-heavy fittings and flanges to have a raised surface 1/16 inch high inside of bolt holes for gasket.

Standard weight fittings and flanges to be plain faced.

Bolts to be ⅛ inch smaller in diameter than bolt holes.

Bolt holes should straddle center lines.

7. Size of all fittings scheduled indicates inside diameter of ports. For outside diameter pipe, use corresponding size of inside diameter fittings.

8. The face-to-face dimension of a reducer, either straight or eccentric, shall be equal to the diameter of the larger flange.

9. Square-head bolts with hexagonal nuts are recommended.

10. Twin ells, double-branch ells, side-outlet ells, side-outlet tees and four-way tees, whether straight sizes or reducing, have the same dimensions center-to-face and face-to-face as regular ells and tees.

11. Bull-head tees or tees increasing on outlet, shall have the same center-to-face and face-to-face dimensions as straight fitting of the size of the outlet.

12. Up to and including the 4-inch size, center-to-face and face-to-face dimensions of reducing fittings shall be the same as that of a straight fitting of the larger opening.

Steel flanges, fittings and valves are recommended for superheated steam.

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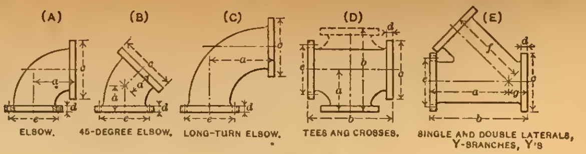
STANDARD WEIGHT U. S. STANDARD FLANGED FITTINGS—III



Type of Fitting	4½-inch					
	Diam. Bolts, ¾. No. Holes, 8; Diam., ⅞					
	a	b	c	d	e	f
A	7	..	9¼	15/16	7¾	..
B	4½	..	9¼	15/16	7¾	..
C	11	..	9¼	15/16	7¾	..
D	7	14	9¼	15/16	7¾	..
E	12½	15½	9¼	15/16	7¾	11⅞*

* For outlets 4 inches and under. For 4½-inch outlets f = 12½ inches.

Type	5-inch					
	Diam. Bolts, ¾. No. Holes, 8; Diam., ⅞					
A	7½	..	10	15/16	8½	..
B	4½	..	10	15/16	8½	..
C	12	..	10	15/16	8½	..
D	7½	15	10	15/16	8½	..
E	13½	17	10	15/16	8½	12¼*

* For outlets 4 inches and under. For 4½- and 5-inch outlets f = 13½ inches.

Type	6-inch					
	Diam. Bolts, ¾. No. Holes, 8; Diam., ⅞					
A	8	..	11	1	9½	..
B	5	..	11	1	9½	..
C	13	..	11	1	9½	..
D	8	16	11	1	9½	..
E	14½	18	11	1	9½	13*

* For outlets 4 inches and under. For 4½- to 6-inch outlets f = 14½ inches.

Type	7-inch					
	Diam. Bolts, ¾. No. Holes, 8. Diam., ⅞					
A	8½	..	12½	1 1/16	10¾	..
B	5½	..	12½	1 1/16	10¾	..
C	14½	..	12½	1 1/16	10¾	..
D	8½	17	12½	1 1/16	10¾	..
E	16½	20½	12½	1 1/16	10¾	13¾*

* For outlets 4 inches and under. For 4½- to 7-inch outlets f = 16½ inches.

Type of Fitting	8-inch					
	Diam. Bolts, ¾. No. Holes, 8; Diam., ⅞					
	a	h	c	d	e	f
A	9	..	13½	1⅛	11¾	..
B	6	..	13½	1⅛	11¾	..
C	16	..	13½	1⅛	11¾	..
D	9	18	13½	1⅛	11¾	..
E	17½	22	13½	1⅛	11¾	14⅝*

* For outlets 4 inches and under. For 4½- to 8-inch outlets f = 17½ inches.

Type	9-inch					
	Diam. Bolts, ¾. No. Holes, 12; Diam., ⅞					
A	10	..	15	1⅛	13¼	..
B	6½	..	15	1⅛	13¼	..
C	18	..	15	1⅛	13¼	..
D	10	20	15	1⅛	13¼	..
E	19½	24	15	1⅛	13¼	17⅞*

* For outlets 8 inches and under. For 9-inch outlets f = 19½ inches.

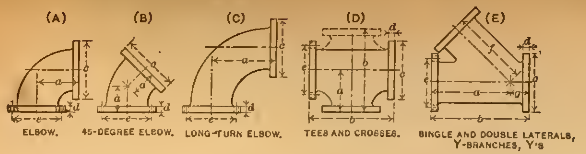
Type	10-inch					
	Diam. Bolts, ⅞. No. Holes, 12; Diam., 1					
A	11	..	16	1 3/16	14¼	..
B	7	..	16	1 3/16	14¼	..
C	20	..	16	1 3/16	14¼	..
D	11	22	16	1 3/16	14¼	..
E	20½	25½	16	1 3/16	14¼	18⅝*

* For outlets 8 inches and under. For 9- and 10-inch outlets f = 20½ inches.

Type	12-inch					
	Diam. Bolts, ⅞. No. Holes, 12; Diam., 1					
A	12	..	19	1¼	17	..
B	7½	..	19	1¼	17	..
C	22	..	19	1¼	17	..
D	12	24	19	1¼	17	..
E	24½	30	19	1¼	17	20*

* For outlets 8 inches and under. For 9- to 12-inch outlets f = 24½ inches.

STANDARD WEIGHT U. S. STANDARD FLANGED FITTINGS—IV



Type of Fitting	14-inch					
	Diam. Bolts, 1. No. Holes, 12; Diam., 1⅛					
	a	b	c	d	e	f
A	14	..	21	1⅜	18¾	..
B	7½	..	21	1⅜	18¾	..
C	24	..	21	1⅜	18¾	..
D	14	28	21	1⅜	18¾	..
E	27	33	21	1⅜	18¾	21½*

* For outlets 8 inches and under. For 9- to 14-inch outlets f = 27 inches.

Type	15-inch					
	Diam. Bolts, 1. No. Holes, 16; Diam., 1⅛					
A	14½	..	22¼	1⅜	20	..
B	8	..	22¼	1⅜	20	..
C	26	..	22¼	1⅜	20	..
D	14½	29	22¼	1⅜	20	..
E	28½	34½	22¼	1⅜	20	22⅝*

* For outlets 8 inches and under. For 9- to 15-inch outlets f = 28½ inches.

Type	16-inch					
	Diam. Bolts, 1. No. Holes, 16; Diam., 1⅛					
A	15	..	23½	1 7/16	21¼	..
B	8	..	23½	1 7/16	21¼	..
C	28	..	23½	1 7/16	21¼	..
D	15	30	23½	1 7/16	21¼	..
E	30	36½	23½	1 7/16	21¼	22⅞*

* For outlets 8 inches and under. For 9- to 16-inch outlets f = 30 inches.

Type	18-inch					
	Diam. Bolts, 1⅛. No. Holes, 16; Diam., 1¼					
A	16½	..	25	1 9/16	22¾	..
B	8½	..	25	1 9/16	22¾	..
C	30	..	25	1 9/16	22¾	..
D	16½	33	25	1 9/16	22¾	..
E	32	39	25	1 9/16	22¾	24¼*

* For outlets 8 inches and under. For 9- to 18-inch outlets f = 32 inches.

Type of Fitting	20-inch					
	Diam. Bolts, 1⅛. No. Holes, 20; Diam., 1¼					
	a	b	c	d	e	f
A	18	..	27½	1 11/16	25	..
B	9½	..	27½	1 11/16	25	..
C	32	..	27½	1 11/16	25	..
D	18	36	27½	1 11/16	25	..
E	35	43	27½	1 11/16	25	25¾*

* For outlets 8 inches and under. For 9- to 20-inch outlets f = 35 inches.

Type	22-inch					
	Diam. Bolts, 1¼. No. Holes, 20; Diam., 1⅜					
A	20	..	29½	1 13/16	27¼	..
B	10	..	29½	1 13/16	27¼	..
C	34	..	29½	1 13/16	27¼	..
D	20	40	29½	1 13/16	27¼	..
E	37½	46	29½	1 13/16	27¼	27⅛*

* For outlets 8 inches and under. For 9- to 22-inch outlets f = 37½ inches.

Type	24-inch					
	Diam. Bolts, 1¼. No. Holes, 20; Diam., 1⅜					
A	22	..	32	1⅞	29½	..
B	11	..	32	1⅞	29½	..
C	36	..	32	1⅞	29½	..
D	22	44	32	1⅞	29½	..
E	40½	49½	32	1⅞	29½	28¼*

* For outlets 8 inches and under. For 9- to 24-inch outlets f = 40½ inches.

Type	26-inch					
	Diam. Bolts, 1¼. No. Holes, 24; Diam., 1⅜					
A	23	..	34¼	2	31¾	..
B	13	..	34¼	2	31¾	..
C	39	..	34¼	2	31¾	..
D	23	46	34¼	2	31¾	..
E	43½	53	34¼	2	31¾	30¾*

* For outlets 8 inches and under. For 9- to 26-inch outlets f = 43½ inches.

MACHINERY

JULY, 1913

FLOATING REAMER-HOLDERS

DESIGNS TO INSURE CONCENTRICITY OF WORK IN HORIZONTAL AND VERTICAL MACHINES

BY ALBERT A. DOWD*†

At first glance nothing is more simple than a reamer-holder which is so made as to permit the reamer to float in any direction. Yet if this is so simple why are there so many types of so-called "floating holders"? All of these must have some special claim to efficiency as a reason for their existence. In order to properly discuss the question, we must first see clearly that there is a necessity for a holder of this type, by analyzing the conditions governing its use, taking as an example a piece of work to be machined in a horizontal turret lathe.

Let us assume that the hole is first carefully generated with a single-point boring-tool held in the turret. It should then be absolutely concentric about the axis of rotation and ready for the reamer. If the reamer is so held that its centers are coincident with this axis and is fed into the work in this position, the resulting hole should be true and of the correct size. Unfortunately, however, machines of this type are subject to slight variations in their indexing, and the inevitable wear upon the ways produces a certain amount of inaccuracy which must be taken care of in some way in the reamer-holder, in order that the reamer may be unrestrained in following the generated hole produced by the boring-tool. It is now apparent that there is a very good reason for the floating type of holder for reamers used in turret lathe work. The problem consists in selecting from the many varieties a holder which will allow the reamer to follow the generated hole without restraint, even when the turret holes are considerably out of alignment with the spindle.

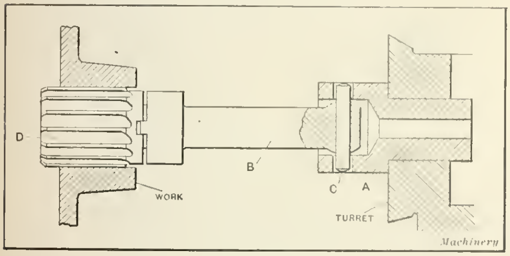


Fig. 1. Common Form of Floating Reamer-holder supported by Ball and Pin

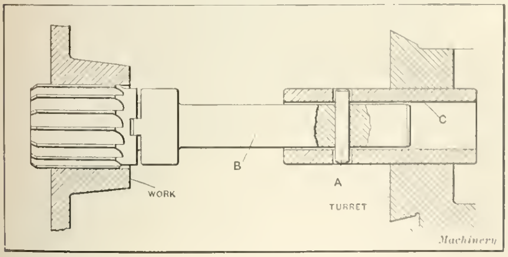


Fig. 2. Another Common Form of Floating Reamer-holder

Let us first consider the holder shown in Fig. 1—a very common type—consisting of the body *A*, the shank of which fits the turret hole, and a stem *B* having a "ball end" through which passes the driving pin *C*. This pin also serves to take the thrust of the cut. The forward end of the stem is tapered to permit the use of various sizes of shell reamers, such as the one shown at *D*. While this holder is probably more commonly used than any other type, its principal claim to efficiency is based on the floating action permitted by the ball end. Yet this ball, although it allows a swivel action, is also a disadvantage in that the reamer hangs so low that it must be very carefully started into the hole by hand. It also has a tendency to produce a slightly bell-mouthed hole, on account of the inevitable wabble when starting. If the ball end is made considerably smaller than the hole in the body (say 0.015 to 0.020 inch) it may be made to produce accurate results when properly handled. Adaptability and moderate cost are points in its favor.

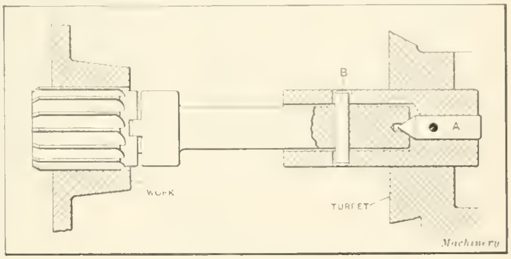


Fig. 3. Improved Form of Holder with Plug A to center the Reamer and take the Thrust

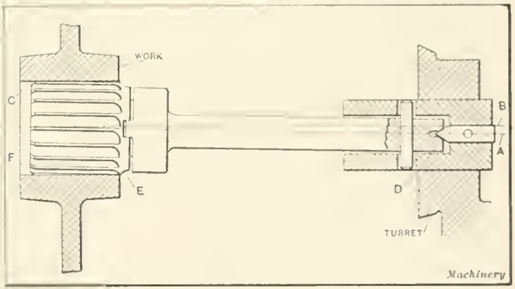


Fig. 4. Disadvantage of Holder shown in Fig. 3 when Turret does not index properly

Fig. 2 represents another very common type, in which the driving pin *A* is sometimes a free fit in the body and in other cases loose in the shank. This also is a holder which may be cheaply made, but it is subject to some of the same objections as the tool shown in Fig. 1. It is frequently made with too much clearance between the shank *B* and the hole *C*, this being as much as 1/16 inch in some cases. From 0.005 to 0.008 inch is much better, as the reamer will then enter the hole without assistance, and is less likely to cut large on its entrance.

An improved form of this holder is shown in Fig. 3, where it will be seen that a centering plug *A* has been added, which, in addition to centering the reamer, also takes the thrust. I believe that in certain cases the use of this plug is a disadvantage; for if the turret does not index properly, the plug must obviously be off center, thus producing a like condition in the reamer itself. Fig. 4 shows such a condition in an exaggerated form. The center of the turret hole *A* is 0.010 inch lower than the center of the spindle *B*, due to improper upkeep, excessive wear on the ways, etc. The hole *C* has been generated by a single-point boring-tool and, therefore, should be symmetrical about the axis of rotation of the spindle. The reamer itself is 4 inches long and the distance from the forward end to the center of the plug *D* is 12 inches. There is a back taper to this reamer of 0.001 inch per inch; consequently it is 0.004 inch smaller at *E* than at the forward end, or 0.002 inch on a side. The point *E*, then, will be 0.0013 inch lower than *F*, and theoretically will cut double this amount, *i. e.*, 0.0026 inch on the diameter.

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† Albert A. Dowd was born at North Granville, New York, 1872. He was educated in the New York University, Pratt Institute, and took an International Correspondence School course in bridge engineering. He has worked for the Atchison, Topeka & Santa Fe R. R. Co., Berlin Iron Bridge Co., Compound Motor Car Co., Columbia Motor Car Co., Pratt & Whitney Co., Stevens-Duryea Co., and Bullard Machine Tool Co. (with which latter concern he is still connected) having held the positions of timekeeper, machinist, toolmaker, lathe hand, experimental worker, chief tool designer, chief estimating department, specialist on turret tool work and machine design. Mr. Dowd's specialty is turret tool design of both vertical and horizontal machines.

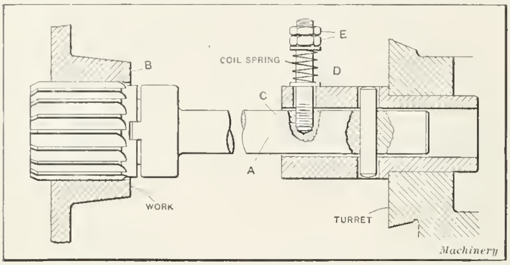

Fig. 5. Method of balancing a Reamer-holder with a Spring

Lest it be said that I have taken an almost impossible case as an example, I will say that about two years ago a condition even worse than this came under my observation. A turret lathe of a well known make had been in use on cast-iron work for only about six months and yet the center of the turret hole was 0.014 inch lower than the center of the spindle, and we were unable to produce a correctly sized hole upon it until the spindle bearings had been scraped to correct alignment with the turret. After this had been done, no further trouble was experienced.

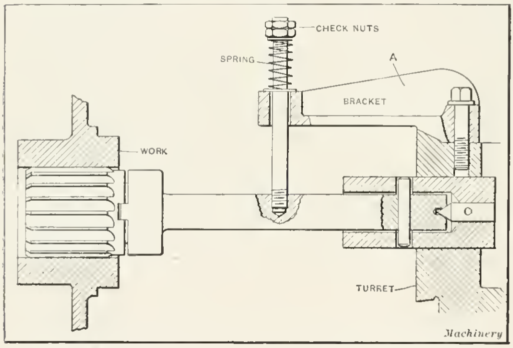

Fig. 6. Method of balancing Reamer-holder with Spring and Bracket from the Turret

An instance of a method of support by means of a spring is shown in Fig. 5, the holder being of the same general type as the one shown in Fig. 2. The reamer in this case was 3½ inches in diameter and the shank *A* rather long. In testing the equipment preparatory to shipment, it was found impossible to obtain a correctly sized hole at the end *B*, where the reamer began to cut. It was bell-mouthed to the extent of 0.003 to 0.005 inch, for about half an inch back, and the entire hole was inclined to be over size. The weight of the reamer being considerable and the shank rather long, caused a "drag" in entering the hole. The shank was drilled and tapped at *C* for a ½-inch stud, and a 5/8-inch clearance hole was provided in the holder directly above it at *D*, a stiff coil spring being placed in position as shown. The check-nuts *E* were then used to compress the spring until the weight of the reamer was properly balanced. This arrangement was found to correct the trouble and the hole obtained was sized properly. Fig. 6 represents a similar case where the reamer was still longer and heavier, but in this instance the supporting bracket *A* was fastened to the turret itself, instead of taking the thrust of the springs directly on the holder.

The holder shown in Fig. 8 was made for a very heavy piloted taper reamer of the dimensions indicated in the illustration. The cross-slide was used during the setting of the work, and it was necessary to provide a long shank for the reamer in order to avoid interference. This increased the weight to somewhat over 40 pounds, and it will be readily seen that some sort of support for the shank was essential to prevent a dragging action in the hole. For this purpose three spring shoes were provided, 120 degrees apart (one of which is shown at *A*). The pressure on the shoes was controlled by the backing-up screws which assisted in keeping the shank in a central position. The thrust of the cut was taken by the screw *B*, and the driver *C* (a detail of which is shown in the upper portion of the drawing) took care of the torsional strain. The clearance hole in the cover plate *D* was only 0.004 inch larger than the shank *E*, thus permitting the end of the pilot to enter the bushing *F* without assistance. Had this clearance hole not been made in this way, it would have been a difficult matter to start the pilot properly, because of the weight which would have had to be lifted and started by hand. This holder gave very satisfactory results.

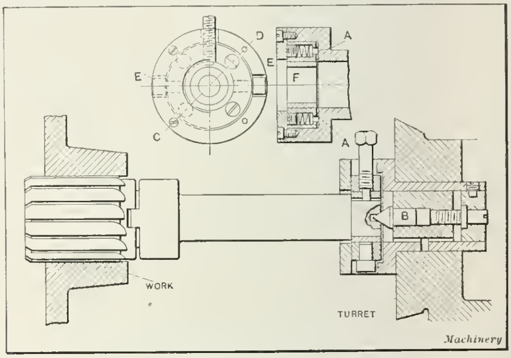

Fig. 7. Pratt & Whitney Reamer-holder equipped with Spring Shoes and Center Support

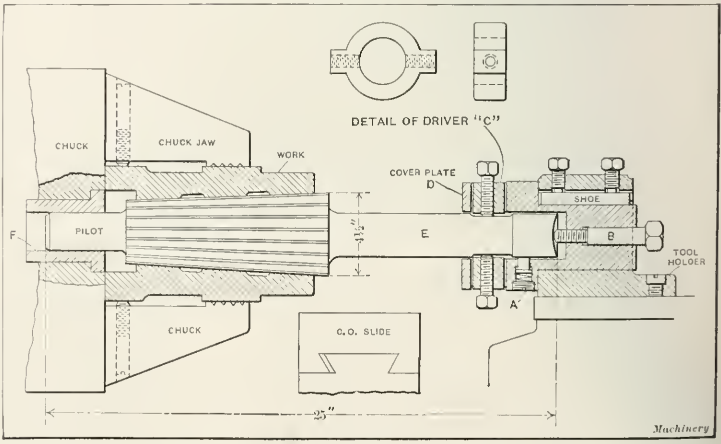

Fig. 8. Large Taper Reamer and Method of balancing it

The Pratt & Whitney Co., Hartford, Conn., manufactures a holder of a somewhat similar construction (see Fig. 7) in which equalizing spring shoes are also employed, as shown in the upper portion of the illustration at *A*, the section being taken along the line *C–D*. An adjustable and renewable center support *B* is an additional refinement. The bushing *F* may be easily made to fit various sized shanks. The drive provided through the pins *E* is exceptionally powerful.

Fig. 9 represents a type of holder suitable for small reamers, which may be so designed that standard tools of this kind and of various sizes may be easily used. The body *A* is made from square stock of suitable size turned down at *B* to a diameter corresponding with the hole in the turret. A piece of cold-rolled steel *D* is drilled and reamed to receive the reamer shank, and a set-screw provided at *E* to hold it in place. The drilled hole at *F* is for the purpose of removing unnecessary weight from the plug. It is obviously an easy matter to make up a set of plugs for different sizes of shanks and a series of bushings *G* to correspond. These bushings control the amount of float in the reamer, and, speaking generally, from 0.003 to 0.005 inch should be sufficient clearance between the bushing hole and the reamer shank. This type of holder is extremely useful on hand screw machines, and although it possesses a centering plug, it is less likely to cause inaccuracy, as its use is confined to the smaller machines where there is less wear and tear and consequently less chance for variations in alignment.

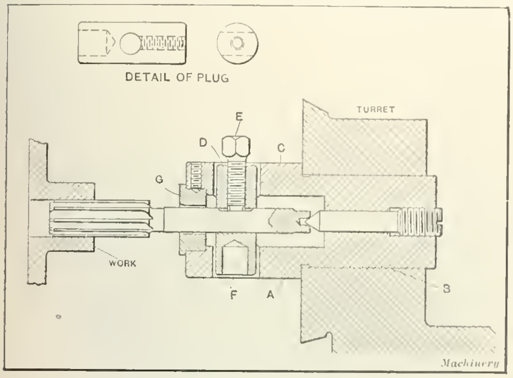

Fig. 9. Reamer-holder adapted for Use on Small Hand Screw Machines

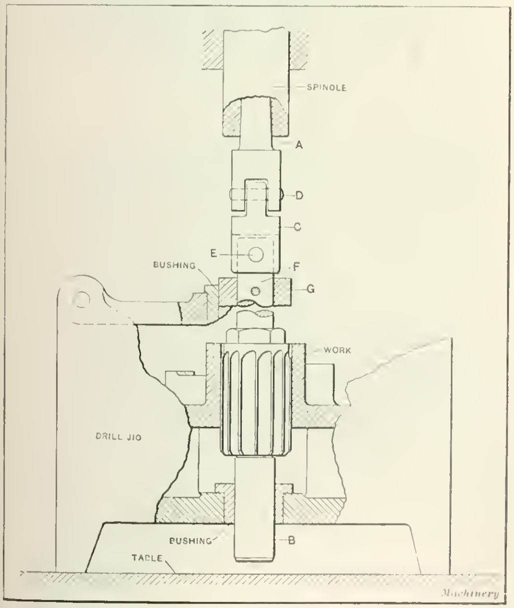

Fig. 10. Reamer-holder with a Universal Joint to provide the Floating Feature

Fig. 12 shows an entirely different type of holder which operates under quite different conditions. It is used on the Bullard vertical turret lathe when the swivel slide carrying the turret has been set over at an angle for the purpose of boring the taper hole *A* in the automobile flywheel shown in the illustration. The reamer hangs vertically from the removable pin *B*, which is free to float in the slotted shank *C*. This shank fits the turret hole and is prevented from twisting by the pin *D*. Obviously the position of the turret "observation stops" must be determined with some care, in order that the reamed hole may be of the correct angle and not distorted by crowding over and thus "cocking" the reamer. The correct position may be easily determined by setting the reamer snugly in place in a correctly sized hole, and then bringing the turret down until the pin *B* passes freely into its proper place. The necessary stops are then set for this location.

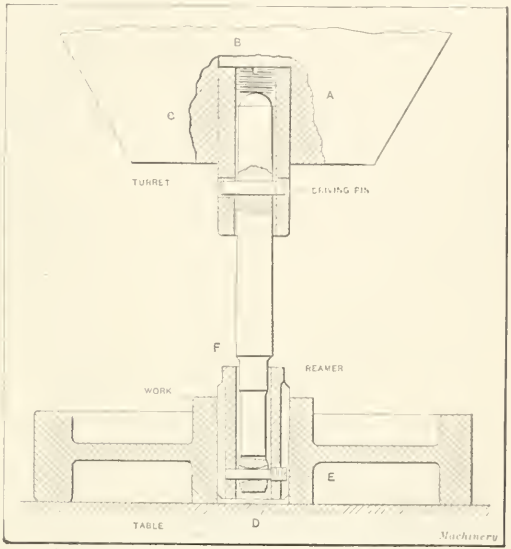

Fig. 11. Reamer-holder adapted for Use on either Horizontal or Vertical Machines

Another type of holder which is used in either a "vertical turret lathe" or in a horizontal machine is shown in Fig. 11. It has a ball-end shank *A* thrusting against the backing-up screw *B* in the end of the holder *C*, through which the driving pin passes. The forward end of the shank *A* is also ball-ended at *D*, and the screw-pin *E* passes through this portion, thus securing the reamer in position. It will be noted that the hole in the shank, through which this pin drives the tool, is bell-mouthed on each side of the center, and that there is also

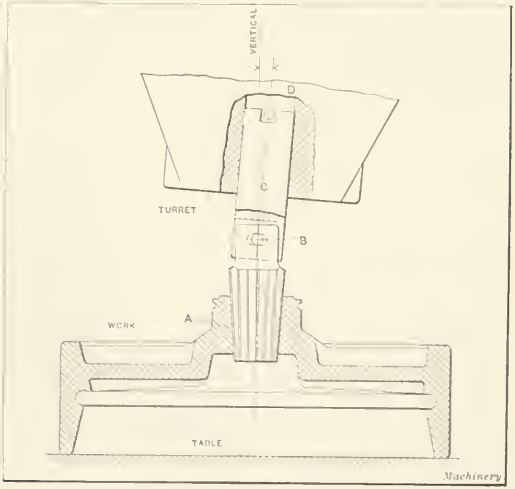

Fig. 12. Holder for reaming Taper Holes on Bullard Vertical Turret Lathe

clearance at *F* between the shank and the reamer shell. This holder gives a free floating action in any direction, and comes nearer to the ideal type than any of those previously mentioned. It was manufactured at one time by the Bullard Machine Tool Co., Bridgeport, Conn.

Fig. 10 represents a holder having a universal joint, which I have seen used in a drill jig of the type shown in the illustration. The shank *A* is made to a standard taper corresponding to that of the drill press spindle, and the piloted end *B* is guided by the bushing in the jig. One end of the intermediate link *C* is milled flat and is hung loosely on the pin *D* through the slotted shank. The other end of this link is slotted at right angles to the first-mentioned flat and serves to drive the reamer through the connecting pin *E*, which passes through its shank *F*. A hardened and ground collar *G* is also pinned to the shank and is guided by the upper bushing in the jig. Various adaptations of this universal joint are seen in connection with fixtures used on horizontal boring machines, and are often made with some device for rapidly interchanging bars, reamers, etc., in place of the pin *E*.

There is another holder (see Fig. 13) which is sometimes erroneously referred to as a "floating holder," but it has no "float" whatever, although it does have both vertical and horizontal adjustment. It is extremely useful in automatic screw machine work. The adjustable cap *D* may be quickly set to correct any inaccuracies of alignment between the turret and spindle by loosening the two screws *B*. The holes in the cap are made 1/16 inch over size to allow for this, and the bushing *A* is fitted to the reamer shank. The body *C* of the holder obviously fits the hole in the turret and is secured by some approved method.

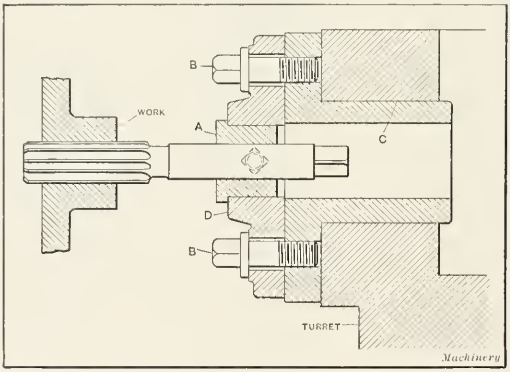

Fig. 13. Reamer-holder with Means of adjusting to Spindle Alignment

Although there are undoubtedly other types of holders which have not been mentioned, those which we have analyzed represent the principal models in common use at the present time, and are sufficient to illustrate the advantages and disadvantages of the many varieties.

* * *

AERONAUTICS IN EUROPE

There are at the present time fifteen factories devoted to the building of aeroplanes and airships in Germany, about twenty in France, six in England and five in Austria. It is stated that there is an over-production of aeroplanes and that the industry is suffering from slackness of business. The interest in flying meets seems to be decreasing. An attempt is being made in Germany to arouse greater interest in aviation and better organization of meets. The Government has appropriated $60,000 for the establishment of an experimental station for aerial navigation at Berlin. Twelve individual manufacturers of automobile and aeroplane motors have affiliated themselves with the station and contribute yearly an amount of about $16,000. The first task of the new institution will be to judge the motors submitted in the contest for the Kaiser's $12,000 prize for the best German made aeroplane motor.

* * *

It is sometimes a good plan to listen to what the other fellow has to say before you begin to talk.

THE COMMON LIMITATION OF MACHINE TOOL CHANNEL ROOM FOR CHIPS

BY CHARLES E. SMART[*]

With the use of high-speed steel cutters and high-speed drills, and a cooling compound, the necessary channel room for chips on milling machines and drill presses for machining steel evidently has not been given the serious study by the designers of these machine tools that it should receive. Take, for instance, one of the latest milling machines on the market, which very easily can remove eighty cubic inches of metal a day, or about twenty-five pounds of dry chips, yet the channel room on the machine has not the capacity to allow more than two pounds of chips to gather before the cooling compound is beginning to drip from the ways of the machine onto the floor. See Fig. 1.

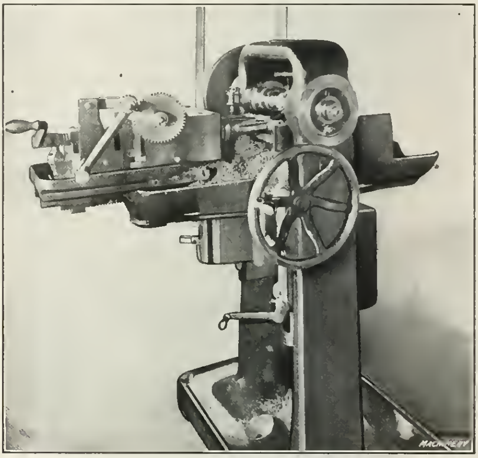

Fig. 1. Showing the Limitation of Chip Room on Table of Late Design of Manufacturing Milling Machine

To sufficiently cool the high-speed cutters at the speed and feed at which they are driven, about a quart of cooling compound is required per minute to each cutter; so unless the channel room is kept fairly free, serious interruptions to the work are constantly taking place. These interruptions impede the production in two ways: Time must be taken to remove the chips more often than if there were enough chip room; time is lost in keeping the floor clean, which could be used in production.

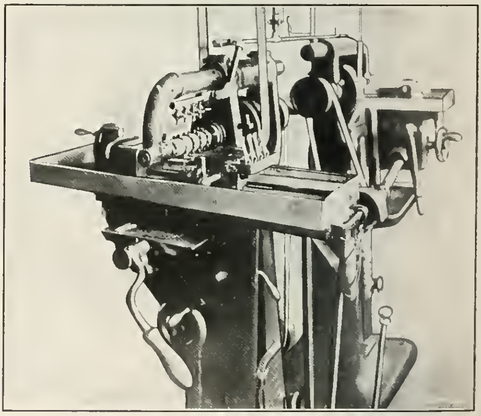

Fig. 2. Galvanized Iron Pan applied to Milling Machine Table to increase Chip Room

Where the design of the machine permits it, the trouble has been solved in the plant of the A. J. Smart Mfg. Co. by placing the milling fixture in a large galvanized iron pan, shown in

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[*] Superintendent A. J. Smart Mfg. Co., Greenfield, Mass.

Fig. 2, but the majority of milling machines on the market are so designed that no provision of this kind is possible.

A width of three inches and a depth of three inches (or the equivalent, nine square inches) where the machine will allow it, around the outside of the milling fixture on milling machines, is none too much, yet so far as the writer knows there is no milling machine on the market to-day that comes up to this requirement. With these channels, scoops of special design can be made to fit the channels so that it would not be necessary to remove the chips more than once in four hours or perhaps five hours.

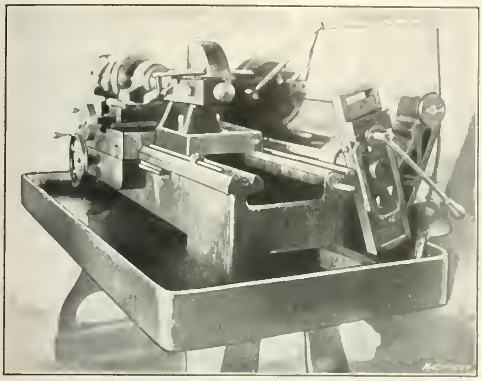

Fig. 3. Special Lathe provided with Large Pan for Oil and Chips

On the special lathe shown in the illustration Fig. 3, the chip room was one of the first points considered after the general design of the machine was settled upon, and it will be noticed that practically the whole machine is enclosed in a cast-iron pan. The only reason that the back of the bed does not show complete enclosure is that the largest planer available for planing the bed was not wide enough to allow the maximum width desired.

The amount of chips produced daily is a considerable item on jig work on the high-speed drilling machine shown in Fig. 4, and the galvanized iron backing was necessary to keep the chips from being brushed on the floor. Unfortunately, the drill press shown had been thoroughly cleaned before the photograph was taken, but the channel room on the bed will not appeal to any one as being at all sufficient. It will be noticed that there are three outlets into the reservoir underneath the table in order that the cooling liquid may escape freely.

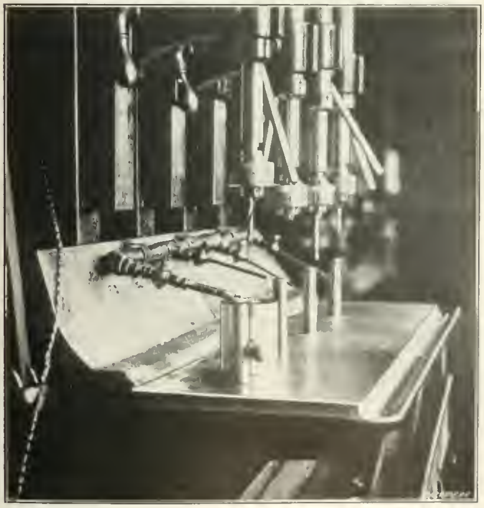

Fig. 4. Illustration of High-speed Drilling Machine showing Lack of Chip Room in Table Channels

SETTING DIAMONDS

Setting diamonds is one of the troublesome jobs that fall to the lot of a machinist or grinder at more or less frequent intervals. The method in general use consists of drilling a hole for the diamond, and after placing it within the hole, closing the metal in about the stone as far as possible, and then pouring molten spelter to fix the diamond in place. The chief objection to this method is that the spelter will not flow evenly around and beneath the stone; consequently the stone is not supported at all points, and quickly works loose.

The following method of setting diamonds has been found to be superior to the method just described: First drill the hole for the diamond to the usual depth, a little deeper than the greatest dimension of the stone. The drilling should be done without lubricant, as oil of any kind tends to prevent the spelter from flowing smoothly. This being done, the hole should be closed in slightly—just enough to make it out of round. The spelter is now poured into the hole, filling it completely, and the diamond, held in a pair of tweezers, is pushed into the liquid spelter in the hole until it strikes the bottom. In doing this, an amount of spelter equal to the displacement of the diamond is pushed out of the hole, and when this drop of spelter makes its appearance it is certain that there are no vacant spots under the stone. After the spelter has cooled, the end of the rod in which the diamond is located can be shaped up in the customary manner. The fact that the hole is slightly out of round prevents the core of spelter from working out of the end of the rod. C. L. L.

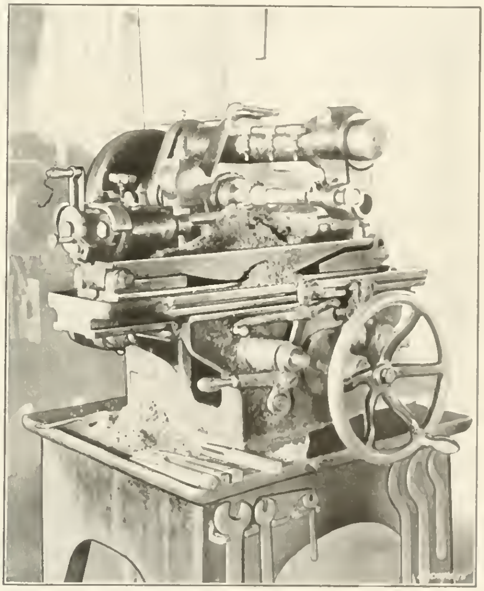

Fig. 5. Typical View of Milling Machine used in Manufacturing, showing Lack of Chip Room on Table

* * *

Some users of motor trucks who have conducted careful comparative tests of solid and pneumatic tires under heavy loads, have arrived at the conclusion that pneumatic tires within certain limits of capacity are the more efficient, considering speed, power consumption, durability of tires and general wear and tear. But in order to realize satisfactory service, pneumatic tires must be provided of a size and strength proportionate to the load. This means tires of great size and heavy cost for large trucks if they are to prove satisfactory. An under-tired truck will cause only trouble and expense. Tire makers are ready to furnish eight by thirty-eight inch pneumatic tires which carry a normal air pressure of 160 pounds per square inch. A tire of this size will support a static load of 4000 pounds with a deflection of less than one-half inch, and is rated at 2000 to 2200 pounds capacity.

MAKING A SHEET-STEEL MITER-BOX IN THE PUNCH PRESS

SOME INTERESTING PUNCHES AND DIES USED IN PRODUCING MITER-BOXES FROM SIXTEEN-GAGE SHEET STEEL

BY DOUGLAS T. HAMILTON*

Some excellent examples of die work obtained in the factory of the H. C. Marsh Co., Rockford, Ill., manufacturer of picture frame tools and miter-boxes, are shown in the accompanying illustrations. These views illustrate some of the most interesting punch press operations on the "Marsh-Ayer" pressed-steel miter-box, which is shown assembled and ready for use in Fig. 1. Every part of this miter-box, with the exception of the posts and an arch shaped forging beneath the table, are made from 16 gage (0.0625 inch thick) 20 point carbon sheet steel, which is known as a fine grade of deep drawing steel.

Not only does the production of this miter-box from sheet steel require the use of intricate dies and tools, but it also demands the aid of a punch press capable of producing the parts on a manufacturing basis. Although the idea is still held by many that the punch press is only suitable for light sheet-metal work, and is not capable of heavy sheet-steel forming, nevertheless, wonderful strides have been made in the past few years in the design of punch presses adaptable to the manufacture of many parts from heavy sheet steel. The production of this miter-box from sheet steel 0.0625 inch thick in a punch press of the type shown in Fig. 3, should be conclusive proof that the punch press of present-day design can be classed as a manufacturing machine.

Press Operations on the Miter-box Frame

The frame of the miter-box, some of the press operations on which are illustrated in Fig. 2, is the most difficult part to produce, and is the one that requires the greatest amount of power. The frame is first cut to blank form, as shown at *A*, and is then drawn up into box form. In its finished shape, it is 18⅝ inches long by 4½ inches wide and 1¼ inch deep (this latter dimension is the finished height, from 1/16 to ⅛ inch being allowed for milling). This difficult drawing operation on the frame, as well as all the operations on the other parts of the miter-box, is accomplished in a No. 4 Rockford geared punch press, shown in Fig. 3, which is operated at 45 revolutions per minute, and at this speed is capable of exerting a pressure of 60 tons per square inch.

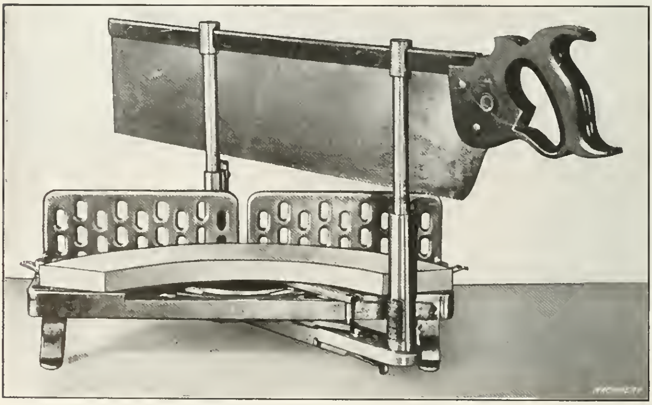

Fig. 1. Sheet-steel Miter-box produced in the Punch Press

The blank for the miter-box frame, which is shown at *A* in Fig. 2, is much longer than the bed of the punch press, so that a special bolster has to be provided, and in this is inserted a pan for catching the blanks as they are cut out. The pan is made deep enough to hold three blanks, and is removed from under the die when this number is cut out. There are, in all, fourteen punch press operations required to produce the frame of the miter-box. Briefly, they are as follows: Blanking (see *A*, Fig. 2); center drawing; embossing (see *B*, Fig. 2); graduating; stamping figures; drawing up into box shape (see *C*, Fig. 2 and also Fig. 3, which shows the operation being performed); center perforating (see *D*, Fig. 2); center drawing; perforating, two operations. Only one-half of the frame is perforated at a time, the same punch and die being used for each end, and the frame being reversed end for end. After perforating the holes in the two end portions of the frame, they are drawn up, one-half the number of holes being drawn at a time and the frame being reversed as before mentioned. The type of drawing die used is similar in construction to that shown in Fig. 7. The final operation is the embossing of the two ends; this requires two operations in the same die, one end being done at a time.

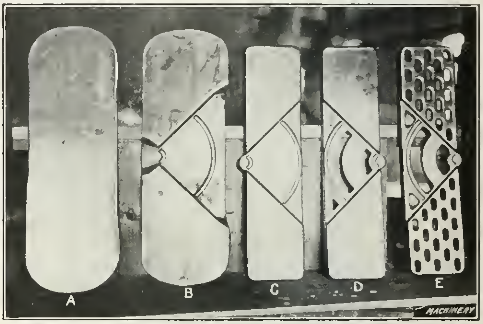

Fig. 2. Some of the Most Important Punch Press Operations on the Frame of the Sheet-steel Miter-box shown in Fig. 1

Graduating and Stamping the Frame

After the center portion of the frame has been drawn up and embossed so that it is in the condition shown at *B* in Fig. 2 (which operations are performed with tools of comparatively simple construction), the next operation is to graduate the center portion. The graduations are made on an arc of a circle, so that any angular movement of the saw guide can be obtained in degrees for any setting within an angle of 90 degrees. These graduations are stamped in the frame in the punch press shown in Fig. 3, by a die which has V-projections of the required length formed on its top face. The other member of the die (or punch) is perfectly smooth, and is only used for pressing the graduations into the frame. The tool used for stamping the figures is shaped somewhat like a regular punch-holder, and is held in the ram of the press. This holder carries, or has inserted in it, the required number of stamps which are of a similar type to those used when stamping by hand, and are held in place in the holder by set-screws. The lower member of this stamping tool is also left smooth, and is provided with guides to locate the work properly.

Drawing up the Sides of the Frame

The drawing up of the sides of the frame is a difficult operation because of its irregular shape, its size, and the height to which the sides are drawn. Fig. 3 shows the tools used for drawing up the sides of the frame set up in a No. 4 Rockford geared press, and gives some idea of the enormous power required for this operation. As can be seen, the die projects a considerable distance past the frame of the press. The drawing die *A* is held on a special bolster *B*, which is bolted to the bed of the press. The work after being drawn is ejected from the lower die by a spring pad which bottoms in a recess in the die shoe, when forced down by the work and upper member of the die, or punch.

The drawing punch is fastened to a large punch-holder *D*, which is held to the ram of the punch press and is provided with two protecting arms, not shown. These arms act as stops for the heavy springs *C* which furnish pressure to the pressure pad *E*, the function of which is to prevent the stock from wrinkling while the deep vertical flange around the edges of the frame is being drawn. It will be noticed that the pressure pad is cut away on its lower face to clear the embossed center portion of the frame, which has been accomplished in a previous operation. The drawing punch is also cut away in a similar manner. The accomplishment of this difficult operation in a press of this size speaks favorably for the high-duty punch presses built by the Rockford Iron Works, Rockford, Ill., and demonstrates in a remarkable manner the manufacturing capabilities of these machines.

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*Associate Editor of MACHINERY.

Drawing up the Edges of the Perforations in the Frame

After the sides of the frame have been drawn up, the center portion is perforated in several places as shown at *D* in Fig. 2. Then the edges of these perforations are drawn up about ¼ inch to increase the strength of the frame. This operation is accomplished with the tools shown in Fig. 4. Here *A* is the punch-holder which is held to the bolster of the punch press in the usual manner, and is provided with hardened and ground pilot pins *a* which locate and guide the drawing die *B*. The drawing punches *b*, which are fastened by screws to the punch-holder *A*, are surrounded by a floating pad *c*, the function of which is to keep the top surface of the stock perfectly flat while the edges of the perforations are being drawn. The drawing punches *b* are, of course, made smaller than the irregular shaped holes in the drawing die to allow for the thickness of the metal. The holder carrying the drawing die *d* is fastened to the ram of the press by the shank, which is not shown in the illustration.

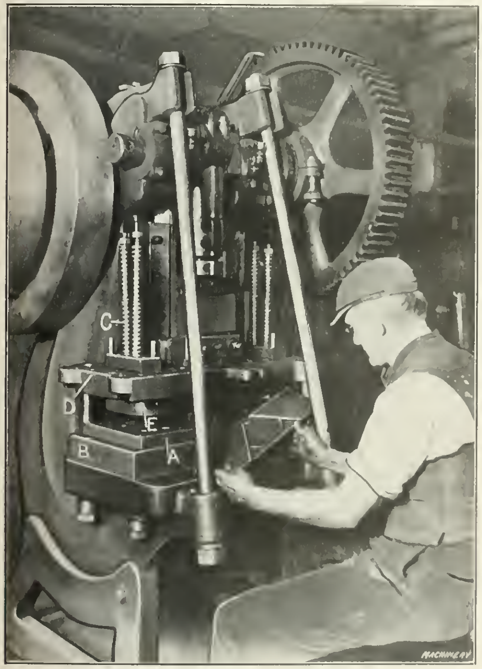


Fig. 3. No. 4 Rockford Geared Punch Press used in producing the Sheet-steel Miter-box shown in Fig. 1, set-up for drawing up the Sides of the Frame

In operation, the frame is laid on the punch *A* and is located by depressions in the floating pad *c* which fit the embossed center portions of the frame. As the press is operated, the die *d* descends and as soon as it touches the blank it holds the latter firmly against the floating pad which prevents the work from bending while the punches are forcing the edges of the perforations into the die impressions. These tools, when made, were intended to draw up the edges of oblong-shaped holes to be cut in the arch shaped strip *e* (see finished frame resting on top of tools), but were discarded when it was found that the frame was rigid enough without this additional drawing operation. The completed frame is shown at *E* in Fig. 2.

Making Miter-box Legs

The legs for the miter-box shown in Fig. 1 are also made from 0.0625 inch, 20 point carbon deep-drawing sheet steel, and are completed in three operations in the punch press. The first operation, shown at *A* in Fig. 6, consists in cutting out a blank of the required shape; this operation is accomplished with a simple blanking punch and die. The next operation, shown at *B*, is the first drawing operation and consists in turning up the two sides of the blank. The work when being drawn is not forced through the die, but is ejected by means of a spring pad inserted in the die and bottoming in a recess in the die shoe, when the ram is at the lowest point of its stroke.

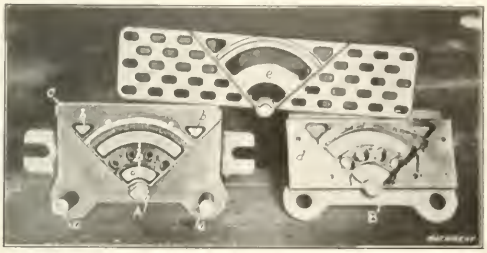


Fig. 4. Punch and Die used in drawing up the Edges of the Perforations in the Center of the Miter-box Frame

The next operation on the miter-box legs, which is the most interesting, consists of the final drawing to shape. The result of this operation is shown at *C* in Fig. 6, and also at *b* in Fig. 5, where the tools used are also shown. The conditions met with in the production of this piece are unusual, in that the depth of the draw is 2 11/16 inches, and the height of the blank 11/16 inch, making a total of 3⅜ inches, whereas the stroke of the punch press used is only 3½ inches. It is evident, therefore, that there is a clearance of only ⅛ inch between the punch and the blank when the ram of the punch press is at the highest point of its stroke. This, added to the irregular shape of the work, made it extremely difficult to remove the finish-formed leg from the die. It was only possible to do so by cutting away the front wall *c* of the die, shown at *A* in Fig. 5, and by using a cam-operated stripper *d* to pull the work from the punch *e*. A knock-out was added for this purpose, but as it projected below the ⅛-inch allowable clearance, when the ram of the punch press was at the extreme height of its stroke, it had to be abandoned. The block *f* which is set into the punch shows the position of this knock-out as originally used.

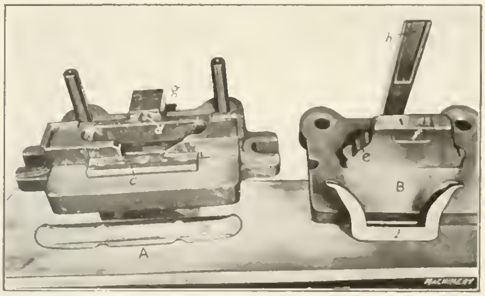


Fig. 5. Punch and Die used for performing Final Drawing Operation on Legs of Miter-box shown in Fig. 1

Referring to the drawing die used for the leg, which is shown at *A* in Fig. 5, it will be noticed that the lower face of the die block projects past the lower face of the bolster. This was found necessary to give sufficient clearance for getting the blank into and out of the die, as it is evident that thickening the bolster sufficiently to give the required depth would have raised it too much above the top surface of the bed of the punch press. The stripper *d*, which consists of a flattened plunger held inward by a coil spring located in the block *g*, is operated by the strip *h* attached to the punch-holder *B*. The blank shown at *a* is located in the correct relation to the punch and die when being drawn, by a milled impression on the top face of the die bolster.

Punch and Die for Drawing up Edges of Perforations in Rear Guide Plates for Miter-box

The back of the miter-box, as shown in Fig. 1, consists of two perforated and embossed plates, which are also made from 1/16-inch sheet steel in the punch press. The punch and die used in drawing up the edges of the perforations in these plates are shown at *A* and *B* in Fig. 7, a completed rear guide being shown at *C*. Before these plates are ready for the final operation—drawing up the edges of the perforations—several operations are performed on them. The first operation consists in cutting out the blanks in an ordinary blanking punch and die. Then the top and side edges of the blank are drawn up, the die used for this purpose being provided with a spring pad for ejecting the work, which is not forced through the die. Following this operation, the holes are pierced, thus preparing the blank for the final operation.

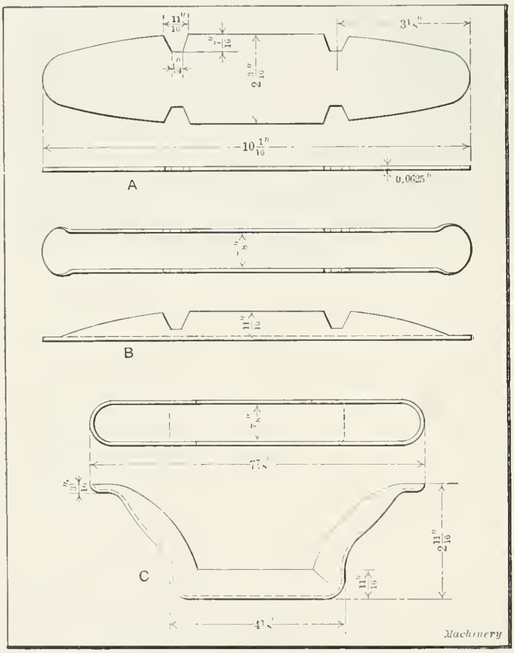


Fig. 6. Illustration showing Sequence of Punch Press Operations on Miter-box Legs

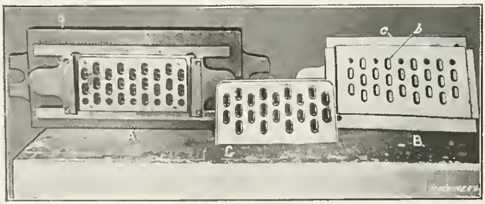


Fig. 7. Punch and Die for drawing up Edges of Perforations in Rear Guide Plates

The drawing die used in drawing up the edges of the perforated holes, as shown at *A* in Fig. 7, also acts as a guide for the blank, locating the latter from the turned up edges. The punches *b*, as was the case with those shown in Fig. 4, are surrounded by a floating pressure pad *c* which keeps the blank straight when the edges of the perforations are being drawn and also assists in stripping the work from the punches. All the perforations in the various members of the miter-box are drawn up to a height of about 1/4 inch from the opposite face of the blank. The object in making these "embossed" perforations, of course, is to strengthen the frame and thus permit it to be made from comparatively thin material. Those familiar with this class of work know that embossing and perforating the material in the manner shown makes it very stiff in comparison with flat plates of the same material. The appearance is also greatly improved by the addition of these apparently expensive operations. On the other hand, while it is possible to carry on these operations successfully in the punch press, it would be difficult to produce a miter-box from material of sufficient thickness to give the same strength, if the embossing operations were not performed.

* * *

DETERMINING GEOMETRICAL PROGRESSIONS WITH A SLIDE RULE

A recent issue of *Page's Weekly* gave the following method of working out geometrical progressions within specified limits. No tables of any kind are required, all that is necessary being a slide rule which is used in conjunction with a piece of paper. The method is limited to progressions which come between the range of 1 to 100, 10 to 1000 and so on with the slide rule closed up. With the slide rule fully extended ranges of from 1 to 10,000 etc., can be handled. The method is based on the fact that the slide rule is divided logarithmically, that is the distances of all numbers from the left-hand index are proportional to the logarithms of the numbers; therefore, all numbers of a series in geometrical progression are an equal distance apart.

The following examples will serve to make the method clear. Suppose it is required to figure out a geometrical progression of 9 terms, the first term being 30 and the last term 320. A stiff piece of paper having a straight edge is laid on the slide rule and marks made on it opposite the 30 and 320 graduations. With a pair of dividers, this distance is divided into eight equal spaces. The points of division between these spaces are marked on the edge of the paper and the latter is then placed on the slide rule between the 30 and 320 graduations. The numbers of the geometrical progression will then be read off opposite the division points which were marked off on the paper. The following solution will be obtained: 30, 40.3, 54.2, 73, 98, 132, 177, 238.5 and 320. These results will be found very close to the solution of the problem obtained by logarithms, and they are quite accurate enough for practical purposes.

The second problem will explain the method of determining a geometrical progression, the limits of which lie between 1 and 10,000. For this purpose, suppose it is required to determine a geometrical progression of 16 terms between the limits of 6 and 310. In this case, the range cannot be covered on the *A* scale of the slide rule, as starting from 6 on the left-hand of the scale brings one up at the 100 graduation at the right-hand end. To get the necessary range, place the left-hand index of the *B* scale opposite the right-hand index of the *A* scale. The limits of the progression then lie between 6 on the left-hand half of the *A* scale and 310 on the left-hand half of the *B* scale. Proceeding in the manner previously described, lay the edge of a sheet of paper on the rule and place a mark opposite the two limits, *i. e.*, 6 and 310. Then divide the distance into 15 parts (the number of terms in the progression minus 1). The paper is then laid on the slide rule and the numbers of the progression read off opposite the division points which have been produced in this way. If this problem is tried, the following results will be obtained: 6, 7.8, 10.2, 13.2, 17.2, 22.3, 29, 37.8, 49.2, 63.8, 83.2, 108, 141, 183, 238 and 310. When a progression of this kind is to be determined for some purpose of design, it is not usually necessary to obtain absolutely accurate results, and the preceding method will be found quite close enough.

* * *

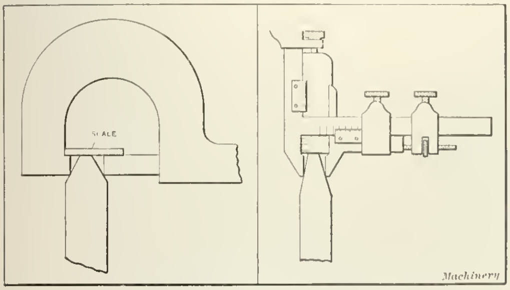
The *London Daily Mail* has offered $50,000 for the first aeroplane flight across the Atlantic Ocean in either direction in seventy-two hours' time. The flight must be made between some point in the United Kingdom and some point in the United States, Canada or Newfoundland. The competition is international and is open to all aviators throughout the world. It is permissible to alight on the water and to take on more fuel if arrangements for this can be made.

MEASURING THE FLAT ON U. S. AND ACME THREAD TOOLS

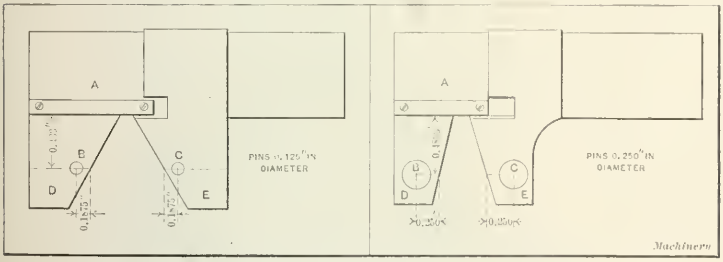
BY GUY H. GARDNER*

The gages sold in the tool stores can be used for measuring the flat on U. S. and Acme thread tools if they happen to have a notch of the required pitch, but it is often necessary to measure a flat for which such gages make no provision. This is especially the case with Acme tools.

Fig. 1 shows a method of making such measurements, which gives a close approximation of the actual value. It is based on the fact that the spindle of a micrometer is of known diameter. Referring to the illustration, it will be seen that a scale or parallel is laid on the spindle and the micrometer anvil, the tool being placed with its flat resting against the scale. The micrometer is then closed to the position shown, and 0.2887 inch is subtracted from the reading in the case of a U. S. tool and 0.1293 inch in the case of an Acme or worm tool. This applies in the case of a micrometer having the usual spindle diameter of 0.250 inch. If a micrometer with some other size spindle is used, the amounts to be subtracted from the readings on U. S. or Acme tools are obtained by multiplying the preceding values by the ratio of the spindle diameter to 0.250.



Figs. 1 and 2. Two Methods of measuring the Flat on U. S. and Acme Thread Tools



Figs. 3 and 4. Special Gages for measuring the Flat on U. S. and Acme Thread Tools

Fig. 2 shows the method of measuring the flat with a gear tooth caliper. If the measurement is made at a distance of ¼ inch from the point, the same values, *i. e.*, 0.2887 inch for U. S. and 0.1293 inch for Acme, are subtracted from the readings of the caliper to obtain the actual width of the flat.

Fig. 3 shows a gage for measuring the flat on U. S. tools, and Fig. 4 for making the same measurement on Acme tools. In both cases, the reading of the micrometer from outside to outside of the pins *B* and *C* is exactly one inch greater than the width of the flat. In using these gages, the thread tool is held with its point resting against the straightedge *A* and its sides between the fixed jaw *D* and the sliding jaw *E*. The distance from outside to outside of pins *B* and *C* is then measured with a micrometer and this measurement is one inch greater than the width of the flat. If these gages are carefully made according to the dimensions given, their use will enable the measurement of U. S. and Acme thread tools to be accurately made.

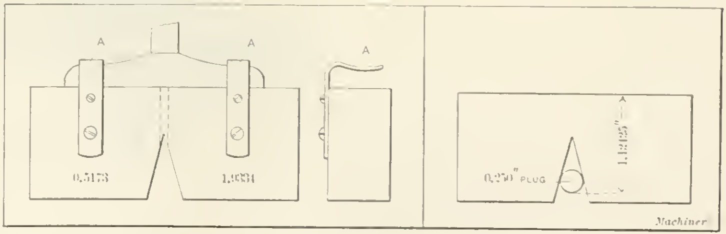


Fig. 5. Gage for measuring the Flat on Acme Thread Tool

A tool capable of making these measurements even more accurately is illustrated in Fig. 5. The gage consists of a block of steel of about ⅝ by 1⅛ by 3¼ inches in size, having a 29-degree V-groove in one face. A hole is drilled through the block from the opposite face to the vee, and two springs *A* are provided to hold the micrometer depth gage in the position shown. In making this gage, the upper face is machined down until the distance from a 0.25 inch diameter plug held in the vee to the opposite side of the block is 1.12425 inch. This locates the vertex of the 29-degree angle at a distance of 0.500 inch below the face of the block. In using the tool, the depth gage rod is run out 0.500 inch, so that its end coincides with the vertex of the 29 degree angle, which represents the "zero" from which measurements are made. With an Acme tool held in the vee, the distance from this zero, as measured by the depth gage, is 1.9334 times the width of the flat. The width of the flat is obtained by multiplying the gage reading by 0.5173. It will be found convenient to have the preceding constants stamped on the front of the block and by preparing a table giving the gage reading for tools ranging from 1 to 12 pitch on the back of the block, the work of making calculations will be greatly facilitated.

Pitch	Gage Reading	Pitch	Gage Reading
1	0.7066	5	0.1334
1⅓	0.5274	5½	0.1202
1½	0.4677	6	0.1094
2	0.3482	7	0.0924
2½	0.2767	8	0.0795
3	0.2289	9	0.0696
3½	0.1949	10	0.0617
4	0.1692	11	0.0551
4½	0.1493	12	0.0497

In the preceding table, a clearance of 0.010 inch is allowed. A similar tool for measuring the flat on U. S. thread tools was described by the writer in the May, 1912, issue of MACHINERY.

[For the tools shown in Figs. 1 and 2, the constant 0.2887 inch which must be subtracted from the reading for U. S. tools is 2 × 0.25 × tan 30 degrees. Similarly for Acme tools the constant 0.1293 is 2 × 0.25 × tan 14 degrees 30 minutes. In making the tool shown in Figs. 3 and 4, the pins *B* and *C* are set so that the distance from outside to outside is one inch when the gage is closed. In the gage for U. S. thread tools shown in Fig. 3, the distance 0.433 inch from the center of the pins to the top of the gage is determined by the ratio of the base to the perpendicular of a 30-degree triangle. In this case the base of the triangle is 0.250 inch, and this fixes the perpendicular as shown in the illustration. Similarly for the Acme tool shown in Fig. 4 the base of the 14 degree 30 minute triangle is 0.125 inch, and this requires the perpendicular to be 0.4833 inch. The constant 0.5173 for the tool in Fig. 5 is obtained from the relation of the perpendicular to the base of a 14 degree 30 minute triangle. Thus the width of the flat is twice the gage reading × tan 14 degrees 30 minutes.—EDITOR.]

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COLD-HEADING—2

REPRESENTATIVE COLD-HEADERS—LIMITATIONS OF SINGLE- AND DOUBLE-STROKE HEADERS AND REHEADERS

BY CHESTER L. LUCAS[*] AND ERNEST W. DUSTON[†]

In the preceding article the principles of cold-heading, together with its early history and a general outline of the machines employed, were given. In this article a brief description of representative machines of each of the principal types of cold-headers will be given, with statements of the possibilities and limitations of the work which may be done on each of these classes of machines. From the preceding article it will be gathered that all cold-headers, whether of the crank- or toggle-operated types may be divided into single- and double-stroke machines on the one hand, and into solid- and open-die machines on the other hand. When we consider that single-stroke machines may be of solid- or open-die types, and double-stroke machines of solid- or open-die types either crank- or toggle-operated, and that the toggle-operated machines may be either one- or two-cycle type, it will be seen that to describe each of the combinations that are found in cold-heading machinery would be an endless job. In addition to the above-mentioned class of heading machinery, there are reheaders of single-, double- and triple-strokes; and in the special industries like that of tack- and nail-making the machines are still more special, but by describing the most common of the machines in general use an adequate idea of cold-heading machinery will be given, as the general operating principles are similar.

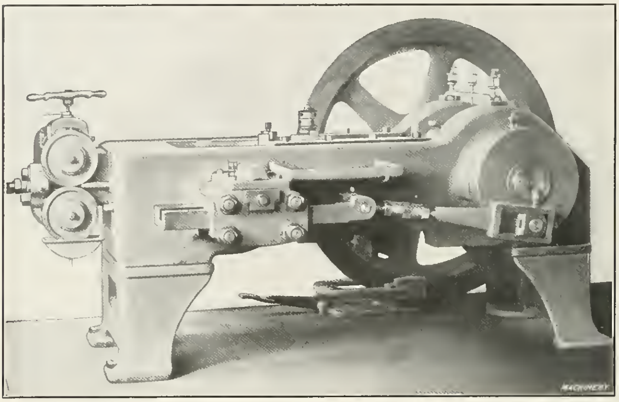

Fig. 16. Single-stroke Solid-die Cold-header—E. J. Manville Make

Single-stroke Solid-die Cold-header—E. J. Manville Make

The single-stroke solid-die header is undoubtedly the simplest of all, and for that reason has been selected for the initial description. This machine is built in six sizes; the smallest size handles wire up to 1/8 inch diameter and the largest, which is the machine illustrated in Fig. 16, handles wire up to 1/2 inch diameter. The frame is of very heavy section and the crankshaft, which is of large diameter, is made of forged nickel steel. The bushings which support this crankshaft have their bearings close to each side of the crankpin so that there is little danger of bending the crankshaft by the heavy work required in cold-heading. The wire is fed in from the front of the machine through the usual type of grooved roll and is lubricated by a reservoir below the lower feed roll. The cut-off is operated from the side in the manner described in the previous article and on this machine a safety connection is provided between the crank and cut-off cam slide. This is in the form of a shear pin so that if excessive load is placed upon the cut-off knife the machine will stop without doing damage other than shearing the safety pin. A patented form of cut-off knife is employed so that the blank will be held rigidly while being sheared and thus cut squarely. This is an essential feature on single-stroke machines, for as there is no preliminary or coning blow to centralize the stock, it must go to the dies in good condition after being cut off. The balance wheel is very heavy in design, and as it is essential that a heading machine be stopped at some point other than the center, a foot brake, shown in Fig. 16, is provided, so that the wheel may be stopped at any desired point in its revolution.

Single-stroke headers of the open-die type are not very largely used except in the wood-screw industry. The main point of difference between this type of machine and the one previously described is the die-operating mechanism, and this mechanism was described in general in the preceding article.

Double-stroke Solid-die Cold-header—Blake & Johnson Make

Fig. 17 illustrates a double-stroke solid-die header made by the Blake & Johnson Co. of Waterbury, Conn. This machine is one of the latest of its class and has some radical differences which are worthy of description. This is the first header to be made with a pan or tray between the frame and legs. In addition to catching dripping oil and odd ends of wire it furnishes a shelf for catching the finished work. This form of construction results in a more rigid machine than any of those types where long slender legs are employed. By observing the cut-off cam-slide mechanism at the center of Fig. 17, it will be seen that the cam groove is cut in the face of a segment rather than in a slide. This segment is pivoted on a stud as shown, and it is claimed that less power is required for its operation; in addition it makes a more compact arrangement. The connecting-rod which operates the cut-off cam is held by clamping at its operating end and when this clamp is set to the proper tension to do the work it acts as a safety device, allowing the

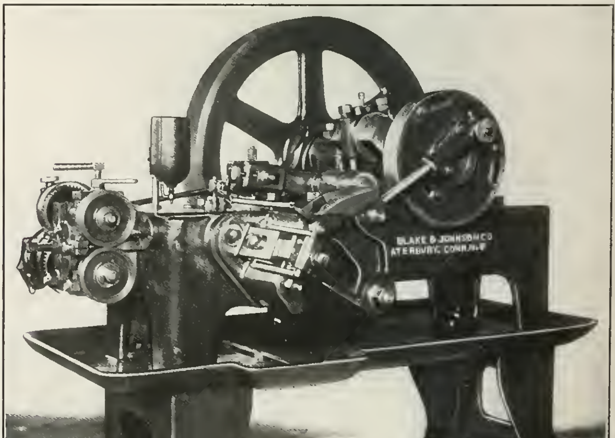

Fig. 17. Double-stroke Solid-die Cold-header—Blake & Johnson Make

connecting-rod to slip if excessive strain is placed upon it. The distinguishing feature between single- and double-stroke machines is the rise-and-fall motion which must be used for raising and lowering the punch-block so that the two punches strike alternately on the head of the wire blank. The mechanism that provides for this is the Ingraham rise-and-fall motion which was fully described in the previous article. This type of mechanism has the advantage of being located at the top of the machine where it is most accessible and convenient to adjust.

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On this machine lubrication is provided for by dripping oil from a cast-iron pot that is mounted on a stud at the head of the machine. From this pot the oil drips to a hole in the bed over the wire line from which it drops on the wire just before the latter enters the dies. Lubrication is an important feature on cold-headers especially when annealed steel or iron wire is being worked, because the lime film which remains from the annealing operation renders the wire hard to eject unless lubricated. The feed is operated by the three-pawl system so that the finest adjustments of feeding lengths may be obtained. The crankshaft bearings are cored out and provided with chain oilers, which are a new feature on cold-headers. The capacity of this machine is the heading of blanks 3/16 inch diameter up to 1¼ inch length under the head.

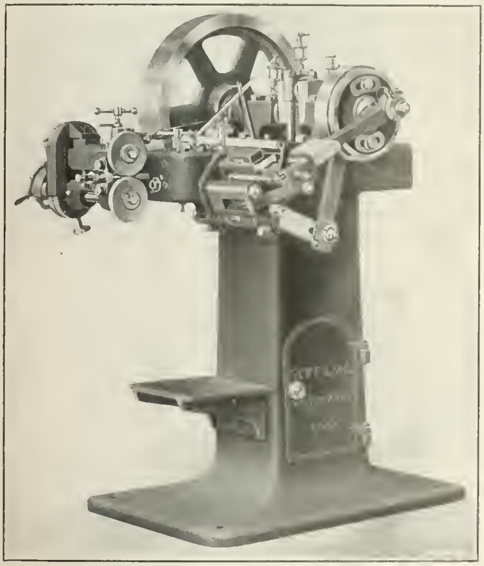


Fig. 18. Double-stroke Solid-die Cold-header, One-cycle Type—Waterbury Farrel Foundry Make

Double-stroke Solid-die Header—Waterbury Farrel Foundry Make

One of the most popular of the double-stroke solid-die headers is that made by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. The machine is made in one- and two-cycle types, shown in Figs. 18 and 21, respectively. Both of these machines are of the toggle-operated type; the operating principles of one- and two-cycle headers were explained in the previous installment of these articles. The machine illustrated in Fig. 18 is the No. 0 size and has a capacity for heading wire up to and including one-eighth inch in diameter. It is designed to handle wire rivets or blanks up to one inch in length under the head, this being the largest amount of one-eighth inch wire that can be easily ejected from a solid die. This machine has been highly developed and embodies all the latest improvements in heading machinery. On account of its being of the one-cycle type, striking two blows to each revolution of the flywheel, the machine can be run at a comparatively slow speed and still obtain a large production. As is usual in solid-die machines, the wire is fed through feed rolls and a cut-off quill, and brings up against a rigid feed-stop so that the length of the feed is arbitrarily determined. The cut-off bar is of the usual type carrying a cut-off blade at its end and in most instances the cutting off and carrying is done with the aid of a "fiddle-bow" carrier.

This fiddle-bow carrier, perhaps, needs a word of explanation, and for that reason is shown in detail in Fig. 19. The purpose of this type of carrier is to back up the cut-off blade when severing the wire and assist in transporting the blank to the heading die. In Fig. 18 a view of the fiddle-bow carrier may be seen. From this, in connection with Fig. 19 which is a view of the die end of the machine from the inside, it will be seen that the mechanism consists of a carrier *A*, supported in a bracket *B* at one end, pivoted and actuated by end bracket *C* which is bolted to the end of the cut-off slide. At the operating end of carrier *A*, an arm *D* is pivoted, being normally kept in its uppermost position through a spring-encircling rod *E*. This rod is slotted at the upper section so that the arm *D* is free to move up or down. Finger *F* is the active part of this carrier, and when the wire emerges from the cut-off quill *G*, this finger is on the opposite side from the cut-off blade, being held there by pressure of the spring located on rod *E*. When the cut-off blade advances, the wire is prevented from being deflected at its outer end under the cutting pressure and is held perfectly square while the cut is being made. Now when the cut-off blade advances with the blank toward the heading die *H*, the fiddle-bow carrier mechanism also advances through contact of bracket *C* with carrier *A* which slides through supporting bracket *B*. After it is in the heading position and the blank partly entered into the die, the cut-off slide returns and finger *F* of the carrying mechanism snaps back over the wire and brings up against the new length of wire which has advanced through the cut-off quill *G*. The advantage in using this type of carrier is that the wire is supported behind the cutting action and a square end on the blank is the result. This is important, for if the cut is not square, the head of the finished product will be "lop-sided."

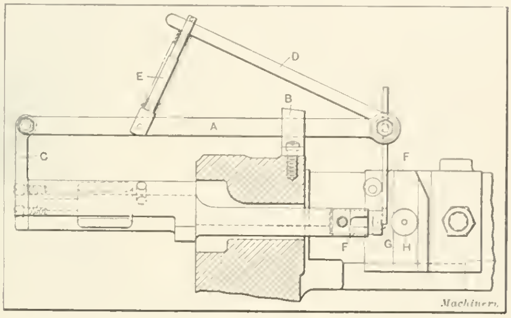


Fig. 19. Construction of the "Fiddle-Bow" Carrier

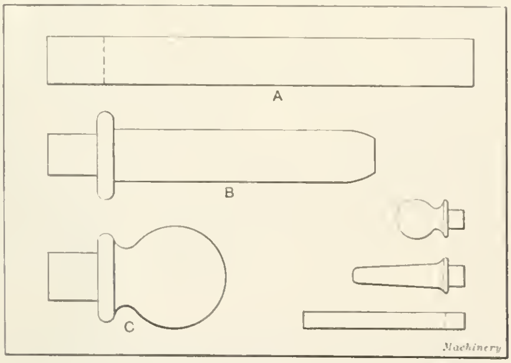


Fig. 20. Typical Examples of Reheading requiring an Open-die Machine

The heading operations are actuated by the well-known powerful knuckle-joint mechanism, of which the Waterbury Farrel Foundry Co. are exponents, and as was explained in the preceding article, the one-cycle type is characterized by the striking of one long stroke and one short stroke of the heading slide as contrasted with two strokes of even length in the two-cycle type. The relative length of the two strokes may be governed by the design of the toggle mechanism, and it is customary to strike the long blow which does the coning or bulbing first. The second blow, which completes the heading, is taken care of by the short stroke; the reason for this is that concentrating the same amount of power into a short stroke gives a more powerful heading effect—just what is wanted for the final setting of the wire. On this make of machine, the heading slide has ample wearing surfaces and is gibbed for taking up wear.

The toggles, upon which so much depend in this class of machinery, are made of a special grade of bronze with adjustable steel side plates for taking up wear. The connecting toggle-pin is, of course, of tool steel, hardened and ground. One important feature of the toggle construction is that the machine can easily be brought "off centers" by hand, in case it should get stuck while operating upon a damaged blank or on account of excessive pressure. This construction also makes the setting of the tools easy when operating the machine by hand. The feed mechanism is of the usual type with two grooved cast-iron feed-rolls through which the wire passes. Cast-iron rolls are used as it has been found that the wire slips less than when steel rolls are employed. By means of a pawl-arm operated from an eccentric on the crankshaft, the length of feed can easily be adjusted even though the machine is in motion. The cut-off is operated through a cam-slide which may be seen at the right of the machine. This cam-slide operates back and forth through the cut-off bracket, thus actuating the cut-off blade. A safety slip device is provided so that if excessive strain is brought against the cut-off blade, the blade will not be broken but will be stopped in its action by the slipping of the safety mechanism. The punch-shifting mechanism is positive, the punch-slide being shifted both in its up and down position against stop-screws so that they will surely be in line when the respective blows are struck. Adjustment is provided so that the punches may be moved sidewise, up or down, or longitudinally. The longitudinal adjustment is obtained from a broad wedge in back of the toggles at the end of the frame. The knockout is located in the end of the bed and ejects the work from the die by means of a lever that pivots in the feed-roll bracket, operated from a cam on the crankshaft. The entire thrust of the heading blow is taken on a stop-screw which backs up the knockout pin and accurately determines the correct length of rivet made.

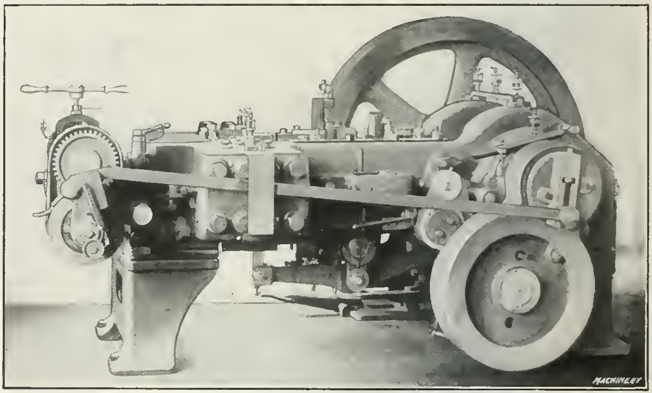


Fig. 22. Double-stroke Open-die Cold-header—E. J. Manville Make

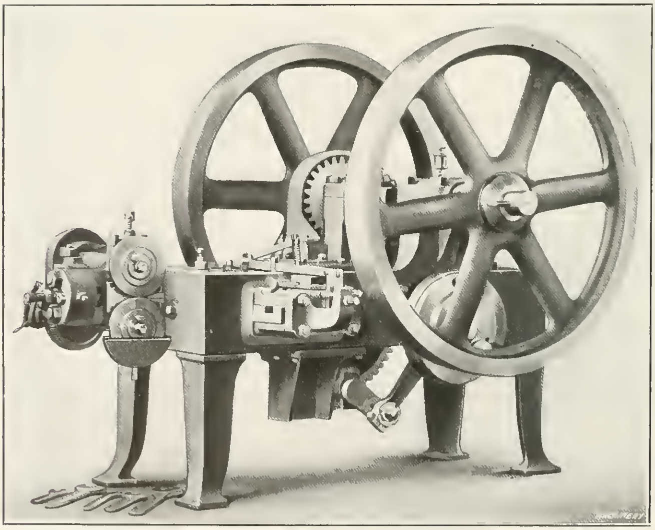


Fig. 21. Double-stroke Solid-die Cold-header, Two-cycle Type—Waterbury Farrel Foundry Make

Double-stroke Solid-die Geared Header—Two-cycle Type

The Waterbury Farrel Foundry Co. also makes a solid-die double-stroke header of the two-cycle type, and Fig. 21 shows the No. 3 size of this machine. It has a capacity for heading three-eighths inch rivets at the rate of fifty-five per minute. This is a geared machine of great power, and it requires two revolutions of the crankshaft to produce each rivet, in accordance with the two-cycle principle. This means that the feeding, cut-off and ejecting mechanism is geared down so that these functions operate only once while the heading slide is making two strokes. While this machine is more powerful than the one-cycle type, it is, of course, slower in its action, and the crankshaft and toggle mechanism must go through twice as many motions to produce a rivet as was the case in the one-cycle type. As in the previously described machine, the wire passes through the feed-rolls and cut-off quill and brings up against the feed-stop. The cut-off blade is actuated in connection with the fiddle-bow carrier which holds the blank to the cut-off blade and assists in carrying it to the heading position in line with the die. The upper heading punch strikes the first blow, forcing the blank into the die and centralizing the wire preparatory to the second blow which is struck by the lower punch, thus forming the finished head. The heading slide then draws back and the punches are shifted down ready to operate on the next blank.

The crankshaft is of large size and runs in bronze lined bearings on the larger machines. The flywheels, of which there are two on the large size machine, are held to the crankshaft between friction disks which slip and prevent damage to the machine should undue strain be imposed. The toggles on the machines are made of the best grade of cast iron, and provision is made for taking up the wear. The feed and cut-off mechanism are the same as in the type of machine previously described, and a safety shear pin is provided so that should the heading die become loose and project out far enough to prevent the cut-off knife from passing, or should the cut-off knife be obstructed from any other cause, the safety shear pin will be severed, causing no other damage to the machine. This shear pin is a plain straight piece so that it is a simple matter to insert a new one.

A relief motion can be furnished for this machine if desired. It consists of a mechanism that allows the knockout pin, against which the blank is forced during the heading operation to draw back after the blow is struck. This allows the metal to flow into the dies more freely on the second blow, and is especially desirable on such work as requires squares or shoulders underneath the head. By a proper knowledge of the use of this relief motion, a great many difficult jobs of heading can be accomplished with facility.

Double-stroke Open-die Cold-header—E. J. Manville Make

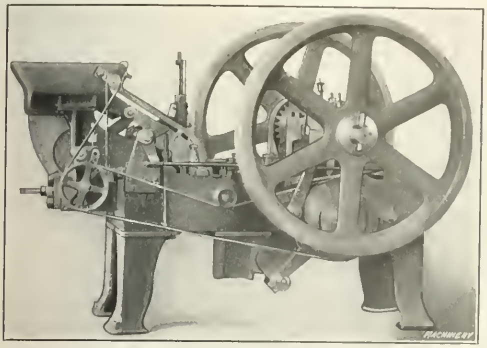


Fig. 23. Double-stroke Solid-die Reheader—Waterbury Farrel Foundry Make

Double-stroke cold-headers of the open-die type are the most complicated of the ordinary run of heading machines, for in addition to the rise-and-fall motion for operating the punch block, provision must be made for opening and closing the dies. In Fig. 22 is shown the E. J. Manville double-stroke open-die header. This machine is made in four sizes; the one illustrated is the No. 4 machine which handles wire up to one-half inch diameter. This header is of the crank-operated type, and the wire enters through feed-rolls of the usual type and thence to its cut-off position between the square dies. The dies are then forced sidewise, shearing the wire and carrying the blank over to the heading position. When in line with the backing block, the first or coning punch centers and partly heads the wire, leaving it in condition for the second punch to finish the work. On this machine the punches are locked automatically in both up and down positions while the blows are being struck. Another distinguishing feature of this machine is that the wire feed is operated from the right-hand side of the machine as may be seen in Fig. 22. This leaves the front corner of the machine on the wheel side free from all mechanism so that the operator can observe the working of the tools easily.

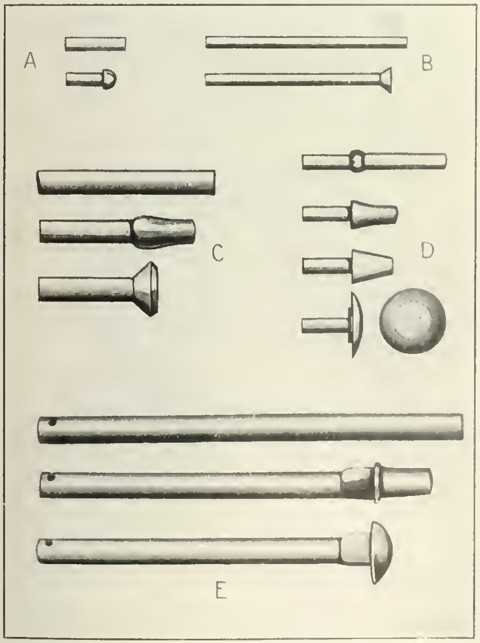


Fig. 24. Examples of Cold-heading from Different Types of Machines

The feed-pawl operates only at every second stroke of the machine, for it will be remembered that this is a double-stroke machine. By means of a handwheel which may be seen opposite the lower parts of the ratchet feed wheel a quick and accurate setting of the pawl may be made and it may be regulated while the machine is running. The wire feed is easily started or stopped by a hand lever.

A safety connection is provided between the die-operating cam and the crankshaft, in which there is a cast-iron plate. Should any obstruction prevent the dies from closing, this cast-iron plate will break and drop to the floor, thus instantly disconnecting the crank and cam-slide. An automatic throw-off instantly stops the wire from the feed when this safety device is brought into play. This machine is also provided with a foot brake to assist in stopping the header at the proper point.

Waterbury Farrel Foundry Double-stroke Solid-die Reheader

The varieties of reheaders are almost as numerous as all the other types of headers combined. The most common types, however, are the single- and double-stroke machines of solid- or open-die types. A representative machine of the double-stroke solid-die type is illustrated in Fig. 23 which shows a machine made by the Waterbury Farrel Foundry & Machine Co. This machine takes partly headed rivets or screw blanks after they leave the heading machine proper, and by means of a hopper feed, the blanks are automatically fed to the die in the reheader, thus making the operation entirely automatic. Automatic hopper feeds are of different types, but the usual form consists of a hopper into which the blanks are thrown promiscuously. They are caught by their heads in a blade which has a slot at the top, slightly wider than the body of the blank. This blade rises vertically through the center of the hopper, and as it passes through the mass of blanks, some are sure to be caught by their heads and are carried to the uppermost position, where there is an extension of the slotted inclined chute. The blanks slide

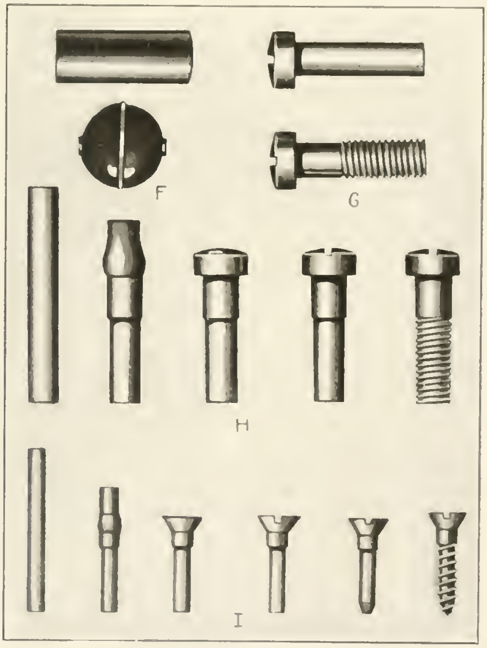


Fig. 25. Some Applications of Cold-heading

down this chute, which may be seen between the hopper and the flywheel, Fig. 23, and a guard which passes over the heads of the blanks prevents any which are not in the proper position from passing. A transfer slide on a line with the dies supports a pair of fingers that pick a blank from the carrier slide and deliver it at the proper time to the heading die where the punches do the reheading. The operation of the heading mechanism is practically the same as that of the standard heading machines; in fact some of the types of standard heading machines can be fitted with reheading attachments. To do this it is necessary to take off the cut-off slide and substitute a transfer slide for conveying the blanks to the die. The reheader here shown, has a capacity for handling ⅜-inch wire, producing from 50 to 60 rivets per hour.

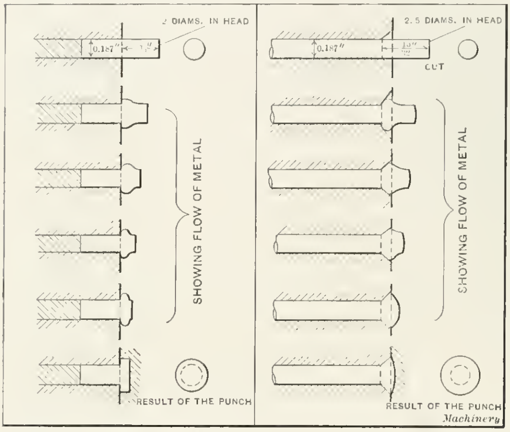


Fig 26. Evolution of Screw Blanks made on Single-stroke Cold-headers

Cold-heading Operations

After describing the different types of cold-heading machines the next step is to take up the work for which each type is best adapted. By the process of elimination we can dispose of the open-die types of machines with the simple statement that, if the blank to be produced is over nine or ten diameters of the wire in length under the head it must be made upon an open-die machine. There are, of course, exceptions to this rule, but they are so special that they need not be considered here. In general, open-die machines are faster than solid-die machines of the same size, as the open-die cut-off mechanism is simple and much more rapid in its action. A rivet or screw-blank made on an open-die machine is easily distinguishable by light raised lines under the head and along opposite sides, caused by the metal being crowded into the crevices between the dies when the heading pressure separates them ever so slightly. The tools used in the open-die machines are more costly to make, and each set is good only for one particular length of rivet. In speaking of the wire in units of diameter, all sizes are included under the general rules. Thus, while only 1¼ inch of ⅛-inch wire can be ejected from a solid die, 3¾ inches would be the limit when working ⅜-inch wire. Similarly, when heading in the single-stroke machines, two and one-half diameters of any size of wire is all that can be put into a head.

Single-stroke Heading

Excluding reheading, we have only the single- and double-stroke heading to consider, since the heading operation on solid- and open-die machines are the same. It has been stated that the limit which may be reached with a single-stroke cold-header is the upsetting of two and one-half diameters of the wire into the head. By this we mean that no matter how soft the wire is, nor how carefully it is cut off, an unsupported length of two and one-half diameters irrespective of the size is all that can be controlled by a single heading punch. If a larger amount of wire is left unsupported and struck by the heading punch it will buckle at the center and be forced over to one side. A typical single-stroke solid-die heading job may be seen at *A* Fig. 24. The upper illustration shows the wire blank and the lower view the finished piece. At *B*, to the right, is a similar single-stroke heading job, but one which requires an open-die machine on account of its length. Now, turning to Fig. 26 the action of the metal under the heading operation may be followed. In the upper illustration the blank is represented with the metal for the head, comprising two diameters, extending from the die. The four illustrations which follow are intended to convey an idea of the way the metal spreads under the advance of the heading punch. The heading punch is, of course, in this case recessed to shape the fillister head which is to be given the blank. It will be seen that we have here the same result as was obtained in our preliminary experiment with the hammer in the first article. The metal, when first under pressure, commences to bulge next to the die and continues spreading out until confined by the limits of the recess in the punch. At the right-hand side of Fig. 26 we have a similar single-stroke heading operation taking place on a wire blank which was too long to be headed in a solid die. In this instance the head was oval, countersunk in shape and two and one-half diameters were upset in the head. This represents practically the limit of a single-stroke heading operation. The flow of the metal is represented by the four illustrations within the brace, and the lower view shows the completed blank in the die ready for ejection.

Double-stroke Heading

It is on double-stroke heading operations that we find the most interesting as well as the most difficult work. Referring to Fig. 24, a double-stroke solid-die product may be seen at *C*, and at *E* a double-stroke open-die product. The only reason for using the open-die machine for producing the work shown at *E* is on account of its length. The head in itself could just as well have been produced on a solid-die machine of the double-stroke type.

In all double-stroke heading operations the first blow, known as the coning blow, is used for centering and starting the heading operation, and leaves the wire in condition to be readily finished by the second blow which does most of the work. Referring again to *C* in Fig. 24, the upper view shows the wire cut off, and in the center is shown the result of the coning blow. The punch which does the coning is shaped so as to "gather" the stock, tapering it at the end and allowing it to partially head next to the die, so that when the second blow is struck the metal will flow naturally toward the desired shape. When the blank is cut off the end is apt to be "out of square" which, of course, means that more metal would be on one side of the head than on the other, and if struck without being centered, the result would be a "lop-sided" head. The limit of the double-stroke heading machine is the upsetting of five diameters of the wire. On certain grades of metal and by using extreme care this

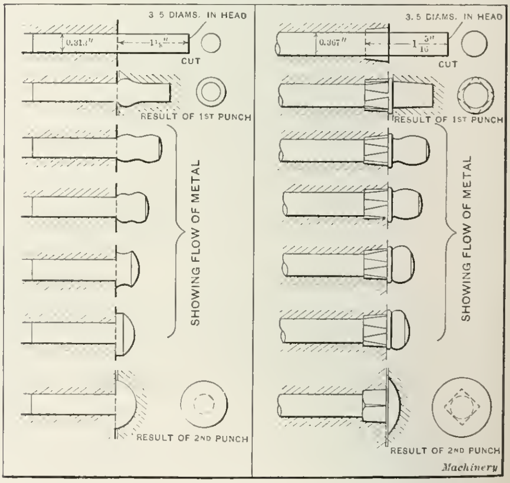


Fig. 27. Evolution of Screw Blanks made on Double-stroke Cold-headers

rule may be slightly exceeded, but a five-diameter head is very nearly the limit. In Fig. 27, at the upper left-hand corner, may be seen the wire blank which has been cut off and is in the die ready for heading. In this instance there are three and one-half diameters of the wire left projecting from the die to be upset into the head. Directly below this may be seen a view which shows the result of the first or coning punch. The four views which follow show exactly how the wire upsets in forming the head, until at the extreme bottom is shown the completed blank, ready for ejection. On the right-hand side is shown the same series of views to illustrate the making of the head of a wagon bolt, which, because of its length, was made on an open-die double-stroke machine.

Many heading jobs are performed upon a double-stroke machine that would seem to come within the range of the single-stroke machines. The reason for this is that with the double-stroke machine the metal can be controlled to a higher degree of accuracy, and for that reason on accurate work the double-stroke machine is often used even though the head requires less than two and one-half diameters of the wire.

Fig. 25 is shown to illustrate some practical applications of cold-heading. At *F* is shown a blank and a headed ball, such as is used in the ball bearing industry. Heading machine manufacturers have given special attention to the heading of steel balls, so that cold-heading is now the usual way of producing ball blanks. At *G* is shown a screw blank and a rolled thread screw, which illustrate a condition of thread rolling practice. When the screw threads are to be rolled, and it still desirable to have the unthreaded section of the screw of the same diameter as the threaded section, the method of heading shown at *H* must be followed. In this section of the illustration the steps in making a rolled thread screw of uniform size are shown. First we have the cut off blank; second, the partly headed blank in which the section which is to be left unthreaded has been upset enough larger to match up with the diameter of the thread which will be rolled upon the lower section. The completely headed blank is shown next, then the slotted head, and last, the finished screw with the rolled thread. Similarly at *I* are shown the successive steps in making a wood screw, and the manufacture of machine and wood screws like those shown forms one of the most extensive uses for cold-heading machinery.

Reheading

Reheading is a more important branch of cold-heading than is generally recognized, and some of the "stunts" which may be accomplished with the proper knowledge of reheading machinery strongly emphasizes this fact. Reheading is usually necessary for one of two reasons; either to produce a head which would require too much work for the double-stroke machine to do, or to produce a head which is larger at the end than at the shoulders as in the case of hinge pins like those shown in Fig. 20. Even though the blanks are usually annealed before going to the reheaders, this operation is one which requires a great deal of force because the metal has already been compressed and is very dense before being reheaded.

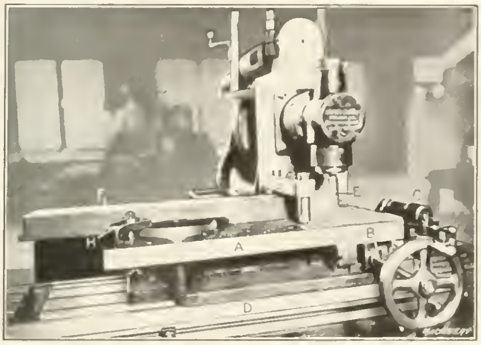
A good example of a reheading job is shown at *D* in Fig. 24. The first two pieces represent the work of the double-stroke solid-die heading machine, and from this point, the blanks are handled in a double-stroke solid-die reheader. The third illustration from the top in this group shows the result of the first reheading operation, and a plan and side elevation of the completed piece is shown beneath. The diameter of the head is very great, as compared with the diameter of the shank of the rivet and it will be readily appreciated that four operations were necessary to keep the metal under control and completely head the piece.

For producing hinge pins like that shown in Fig. 20, an open-die reheader is necessary. This is really a very interesting job of cold-heading, as there are eight diameters of the wire in this head. Two operations are necessary to bring the blank *A* into the position shown at *B* and these operations are performed upon a double-stroke header. After this point, the partly formed blanks are annealed and finished in a double-stroke open-die reheader, producing the result shown at *C* in two additional operations. The hinge pin shown at the right-hand side is similar but smaller.

LARGE CIRCULAR MILLING ATTACHMENT

The circular milling attachment shown in the accompanying illustration was designed by the Oesterlein Machine Co., Cincinnati, Ohio, for milling the arcs on the ends of its cutter grinder tables. This operation was previously accomplished on a regular circular milling attachment, but this proved to be inadequate for the work in hand. The chief reason for this was that the point of cutting was too far removed from the source of power, so that an excessive strain was imposed on the rotating mechanism of the circular milling attachment when it became necessary to carry the work around against a fair cut.

After trying different methods on the regular circular milling attachment with unsatisfactory results, the attachment shown in the accompanying illustration was made. The top part *A* of this fixture is cast with a projecting lug in which worm teeth are cut, which mesh with a worm mounted on the shaft *B*. The worm is driven from the universal-jointed shaft of the milling machine through the small fixture *C*, which is attached to the milling machine table and is of similar construction to the feed-box used for governing the table reverse. The bottom part *D* of the fixture is clamped to the milling machine table, and is located in proper alignment by tongues fitting in the table groove.



Circular Milling Attachment used by the Oesterlein Machine Co. for milling the Radius on the Ends of Tool Grinder Tables

It will be noticed that the source of power is practically directly under the end milling cutter *E*, which is used for milling the arcs on the ends of the grinder table *F*. This feature enables heavy cuts to be taken with ease and dispatch. The work is clamped to the fixture by a swinging clamp *G* and two L-shaped clamps *H*, only one of which is shown.

D. T. H.

* * *

The enormous increase in number of internal combustion engines and the consequent greatly increased use of gasoline and fuel oil, has caused considerable apprehension as to the future of the internal combustion engine. If liquid fuel supply becomes inadequate to meet the demand, the future of the automobile and motor boat industries, to say nothing of other industries depending on the internal combustion engine, will be greatly restricted, if not crippled. Interest, therefore, is keen in the invention of Mr. Archibald Low, an English engineer, who has developed a gas engine using coal direct. The engine is virtually a gas engine with a gas producer in the cylinder. Mr. Low has built an engine of 80 to 100 H. P., that operates satisfactorily. Pulverized coal is fed to the cylinder by worm conveyers running in tubes located across the cylinder in the head. The tubes act as a gas producer and distill the gases from the coal during its progress through the cylinder. The ash is discharged on the opposite side of the cylinder from the coal feed hopper. The fact that an engine of this type is very compact, that all the apparatus is in one unit and that it can use coal of the cheapest grades, makes the development of extraordinary interest to engineers and all users of power. It has not been developed to the stage where it can be regarded as a competitor of the ordinary gasoline type for vehicles, but its compactness and simplicity give promise that it may become so.

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CIRCULATING CATALOGUES IN SHOPS

Progressive manufacturing concerns generally encourage their employes to read technical books and journals which better fit them for their work. Intelligent, well-informed employes familiar with improved machines and methods connected with their work are among the most valuable assets—for want of a better term—that a concern can possess. They are, as a rule, better contented than ignorant men, they take more interest in their work and have a wider range of subjects to think of. Reading and thinking awakens their interest and stimulates their ambition so that valuable inventions and improved methods originate where such men are employed. The atmosphere of such shops is agreeable to a stranger of the same character, and a mechanic coming to a plant of this type finds it congenial, if he too is of the progressive type. Thus kindred minds flock together, and the result is an expanding group of very desirable employes.

To foster the spirit of self-help and the desire to know more, is not always or altogether an easy matter. If undertaken in a paternal or patronizing manner, resentment may be aroused and the effort rendered fruitless. To advertise educational work is to defeat the object with some men; but if books and papers are provided unobtrusively and apparently incidentally at first, the taste for them is cultivated and stimulated.

An effective means for interesting men are the catalogues issued by other manufacturing concerns. These can be made part of a circulating library scheme, and instead of being carefully filed away where they rarely are seen, they can be made effective in placing descriptions of the latest machinery in the hands of men likely to study them with interest and profit. Not only will such study be beneficial in itself, but it will often result in suggestions for installing machinery and tools in the plant that will increase production and reduce costs. Concerns that circulate catalogues have found a keen interest manifested in them by men who rarely read a book of any kind. Studying catalogues often helps such men to form a taste for technical books, and especially for trade journals which bring the information in catalogues right up to date and keep the reader informed on all the latest ideas, developments and short cuts in his field. The employe who reads the literature of his trade becomes thoroughly familiar with the tools and methods employed in it, and learns to think and act for himself. Such a man is a constant source of original ideas in a plant and increases in value from year to year.

* * *

TAKING CARE OF CHIPS

The function of common machine tools is the production of chips. The removal of excess material leaves the form desired, whether the operation be drilling, milling, turning or planing. When the amount of material to be removed is small, or a small fraction of the total volume of the piece machined, the disposal of chips is readily accomplished, although usually it is done in a careless and untidy manner, but when the amount of material removed is relatively large and its removal is accomplished in a short time, the problem of taking care of chips is of considerable importance. A lathe turning a steel shaft for example, will soon accumulate a large pile of springy turnings which strew the floor and pile up on the machine. Chip-breakers are evidently required, and also chutes or conveyers for carrying the broken chips away as rapidly as produced.

Such conveniences are not likely to be provided for lathes except for those uncommon situations where the chip production is abnormal. But what can be done, and what should be done for milling machines particularly, is providing tables with wider channels for chips. More chip room would mean relieving the operator of the necessity of frequently removing the chips. The channels commonly provided are narrow, and a small narrow hand shovel must be used to clean them out. Wider channels would require less frequent cleaning, and when cleaning was necessary a broad shovel could be used to remove them quickly. The article by Mr. Smart in another part of this number is written in the light of experience with milling machines in general, applied to specialized manufacture. The importance of wider tables and larger channels for chips should be realized by milling machine makers especially, and machine tool builders generally.

* * *

SYSTEM FOR SYSTEM'S SAKE

Why are practical shop men often so antagonistic to shop systems? Is it not because these systems are often installed by office men who are out of touch with the actual shop conditions, who look upon the men working under the system as mere cogs in a machine, and who often require systems to be adhered to so rigidly that instead of the system being an auxiliary and helpful means to production, it becomes an inflexible law that can never be adjusted to suit conditions? In other words, they devise a system for system's sake. An interesting example of system running wild is told of a large eastern shop.

A machine had been promised for delivery on a certain date, and a heavy penalty had been prescribed in the contract of sale in case of delay of delivery. The foreman of the erecting department had been informed of this fact and was prepared to have everything ready for shipment on the date required. Some castings of a special alloy used on the machine, however, were ordered from another firm, and were not delivered in time to be machined and assembled with the machine, so that delivery could be made on the prescribed date. The foreman, eager to avoid the penalty that would be required of his firm, remembered that castings of the same alloy, intended for use on a larger size of machine built some time before, had been scrapped on account of a mistake in the machining operation. He looked them up and found that they were large enough to be worked over to fit the present machine. He had these pieces finished, assembled with the machine and the machine delivered on time. A few days later, the castings originally ordered for the machine were delivered. The foreman turned them over to the storekeeper in the unfinished state, but the storekeeper could not, under the system, accept the pieces before they had been machined and declared (on a special form provided for the purpose) to have been spoiled, and hence could be classified as scrap.

When a system is being operated for its own sake in this manner, it is time to reform it. Systems should facilitate production and should be flexible enough to permit of exceptions when the exceptions save time and effort.

SOME ASPECTS OF AVIATION

During the last five years, the governments of the United States and of European and South American countries have expended more than $86,000,000 in the building and operation of 2125 aeroplanes and 115 dirigible balloons. In four European countries, there was also raised by public subscription an additional sum of $7,000,000 for military and naval aircraft—a total expenditure of more than $93,000,000 during this period. The present plans of Germany alone call for an expenditure, spread over the next five years, of $37,500,000 for these purposes. The "nations' airy navies" grow apace.

A glance at the results which have been attained will show reasons for this feverish activity in development and construction. Air-craft are no longer the dream of a visionary, but factors of grave importance in the scheme of national defence. The aeroplane has made a speed of 114 miles an hour; it has traveled for thirteen hours at an average speed of 49 miles an hour; it has climbed to an altitude of 3.64 miles; and it can be built to carry a total load of more than half a ton. Communication by wireless can be maintained with it; in Europe, it has been equipped with machine guns; at a height of 3500 feet, it is, in general, immune from small arms and shrapnel fire, and, at one mile, it is both absolutely safe and invisible to the naked eye, although, even at that altitude, a trained observer can distinguish between troops of the various arms below.

The latest dirigible is a huge ship, whose gas-bags have a capacity of 688,350 cubic feet and a total lifting power of 24.2 short tons. Recent ships like this can float for fifty hours, have a speed of fifty miles an hour in favoring air, can cruise for more than 2000 miles, and each carries an armament weighing two tons. Their disadvantages are their great bulk, their vulnerability, and the sinking effect of rain and snow. The commercial Zeppelins are now making fairly steady runs in passenger service, and, with greater experience in handling them, their spectacular wrecks have ceased, while military authorities, in Europe at least, regard the dirigible, in its capacity for extended operations, as a formidable engine of war.

While the basic principles of the art of flying were virtually established in the United States by Prof. Langley, and its first successful applications were made here by the Wrights, its commercial development in this country lags so far behind that in Europe as to be almost negligible. There are now more than three hundred manufacturers of aeroplanes and their accessories, and but twelve of these are American. Our product in 1912 was 174 machines as against 1600 in France alone. In Germany, there are more than fifty companies engaged partly or wholly in this work.

One of the reasons for this stunted commercial growth is doubtless the long death-roll of the aeroplane, due so largely to reckless aviators in the early exhibition days. This stage has passed, automatic stabilizers have appeared, and the hydro-aeroplane, traveling in relatively steady air over water-courses, is now a reasonably safe machine. The main cause is, however, the lack of governmental encouragement. Despite the importance of aerial navigation in national defence, Congressional appropriations have been most meager—not more than half a million dollars from the beginning. Approximate estimates place the total investment, the world over, in aeroplane manufacture, aviation schools, etc., as $250,000,000. The proper equipment of our army and navy would restore and stimulate private interest and aid in giving the United States its rightful share in this great commercial opportunity.

* * *

THE MACHINIST

It is advantageous for the young man who has a liking for the machinist's occupation to go into the producing end of the works. Fifty per cent of the young men who complete a course in a technical school go into the drafting room. The work there is clean and honorable and necessary. It requires skill of hand combined with a considerable degree of technical knowledge. Sometimes, too, men advance from the drafting room to better positions. More often they stay right in the drafting room. When they rise to executive positions they, of course, receive desirable salaries. Draftsmen rarely receive more than $80 or $90 a month, however, and they are to be found in plenty. The supply seems to exceed the demand.

The same is not true of the man in the shops, speaking now of the intelligently trained machinist who takes a pride in his work and who is willing to strive, either individually or as one of the shop group, to increase production or better it. The results of his work are apparent in increased or improved production. The office man or the draftsman has not an equal opportunity. The results of his work are but vaguely apparent or not apparent at all. Moreover, there is a constant cry from the administration end of the factory for good executives, capable foremen and superintendents, as well as for men in the shops who can and will work with all their intelligence. That is the kind of a man who becomes an executive. Here the demand exceeds the supply.

Two phases of the situation perhaps render opportunity for the young, capable, enterprising machinist better than ever before. One is the automobile industry, which has enjoyed such a tremendous growth within a very few years. While the demand in this industry, because of the division of the processes of manufacture, for superior machinists is not so pressing, that very fact gives the ingenious young man a better chance. Most of the individual machinists in an automobile factory perform only a few operations. Each machinist works on some particular part of the engine or car, and he is thus merely a cog in a great manufacturing machine. Working in such a shop, however, the keen-eyed, observant machinist can often detect points at which production can be improved or increased without increasing expense, thus actually reducing the cost of manufacture. Suggestions of this character should always be gladly received by the manufacturer or his executives. Credit for them often means better positions for the man who suggests them.

The second factor which creates opportunity is the introduction into the shops of much foreign labor. They, as a rule, do heavy, mechanical work in a heavy, mechanical way. It is assumed that the bright American youths who study the machinist's trade are not only fitted to become capable journeymen but that they are properly ambitious to advance to higher positions.

An instance of rapid self-betterment is found in the cases of three young men who completed their apprenticeship four years ago. They immediately started a shop of their own in Muskegon. Now it is said that any one of the three can write his check for $25,000. And their foreman in apprentice days, who studied and worked with them, is now with the General Electric Co. in Schenectady, N. Y., on a salary approximating $6000 a year.

Such schools as the Lewis Institute, which offers a part time course for machinist apprentices, afford good opportunities for practical study leading to responsible positions. One graduate of this course had completed only the sixth grade in the public schools. When he began the machinist's course he had been in a machine shop six months and his work had consisted largely in keeping the shop in order. Seven months after finishing the two years' course his wages had increased 60 per cent, and now, less than two years after his graduation, he is assistant foreman in the shop where he was employed while taking the course.

Even though the young machinist were not ambitious, however, he might be assured of a fair living as a journeyman. At the present time shop men are paid 39 cents an hour, or about $3.50 a day of nine hours' work. Compared with some of the other trades the wage does not seem high, but there is little risk in the work and employment is steady. Trades that pay much higher wages are usually hazardous and irregular. Machinists on construction work, for example, receive 67½ cents an hour, or about $5.40 for an eight-hour day, because the work is more hazardous and is intermittent. Like virtually all the trades, the machinist's wages have risen. About ten years ago the shop machinist received from 23 to 27 cents an hour and worked ten hours a day. Then the erecting machinist got about 40 cents an hour.—*Chicago Daily News.*

* * *

Let us not forget while striving for higher efficiency, says one of our contemporaries, that better work and higher quality should be as important items as mere increase in production.

METHODS OF FINISHING METAL SURFACES

THE PURPOSE OF VARIOUS FINISHES AND HOW THEY ARE APPLIED

BY EDWARD K. HAMMOND*

The term "finish" is used to denote the final step in the production of any product, and the finishes applied to metal surfaces are obtained by a variety of methods. Among these, the following may be mentioned: Machining the natural surface of the metal to the required shape and smoothness; covering the surface of the metal with some protecting coating such as paint, lacquer, enamel or some other metal; or by heat-treating the metal to make it take on some desired color or property. Finishes are applied for three general purposes: First, to improve the appearance of the product; second, to protect the metal from deterioration; and third, to add to the mechanical efficiency with which moving parts operate in contact with one another. These three considerations over-lap each other to a considerable extent. For instance, the parts of many mechanisms are carefully finished by lacquering or other means, the primary object of which is to make them attractive in appearance; at the same time this finish serves the additional purpose of protecting the metal from corrosion. Another example of this kind is seen in the case of cutlery and other steel products which are given an extremely smooth finish. Experience has shown that very smooth surfaces are not so likely to be affected by rust as rough surfaces, the reason being that there are no cavities to hold moisture that will act on the metal.

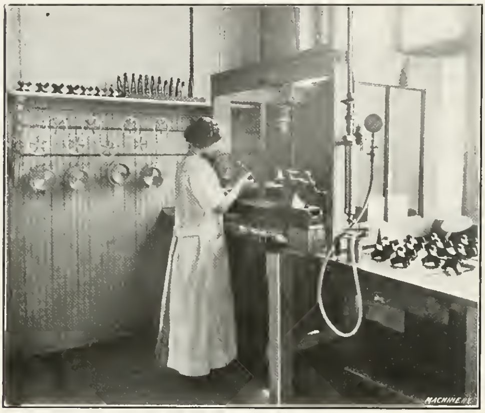

Fig. 1. Lacquering Round Pieces mounted in a Lathe

The question of the amount of finish which should be put onto machinery for the purpose of adding to its appearance is one over which there is considerable difference of opinion. Those who go to the extreme in one direction claim that no time should be devoted to the production of finish which is for a purely decorative purpose, the argument being advanced that the purchaser of the machine is paying in such cases for work that is of no value to him. The advocates of finish go to an extreme in the other direction, stating that the appearance of a machine is, to a certain extent, responsible for the ideals which a mechanic will attempt to attain in the work that he turns out on it. For this reason, they claim that it is desirable to produce machines upon which the finish has been brought to at least a reasonable degree of perfection. Both of these extremes are undesirable, the proper degree to which to carry the finishing of machine parts probably lying somewhere between the two. It will, of course, be obvious that different classes of machinery require the finishing of their parts to be brought to a different degree of perfection. In all cases, however, it should be borne in mind that any finish used must be of a character that will not deteriorate rapidly under conditions of service for which the machine is intended.

Finishes used by the Eugene Dietzgen Co.

In the factory of the Eugene Dietzgen Co., Chicago, Ill., which is engaged in the manufacture of surveyors' instruments, a number of interesting methods are used in finishing different metals to produce a variety of attractive results. The problem in finishing parts of surveying instruments is of the class referred to in which the finish must serve the double purpose of producing an attractive appearance and protecting the metal from deterioration. There are also special problems which have been solved by the application of finishes, two of which will be referred to in later paragraphs.

Silver Finish

In deciding upon the best finish for the compass box of a transit, several considerations are involved. First, the surface must be of a light color in order to enable readings to be accurately made; and second, the surface of the dial must be of such a nature that the surveyor will be able to read the instrument from all positions without being hindered by the glare of the reflected light. The finish finally adopted by the Dietzgen Co. to accomplish this purpose is known as the "silver finish" and is produced in the following manner: The dials consist of phosphor-bronze castings which are turned and ground to as smooth a surface as possible. It is impossible, however, to reduce the surface to the desired degree of smoothness by grinding, and for this purpose the surface is lapped down with a glass plate and pumice powder. The preparation of the pumice powder is as follows: Ordinary commercial pumice powder cannot be used for this purpose in the form in which it is put on the market, owing to the coarse particles which it contains. To remove these particles, the commercial powder is placed in a glass jar and water is added to it. The powder is then shaken up in the water and allowed to settle for several hours; this treatment causes the coarser particles to sink to the bottom of the jar and the upper portion of the liquid containing the finer particles of pumice is decanted into a second jar. This process of washing is repeated three or four times, the upper portion of the pumice powder being transferred to the next jar in each case. The final powder obtained by this method, containing only the finest particles, is used for lapping down the dials. If the ordinary commercial pumice powder were used, the coarser particles would produce scratches that would spoil the appearance of the surface of the dial.

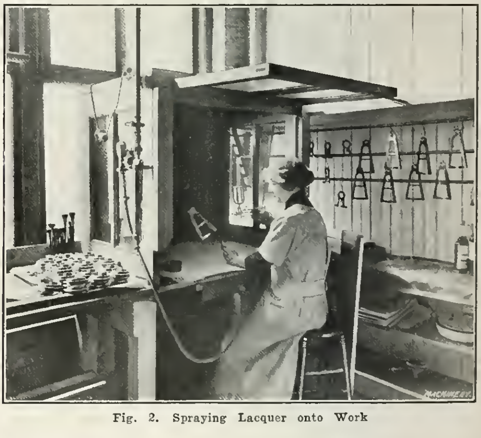

Fig. 2. Spraying Lacquer onto Work

After being lapped, the work is ready to receive the silver finish. In the case of this silver finish, and also the three other finishes which will be referred to in the following paragraphs devoted to methods used by the company, it is necessary for the surface of the metal to be chemically clean before attempting to apply the silver paste. In the present case the surface of the casting is thoroughly washed with a solution of ordinary salt and water. After the work has been cleansed by this means, the surface is rubbed with silver paste until an even coating of silver is formed over the surface of the dial. The dial is again carefully washed and allowed to dry after which it is graduated and then given a coat of colorless lacquer.

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*Associate Editor of MACHINERY.

The silver paste is made up as follows: Five ounces of silver shavings are placed in a glass jar containing sixteen ounces of nitric acid, and after the silver has dissolved, chloride of sodium is added to the solution until no more white precipitate is formed. When this result has been obtained the white precipitate of silver chloride is filtered off and mixed with ten pounds of cream of tartar, care being taken to secure a thorough mixture. This silver paste is then placed in sealed opaque glass bottles to preserve it from the atmosphere and the action of the light until used.

Lacquering Copper Composition Surfaces

Different grades of metal are used in the construction of surveying instruments and the company has been able to secure some particularly attractive finishes by the use of suitable lacquers which bring out the color of the copper composition and at the same time protect it from tarnishing. The work is machined in any approved fashion to produce a smooth surface and is then thoroughly cleaned by washing with gasoline to remove any oil or other form of grease before the lacquering operation is commenced.

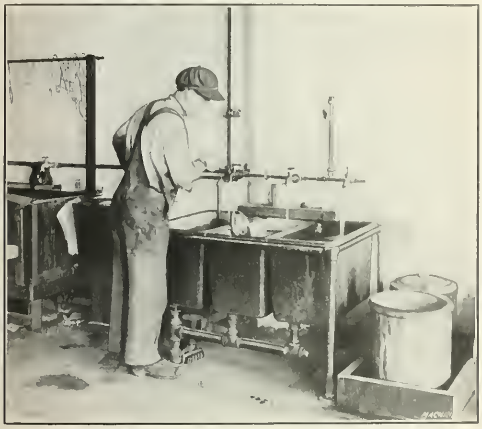


Fig. 3. Method of dipping Work in Bronzing Solution

In the case of circular surfaces such as the eye-pieces of transit telescopes, etc., the work is mounted in a bench lathe and the lacquer applied to the revolving surface with a camel's-hair brush. The work is given a number of successive coats, the number of coats applied depending somewhat on the character of the work in hand. Each coat is very thin and is dried by the heat of a Bunsen burner so that it is not necessary to lose the time which would be taken up in remounting the work in the lathe for each successive coat. In the case of other than the circular shaped pieces, the work is held by one end with a pair of pliers and the surface is lacquered with a camel's-hair brush. In finishing all classes of work in this way, care must be taken to have the lacquer spread perfectly smooth and considerable dexterity is required on the part of the girls who do this work.

In addition to the method of applying the lacquer with a camel's-hair brush, the company has recently adopted the method of spraying lacquer onto certain classes of work. The lacquer is held in a small pot and the flow of lacquer is controlled by a button which is pressed down with the thumb. When this button is depressed a stream of compressed air is admitted to a small injector situated in the tube leading from the lacquer pot to the nozzle. The action of this injector draws the lacquer up from the pot and discharges it through the nozzle onto the surface of the work. The advantage of this method lies in the fact that it is a relatively simple matter to secure an even distribution of the lacquer, and the work can be done with considerable rapidity. This method of lacquering is conducted in a draft-hood which is exhausted by an electric fan, so that the lacquer fumes are drawn away before they become objectionable to the operator. A careful study which has been made of the selection of the proper lacquer for each class of work has resulted in the production of a number of particularly attractive finishes, in colors ranging from lemon to a deep gold and with a high luster in all cases.

Bronzing

A number of the parts of the Dietzgen transits and levels are finished by a method of bronzing which can be applied to practically any metal. Work which is to be finished by this method is turned to the desired size and the surface is then finished as smooth as possible, the final surface being obtained by rubbing the work with fine emery paper. After the desired surface has been obtained the work is thoroughly cleaned by washing with gasoline, and it is then ready to be dipped in the bronzing solution. Two large earthenware jars are used for this purpose, the first containing the bronzing solution and the second water. The work is suspended by a wire and dipped into the bronzing solution for the required length of time to secure the necessary deposit upon the surface; it is then dipped in the jar of water and thoroughly washed, after which it is hung on a wire and allowed to drain and dry. At this stage the surface of the metal is covered with a deposit of dark colored metal closely resembling bronze in its appearance, and the surface produced in this way can be readily polished by rubbing with a soft cloth. After the preliminary finish has been put on the metal in this way, the work is transferred to the lacquering department and given the required number of coats of a suitable lacquer to produce a lustrous finish that will not be tarnished by exposure to the atmosphere.

The formula for the bronzing solution is: Arsenic, 2 pounds; oxide of iron, 4 pounds; muriatic acid, 8 gallons. This solution is mixed in an earthenware or glass jar and allowed to stand until all of the solid constituents have been completely dissolved.

Cloth Finish

The accuracy of surveying instruments would be considerably impaired by any considerable amount of expansion or contraction due to changes in temperature. It is obvious, however, that there are bound to be considerable variations in temperature while a surveyor is at work in the field, and to reduce the amount of expansion or contraction resulting from these changes in temperature, what is known as a "cloth finish" is applied to the parts of the instruments where changes of size would be particularly likely to introduce an error in the results. This cloth finish can be applied to any metal and would be useful in all work where changes of size due to changes in temperature would affect the accuracy. The method of applying is as follows: The work is turned to the required size and then thoroughly cleaned by first washing it in a weak solution of lye and afterward in gasoline or benzine. After removing all oil or other greasy matter in this way, the surface is given a coat of enamel and is then baked at a temperature of 300 degrees F. When the first coat of enamel has dried, a second coat is applied and the work is rebaked until the enamel has partially hardened; the work is then covered with fibrous material called "flint" or "flock" which is held by the partially dried enamel. After this coating of flock has been applied, the work is replaced in the oven and baked until the enamel is completely hardened. The appearance of the finish produced in this way closely resembles coarse cloth. Experience has shown that metal protected by a finish of this kind is not so readily affected by changes of temperature as it is when covered by any other finish which has been tried so that it will be seen that this cloth finish is particularly efficient in reducing expansion or contraction in the instrument. The finish cannot be washed off and an instrument covered with it is not damaged through being used in the rain.

American Gas Furnace Co.'s Carbonia Finish

The carbonia finish which has been developed by the American Gas Furnace Co., Elizabeth, N. J., consists of a method of coloring iron and steel surfaces with any of the temper colors that are obtainable by heating steel to different temperatures. The operation is carried out in the rotary American gas furnace and a finish is produced which has a high luster. A well-known example of this finish is that on the action of Winchester repeating shot guns.

The following outlines the method of operating the furnace to obtain a black carbonia finish. The work is placed in the retort with about 8 quarts of crushed bone having granules ranging in size from 1/8 to 1/4 inch. The retort is maintained at a temperature of from 625 to 700 degrees F., and the result of this treatment is to give the surface of the work a preliminary oxidation which forms a foundation for the carbonia finish which will be completed in a subsequent stage of the operation. The work must be left in the retort for about an hour, or until it has reached a full black. If fresh bone is not available for this purpose it is possible to use the bone from a preceding charge, as the carbon will only have been partially removed from it; where it is possible, however, it is advisable to use fresh bone for the oxidation.

After the oxidation has been completed, the work is left in the retort and 8 quarts of bone mixed with about a pint of "carbonia mixture" is added to the charge. The carbonia mixture consists of a special oil which is compounded for this purpose by the American Gas Furnace Co. In this connection, it should be mentioned that it is of particular importance to have the carbonia mixture thoroughly mixed with the bone, in order to secure the best results, and a thorough mixture can be secured much more easily if the bone and carbonia mixture are warmed before the two are stirred together. If this precaution is not taken there is a possibility of the work coming out spotted. The length of time necessary to expose the work to the action of this mixture varies according to the character of the work, from one-half to three hours being required. The operator will learn from experience about the length of time that is necessary for producing the desired finish on any class of work, and when this time has been approximately reached, a sample is taken from the furnace, dipped in oil and then rubbed with a cloth. The surface of the work will be a dull gray when it is taken from the furnace, so that the condition cannot be judged until it has been polished. It this test shows that the desired finish has been obtained, the gas is turned off and the furnace is opened up to remove the work. The bone dust is sifted away and if the work is of a character to enable it to be treated somewhat roughly, it is dumped into a wire basket and then dipped in oil. In some cases it is not desirable to dip the work into an oil bath, and in such cases the treatment is obtained by tumbling it in powdered cork saturated with sperm oil. After the work has been cooled in this way, it is dried by tumbling in powdered cork or sawdust. Experience has shown that powdered cork gives the most satisfactory results, as the fine particles in sawdust are apt to form a paste with the oil and clog screw threads or other small openings in the work. It is possible to use the furnace in which the heat-treatment was carried on for cleaning the work in this way. When the work has been dried, it will also have been rubbed sufficiently so that it has the characteristic luster of the "carbonia finish." In cases where the very finest finish is required the work should not be removed from the retort until the heat has been allowed to decrease sufficiently to prevent oxidation of the carbonia finish when it comes into contact with the air.

In the case of such articles as gun barrels and receivers, sewing machine parts and similar work which cannot be tumbled, special fixtures must be provided upon which these articles are held in the retort while the oxidation and the production of the carbonia finish are being carried on. For this purpose, supports are attached to the walls of the retort upon which the work is mounted so that it is kept covered with the crushed bone and carbonia as the furnace revolves but does not strike against other pieces of work in the furnace.

The preceding description of operating a furnace for the production of a carbonia finish applies to cases where a deep black color is desired. Other colors can be produced by this method, however, ranging from a pale straw to black with all of the intermediate colorations that can be produced by heating steel to different temperatures. Where lighter colors are desired the bone and carbonia mixture which has previously been used for finishing black work is recommended, and no additional carbonia is needed until the process has proceeded to such a point that no more smoke issues from the retort. If fresh bone is used, only about 1/8 of the amount of carbonia used for black work is added in producing the lighter colors. The length of time required to produce the finish depends considerably upon the character of the surface of the work and also upon the color of the finish which is desired.

Grinding, Lapping and Polishing

Many machine parts are finished by simply producing a smooth surface on the metal, and the most common method of carrying on this work is by grinding; but where a smoother surface is required than is possible to obtain by grinding, the finish can be brought to a more perfect condition by lapping and polishing. In addition to having its appearance improved by such a treatment, a surface finished in this manner is protected to a considerable degree from oxidation for two reasons. First, it can be rubbed with an oily rag so that all moisture is removed, leaving the metal thoroughly protected by a film of oil; and second, the roughness of the surface has been reduced so that pockets of moisture are not held on the metal.

Grinding and polishing is a common method of finishing surfaces of moving parts which engage with one another, and the perfection of the finish which is obtained is largely responsible for the efficiency with which the mechanism operates. A common example of this kind is the finish applied to the balls and races of ball bearings. In this case it is necessary to have the finish brought to the highest possible degree of perfection, because any roughness of the surfaces which engage with one another will set up a grinding action which will soon ruin the bearing. It may be mentioned in this connection that even the most highly finished surface is in reality nothing but a mass of minute scratches, and the problem in lapping and polishing is merely a matter of reducing these scratches to the smallest possible size. The surface of a properly finished ball bearing should be so smooth that no roughness can be detected with a powerful pocket magnifying glass. The surface produced on parts which move in contact with each other is the most noticeable factor in the finish which is given them, but there is another important factor in this finish, *viz.*, "hardening." The balls and races of ball bearings are hardened right to the center of the metal, and it is obvious that this hardening can really be classified as a finish because, although it does not alter the appearance of the work in any way, it is instrumental in preserving the finish which has been produced.

Another example of this kind is seen in the practice of casehardening the surfaces of gun-actions and similar parts in order to preserve the finish which has been applied to them. Work of this kind is first casehardened and then ground and polished. The object of this treatment is to preserve the finish, as in the class of service for which a gun is intended the surface produced by grinding and polishing would quickly be destroyed if the metal were left soft.

Painting

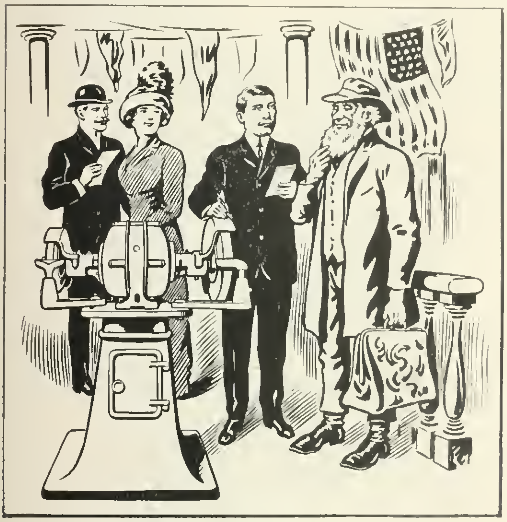
Painting is one of the commonest methods of finishing certain parts of a great variety of machinery, but although this practice is very general, there are one or two points that may not be understood by all. The roughness of the metal makes it necessary to apply a "filler" before putting on the paint, in order that the uneven surface of the metal may be thoroughly filled up and to prevent the painted surface from appearing rough. The method of using filler for this purpose is to mix it to a paste and rub it into the work with a putty knife, the paste being too thick to make it possible to apply it with a brush. After applying the filler in this manner, the work is given a number of coats of paint, depending on the perfection to which it is desired to bring the finish; on an average three coats of paint will be found adequate. Experience has shown that it is impossible to produce a good painted surface over iron that is badly rusted, and in some foundries a practice is made of painting the parts of the castings which are not to be machined in order to protect them from rust. Where this plan is followed, only one coat of paint is applied in the foundry. The remaining coats are put on after all of the machining operations have been completed in order to avoid marring the finished surface of the paint.

COUNTRY BLACKSMITH WANTS WIRELESS MOTORS

BY F. S. CULVER*

The experience of Mr. A. P. Press as related in "Wanted, A Hydraulic Engineer," in the March number of MACHINERY is indicative of the ignorance of the general public or individuals on matters pertaining to things outside their immediate zone.

The writer recalls an incident coming under his attention at the World's Fair at St. Louis in 1904. In the exhibit of one of the motor manufacturers there were shown several motor-driven buffers and grinders. As most readers know, these are simply a specially designed motor having suitable shaft extensions for carrying the grinding or buffing wheels and provided with suitable tool rests and wheel guards, the whole being mounted on a pedestal arranged to support the motor at a convenient height.



"Well, by gosh I'll take one of them machines!"

Inside the pedestal is mounted the motor starter, and as the motor is provided with dustproof covers, to the casual observer, nothing is revealed but the revolving wheels. In this particular exhibit the power circuit was wired to the motor from beneath the floor and into the pedestal in such a manner that no wires were visible.

One afternoon the demonstrator was showing the grinding possibilities of one of these machines to the usual crowd of spectators when a very ordinary looking and much bewhiskered gentleman entered the exhibit and after watching the performance for some time, commenced a series of questions as to the location of the factory that built the grinder, the speed at which it was running, how long it would last, the weight and finally, the price. All questions having been answered to the man's satisfaction, the demonstrator was surprised to have his visitor say, "Well, by gosh, I'll take one of them machines!"

It was then the demonstrator's turn to ask a few questions so that he could properly enter the order for transmission to the factory. "What is the voltage of your power circuit?" asked the demonstrator.

"The what?"

"The voltage of the power circuit or lighting circuit."

"Why, I never heard of such a thing. I have a gasoline light outfit in my shop."

"But are there no electric lights in your town?"

"No. But what's that got to do with this thing? Does this machine need to have an electric light to run by?"

"Not necessarily lights, but the motor needs to be connected by wires to a power circuit."

"Do you mean to tell me that thing needs power of some kind to keep it going?"

"Yes, sir."

"What's running it now?"

"It is being operated by power from the 220-volt power circuit of the exposition company."

"Well, how does it get into the motor?"

After this was all explained to him he remarked, "Well, by gum, I thought that was one of those wireless things that I've heard of, and that all you had to do with the thing was to set it down anywhere and it would go. You see, I am the leading blacksmith in my town and wanted to send something home that would make those fellows open their eyes." So the demonstrator lost his sale and the visitor walked away apparently disappointed and probably thinking the demonstrator was deceiving him for the benefit of the crowd that was standing around.

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CONDITIONS GOVERNING EFFICIENCY OF COMPRESSED AIR EQUIPMENT

In a paper read before the Liverpool Engineering Society, Liverpool, England, Mr. George J. Gibbs pointed out the importance of several conditions which govern the efficiency of equipments operated by compressed air. Among these, the following may be mentioned. In any but the smallest installations, the design of the plant for the compression, storage and distribution of air warrants most careful attention. The air compressors should be supplied with cool, clean air which is as dry as possible. After compression, the heated air should be cooled before it is passed into the mains. Where this precaution is not taken, cooling in the mains will result in a deposit of water of condensation which will gradually collect and be driven forward with grit and rust until it finally causes trouble in the working parts of the apparatus. Compressed air can be conveyed through pipes for considerable distances with practically no loss, especially where the demand is intermittent and where a supplementary air reservoir is placed near the opposite end of the mains from the compressor. Although these are points which are generally recognized, their importance warrants keeping them before the attention of users of compressed air equipment.

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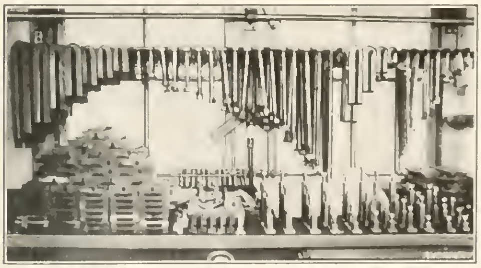
PLANER CONVENIENCES

In many planing departments much time is wasted in looking up straps, bolts and jacks of proper lengths when setting up work on the planer. It is common practice to throw these useful adjuncts promiscuously into a box beside the planer. A convenient method of keeping these tools is illustrated in the accompanying view which was taken at the B. C. Ames Co.'s factory at Waltham, Mass. In their planing department, the machining of beds and other parts of their bench lathes is the principal work, and by using this method of keeping bolts, straps and jacks, the setting up of work is facilitated.



Method of keeping Planer Straps, Bolts and Jacks

From a wooden support along the wall, long hooks extend upon which the U-straps and bolts are hung. These are graded according to length, so that it is a simple matter for the planer hand to pick out a strap or bolt of the required length without sorting over a boxful of "junk." Similarly, screw jacks of different lengths are kept in graded rows upon the bench, and as the heights of these jacks are adjustable it is easy to get just the right support without resorting to shimming or papering up. A large assortment of these adjustable jacks has proved to be a time-saving investment. C. L. L.

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SLIDE-RULE FOR SPRING CALCULATIONS

RAPID METHODS OF CALCULATION BASED ON BEGTRUP'S FORMULAS

BY JOSEF Y. DAHLSTRAND*

In designing springs, numerous calculations generally have to be made, such as changing the diameter, the number of coils and the size of the wire, in order to get the scale desired and to keep the fiber stress within safe limits. The purpose of the rule here described is to eliminate these calculations and place before the designer the entire number of springs which should receive consideration, so that he can select the one most suitable for his conditions. The rule consists of one set of scales shown in Fig. 1, pasted on a thin circular board, as shown in Fig 5; this part of the rule we will call the frame. The scales shown in Fig. 2 are cut out, thus making two separate rings to be pasted on a circular transparent celluloid plate, called "the runner," which is pivoted at the center as shown in Fig. 5. When placing the runner on the frame, the scales in Fig. 1 will appear outside, between and inside those shown in Fig. 2.

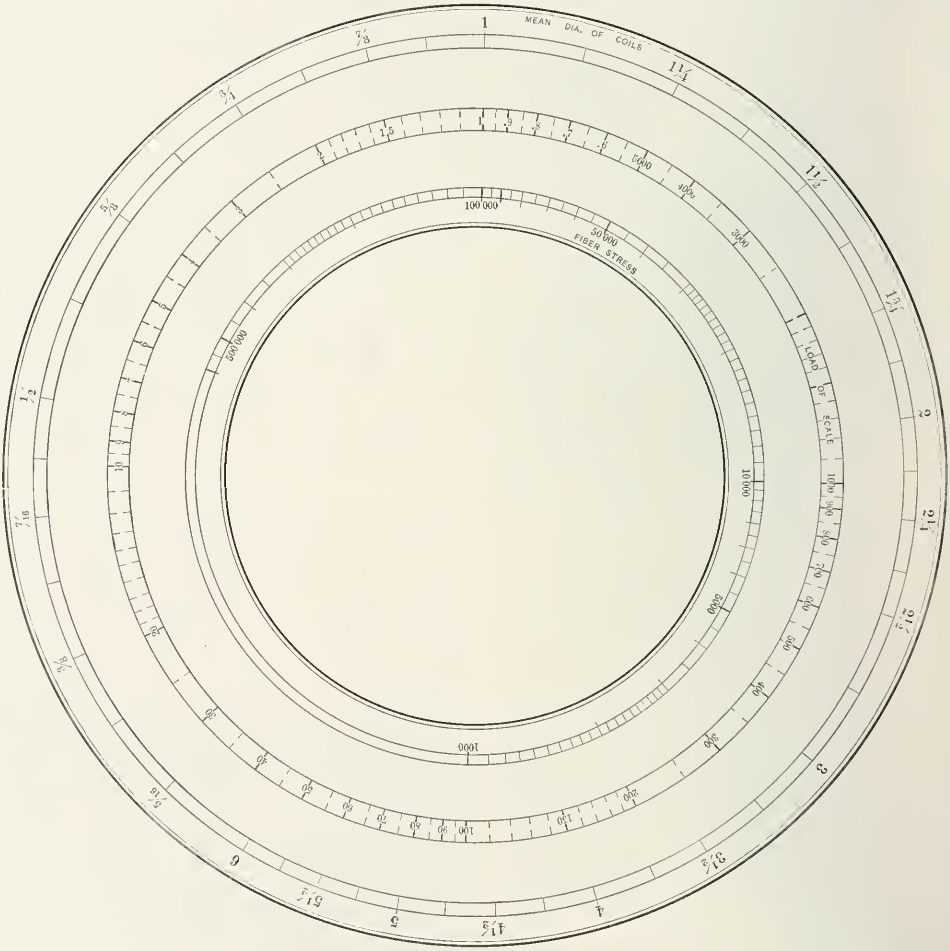

Fig. 1. Fixed Scales which are glued to Frame of Rule

The rule has been worked out from the well-known formulas developed by Begtrup and published in "Kent's Mechanical Engineers' Pocket Book." These formulas, with some modifications, are:

$$1 = \frac{8PD^3N}{Ed^4} \qquad (1)$$

$$W = 0.3927\frac{Sd^3}{D} \qquad (2)$$

where

$P =$ scale of spring (weight required to compress or elongate spring 1 inch);
$D =$ mean diameter of coils;
$N =$ number of coils;
$E =$ torsional modulus of elasticity;
$W =$ maximum load in pounds;
$S =$ fiber stress in pounds per square inch;
$d =$ diameter of wire.

The graduation of the rule is based on a value of $E =$

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* Address: Wellsville, N. Y.

11,500,000, but, as will be seen later, springs with any modulus of elasticity can be figured. The assembled rule has seven scales. When determining the size of a spring, that is, any of the quantities D, N, d and P, the three outer scales and the middle scale are used; and when determining the fiber stress, the middle and the three inner scales are used. Loads and scales are figured in pounds, and diameters in inches.

The method of using the rule can best be illustrated by an example. (See Fig. 3.) The quantities $D = 3\frac{3}{4}$ inches, $d = \frac{7}{16}$ inch, and $N = 5$ are given. The scale of the spring is required. Place diameter of wire ($\frac{7}{16}$ inch) on runner opposite the mean diameter of coil ($3\frac{3}{4}$ inches) on frame, and read off the desired scale of the spring on rule marked "load or scale" opposite number of coils (5). The scale of spring is found to be 200 pounds. If, for example, the diameter of the wire had been desired, instead of the scale of the spring, the three quantities D, N and P being given, the order of operations would be reversed. After the number of coils (5) on runner had been placed opposite the scale of the spring (200 pounds) on frame, the diameter of wire could be read off on the runner opposite mean diameter of the coil ($3\frac{3}{4}$ inches) on the frame. It will readily be seen that, in a similar manner, any one of the four quantities can be determined when the other three are given.

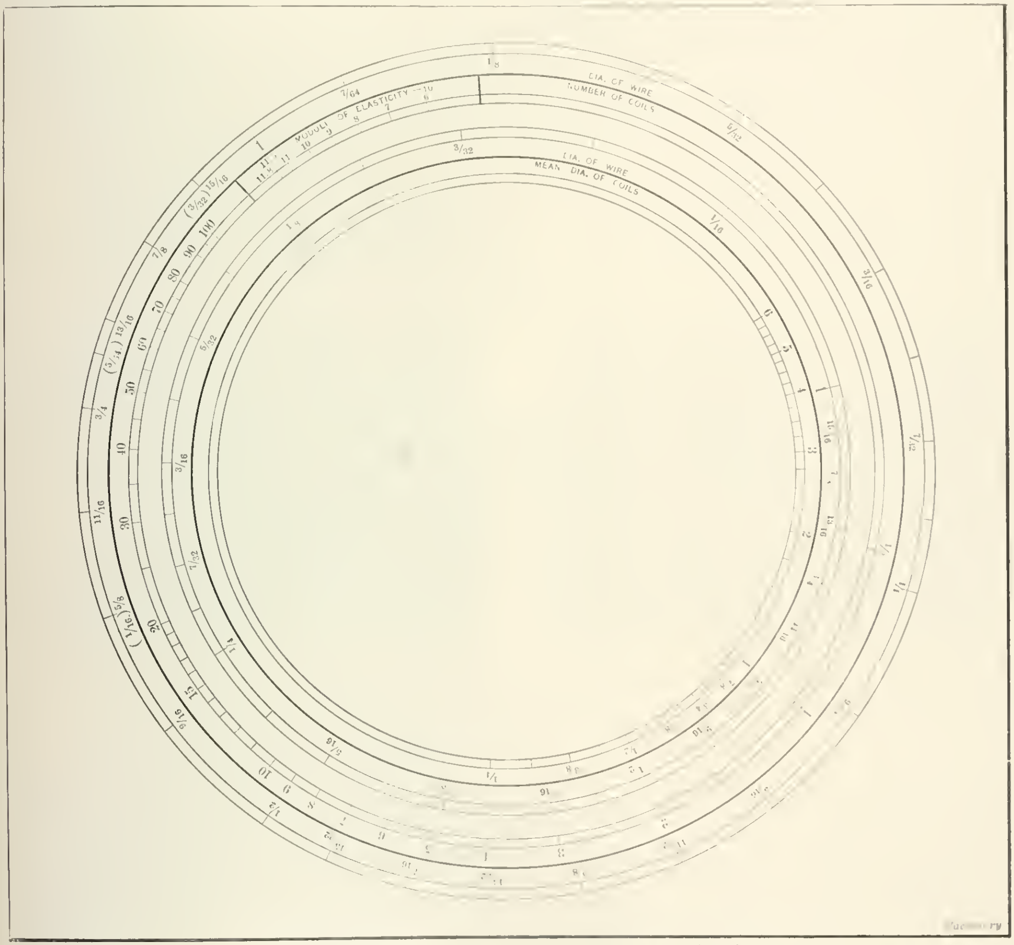

Fig. 2. Movable Scales mounted on Pivoted Disk or "Runner" of the Rule

Suppose that the spring has to carry a maximum load of 600 pounds, thus being compressed or elongated 3 inches from its free length. To find the stress, the four inner scales are used as in Fig. 4. Place the diameter of wire ($\frac{7}{16}$ inch) on runner opposite the load (600 pounds) on the frame, and read off the desired fiber stress on the frame opposite the mean diameter of coil ($3\frac{3}{4}$ inches) on the runner. The stress is found to be 70,000 pounds. In like manner, the order can be reversed, so that any one of the four quantities W, d, D and S can be determined, when the other three are known.

For small wire sizes the figures found by actual test do not quite agree with those obtained by Begtrup's Formula (1). A probable reason for this is that E, the modulus of elasticity, is slightly increased as the wire is drawn fine. In order to correct for this error and make it possible to figure springs of any material, with any modulus of elasticity, this rule has a correction scale, shown in Fig. 2, marked "moduli of elasticity." The figures shown on the scale are the moduli divided by 10^6. For steel wire sizes below $\frac{1}{8}$ inch, E can be assumed to equal 11,800,000. Bronze has a value of E of about 6,000,000. Suppose the scale of a bronze spring is found to be 200 pounds by the use of the four outer scales of the rule. The correct scale of the spring can be found by turning runner until $E = 11,500,000$ (on which the graduations of this rule are based) comes opposite 200 pounds on scale marked "load or scale," and reading off the figure opposite the correct modulus of elasticity for bronze, which is 6,000,000. The correct scale is 105 pounds. The modulus of elasticity varies for different qualities of steel and the most correct way would be to use moduli found by test of the material used. When figuring springs it should be borne in mind that the working conditions of the spring determine the fiber stress that can be allowed. For a spring which is continually under its maximum load, but which must expand to its original free length when released, it is not advisable to allow stresses higher than 50,000 or 60,000 pounds per square inch; while for a spring which only carries the maximum load intermittently, it is safe to run the fiber stress as high as 100,000 pounds per square inch. By the use of this rule, all possible combinations of size wire and diameter and number of coils can be obtained for the scale and fiber stress given by simply turning the runner.

The scales of this spring rule are laid out by plotting the logarithms for the different quantities in Begtrup's equations on the circumference of a circle, and then drawing radial lines through the plotted points to any diameter desired. When taking the logarithms of both sides of Equation (1) we find:

$$0 = \log P + \log D^3 + \log N - \log d^4 - \log \frac{E}{8},$$

and $\log \frac{E}{8} + \log d^4 = \log P + \log D^3 + \log N$.

of which Fig. 6 shows a graphical demonstration. It can be easily seen that two runners or slides are necessary. But when taking:

$$-\log P = \log D^3 - \left(\log d^4 + \log \frac{E}{8}\right) + \log N,$$

and plotting the logarithms of P in the opposite direction from point 1, as shown in Fig. 7, only one runner or slide is found to be necessary, and the rule is based on this principle.

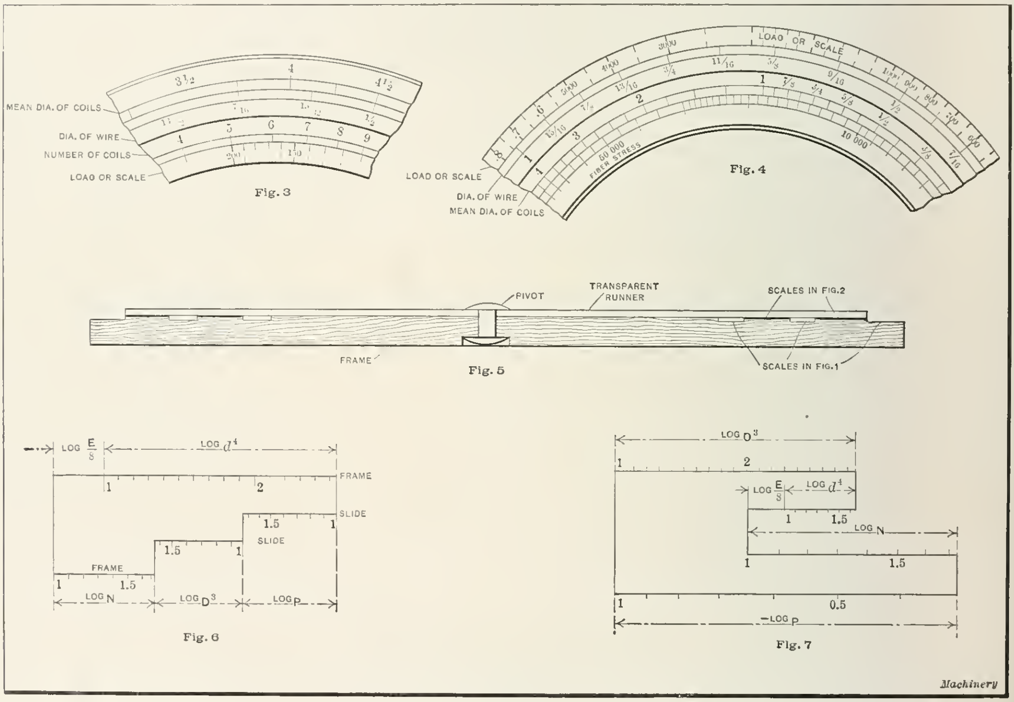

Fig. 3. Method of finding D, d, N or P. Fig. 4. Method of finding W, D. d or S. Fig. 5. Cross-section of Rule. Figs. 6 and 7. Methods of plotting Logarithms of Quantities in Begtrup's Equations

* * *

Shock absorbers on automobile springs are effective in preventing breakages, chiefly because of limiting the recoil. The primitive device used on carriages for the same purpose was a leather strap. One form of shock absorber that is claimed to be effective is a short opposing spring held by the regular spring clips above the long leaf of the spring so as to meet it on the recoil and check its movement. The device has the merit of simplicity and freedom from moving parts.

WEIGHTS OF FLAT ROLLED STEEL*

BY G. W. LINN†

The accompanying Data Sheet Supplement gives the weights of flat rolled steel per lineal foot for various gages and widths of stock. Referring to the supplement, it will be seen that gages ranging from 7-0 to No. 38 are given in the left-hand column, while different widths of metal ranging from 1/16 inch to 1 inch by sixteenths, and from 1 inch to 20 inches by whole inches are dealt with. The thickness of the metal in inches, corresponding to the different gages, is also given. The calculations are based upon the weight of one cubic inch of steel, which is 0.2834 pounds, the result shown in the tables being in pounds.

* * *

In spite of the extreme delicacy of many scientific instruments, notably those in which the services of the spectroscope and the electroscope are enlisted, the human eye and the sense of smell are capable, in regard to some substances, of detecting even greater refinements than these instruments. For example, according to *The Lancet*, the tinctorial power of some of the rhodamine dyes, which produce red shades, is so great that they show distinctive color to the eye when only a 0.000,000,000,1 part is present in a solution. The sense of smell is capable of detecting even smaller amounts of some particles, for the presence of attar of roses in the air is readily recognized when only 0.000,000,000,3 gram is present in one cubic decimeter of air. The spectroscope is generally regarded with wonder because of its power to detect the very minute quantities of matter, but compared with the human nose it is not a very sensitive instrument.

* * *

It is stated in the *Mechanical World* that the London fire department has used pure paraffine as automobile fuel for the last year with satisfactory results. The cost is about fourteen cents per gallon and the general efficiency is reported to be equal to that obtained with gasoline.

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* With Data Sheet Supplement.
† Address: 1606 Broadway, Indianapolis, Ind.

TURNING VALVE NEEDLE POINTS IN A HARDINGE BENCH LATHE

The turning of the valve needle points for carbureters is a difficult operation, owing to the fact that not only must the angle of the point be exactly the same as that of the valve seat, but smooth finish must be secured as well, and the point must be perfectly round. Many manufacturers of carbureters produce these points by grinding, but this method has not been satisfactory in all cases, and an endeavor has been made to secure a greater proportion of good points, as those which leak, of course, have to be discarded. The Findeisen & Kropf Mfg. Co., Chicago, maker of the Rayfield carbureter, had considerable trouble in obtaining a leak-proof point by grinding, and as a last resort attempted to do this work on a Hardinge bench lathe. Fig. 1 shows this lathe set up for doing the work. The results were entirely satisfactory. The point, which is made from a steel containing a high percentage of nickel, is hard to turn, and to get a satisfactory job a high-speed steel turning tool is used. This is held in the toolpost in the usual manner and the turning is done by using the compound rest.

A special gage is used for setting the turning tool in the correct relation to the center of the work, so that it can be removed for grinding and replaced with the certainty that it will be absolutely on the center. Fig. 2 is a closer view of the equipment and shows a rough and finished point, that shown at *A* being finished, where it can be seen that the sharp point has been removed with a file. The body of the point, however, is not touched with the file at all, as it would be a difficult matter to secure uniformity if any hand work were done. The turning is watched by the operator through a magnifying glass in order to see that a perfectly smooth job is produced. With the exception of the special gage for setting the lathe tool, this lathe equipment is substantially the same as that furnished regularly by the Hardinge Bros. for ordinary work, and is supplied with their well-known ball thrust bearing on the spindle. This job shows up to good advantage the efficiency of this type of thrust bearing for small bench lathes, as it is evident that if there were the least amount of end play in the spindle an imperfect job would result. Further proof of the efficiency of this method of machining valve needle points is the fact that by grinding only about forty per cent of the points were good, whereas by finishing in the Hardinge lathe the average never runs below 98 per cent. D. T. H.

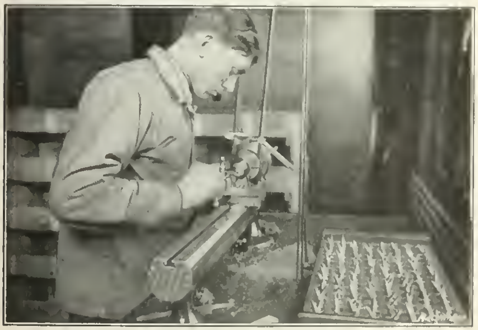

Fig. 1. Turning Valve Needle Points in a Hardinge Bench Lathe

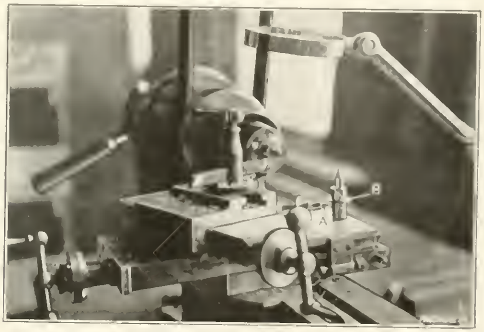

Fig. 2. Closer View showing a Rough and Finished Valve Needle Point

* * *

It is announced that a well-known British electrical engineer has been successful in experiments undertaken with a view to obtaining higher efficiency in the steam turbine. The method is said to consist in re-superheating the steam after it has passed through one of the stages of the turbine, and using higher temperatures than ordinarily, these temperatures being made possible by coating the steel blading with nickel. A 5000-kilowatt steam turbine generator working on this system is said to have consumed only seven pounds of steam per shaft horsepower, and a still better performance, bringing the steam consumption down to about six pounds of steam per horsepower, does not seem improbable.

LIGHT WEIGHT RECIPROCATING PARTS FOR MOTORS*

During recent years, the problem of reducing the weight of reciprocating parts of gasoline engines has received considerable attention among automobile engineers. The first attempts in this direction were along the line of cutting down the weight of the cast-iron pistons, making the walls thinner and machining the inside as far as possible. Cast-steel pistons were then tried and experiments have recently been made with forged-steel pistons. Aluminum will not stand the wear to which a piston is subjected, but magnalium—an alloy of aluminum and magnesium which is lighter than aluminum—has been used successfully for a number of years in making the cylinders of gasoline engines where light weight is of great importance. As magnalium demonstrated its ability to stand the wear resulting from the use of cast-iron pistons in cylinders of this material, the natural sequence of events was to try the use of a magnalium piston in a cast-iron cylinder. The results have proved satisfactory.

The specific gravity of magnalium is 2.50, as compared with 2.56 for aluminum, and 7.50 for cast iron. The ordinary grade of cast iron used for pistons has a tensile strength of from 18,000 to 20,000 pounds per square inch. Magnalium has a tensile strength of about 23,000 pounds per square inch and is considerably tougher than cast iron. While not as hard as cast iron, magnalium is a better bearing metal. The results of experiments have shown that it is even better for this purpose than bronze or babbitt. Tests conducted at 280 revolutions per minute under a pressure of 250 pounds per square inch, showed the coefficient of friction of babbitt to be 0.0075, of phosphor-bronze 0.0069, while the coefficient of friction of magnalium was only 0.0056. Tests conducted under various conditions of speed and pressure gave results which are approximately the equivalent of the preceding figures.

One of the interesting points in connection with the use of magnalium for pistons is that the melting point at atmospheric pressure is only 1256 degrees F. This melting point is considerably less than the temperature often attained in the cylinder of a motor. The reason that magnalium pistons are able to stand up in actual service is because the thermal conductivity of the metal is very high—fourteen times as great as iron—and as a result, the dome of the piston does not get as hot as that of an iron piston. The heat is carried away from the dome of the piston to and through the walls of the cylinder to the water jackets.

An advantage of the use of magnalium for motor pistons is the remarkable reduction of vibration which is effected. Another advantage is secured through the reduction of the inertia of the reciprocating parts. When the maximum force of inertia is reached at the end of the stroke, none of it can be transmitted to the flywheel and as a result, the entire force is received by the bearings at the ends of the connecting rod. This hammer-like action is reduced by the reduction in weight of the reciprocating parts which is effected through the use of magnalium for the piston material. At a given speed, the reduction of inertia forces reduces the amount of friction between the piston and cylinder walls, and also in the connecting rod and crankshaft bearings, with a corresponding increase in the horsepower of the motor. The result of this reduction of friction means that the motor can be run at a higher speed with a consequent increase of horsepower. The inertia increases as the square of the speed, and consequently as the speed increases the friction increases, until it finally reaches a point where the speed of the motor must be held down.

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* Abstract of a paper read by Maurice R. Machol before the Metropolitan Section of the Society of Automobile Engineers.

As magnalium is a good bearing metal, it is practicable to fasten the wrist-pin in the connecting rod and allow it to make its own bearing in the magnalium piston. Experience has shown that there is no tendency for the bearing to pound or wear loose when constructed along these lines. In recent years, several of the large motor car builders have laid stress on the ability of their cars to accelerate rapidly. The acceleration of the motor is dependent, to a large extent, on the weight of the reciprocating parts. If the motor has magnalium pistons, it is able to accelerate much faster, due to the reduction in weight. The claim has also been made that there is less tendency for carbon to deposit on the domes of magnalium pistons. Magnalium has also been successfully used for the connecting rods of gasoline motors. In such cases, the connecting rods have made their own bearings at both ends, and have demonstrated their ability to stand up satisfactorily.

* * *

A HIGHLY DEVELOPED BROACHING OPERATION

As an evidence of the progress which has been made in the broaching machine and its use may be cited a broaching operation which is being performed at the factory of the Kinsler-Bennett Co., Hartford, Conn., manufacturers of universal joints for automobiles. In Fig. 1 is illustrated two plan views of the piece which is to be broached, showing the work done at each of the two operations. Fig. 2 illustrates the special broaching fixture and broaches used for doing the work, and at *E* appears the rough steel forging upon which the broaching is done. This is one of the parts of a universal joint. It is one inch thick, having four roughly formed rectangular holes, which must be broached on all four sides, finishing each hole to an accurate size; moreover the broaching must be so done that the finished holes will all be equidistantly spaced from the central hole. This central hole is finished by drilling and reaming and the outside edge of the piece is turned, so that the piece may be held by the edge.

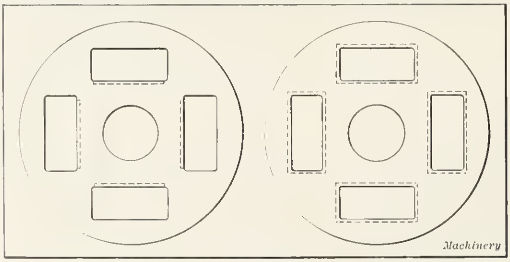

Fig. 1. Plan Views of the Work, illustrating Broaching done at Each Operation

Referring to Fig. 2, it will be seen that the broaching fixture consists of a very heavy faceplate casting *A* that fits on the head of the broaching machine, and this casting is bored out to receive the other half of the fixture *B*, which acts as a guide-sleeve.

The faceplate *A* is fitted with four hardened steel guides *C* which are adjustable radially by means of set-screws *D*. It will be noticed that these guide-blocks are slotted to receive and guide the broaches while they are cutting. The piece to be broached indicated at *E*, is a snug fit for the smaller bored hole in casting *A*, allowing it to seat close to the guide-blocks *C*. After being placed in this recess, guide-sleeve *B* which is a sliding fit for the large bored section in faceplate *A*, is inserted. This part of the fixture is also provided with four hardened steel guide blocks *F* which may be adjusted radially after the manner of chuck jaws. Guide-sleeve *B* while free to slide in faceplate *A*, is prevented from turning and throwing the two sets of guide-blocks out of line, by means of suitable tongues.

There are two operations required to complete the broaching on this piece. At *G* is shown the broach holder with the four broaches *I*, used for the first operation. One of the features of this job is that four cuts are made at each draw of the machine. The first operation is performed after adjusting the position of jaws *C* and *F*, so that when the four broaches *I*, held on broaching head *G*, start to cut, they will clean out a place on the inside edge of each of the four holes, leaving the forging with four cuts as indicated by the dotted lines in the left-hand view in Fig. 1. It will be seen that by adjusting the guide-blocks *C* and *F*, against which the blank sides of the first operation broaches bear, the broaching may be controlled as regards its distance from the central hole in the forging.

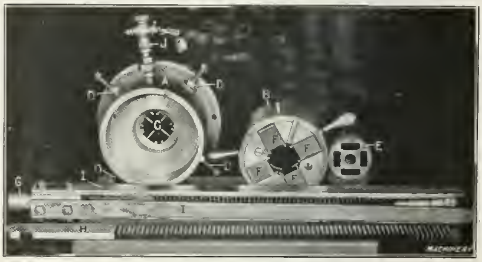

Fig. 2. The Broaches, Broaching Fixture and Work

This completes the work done at the first operation. The second operation is performed with the aid of four broaches, one of which may be seen at *H*, Fig. 2, which are held upon the same broaching head *G*. These broaches are provided with one flat side which bears against the surface already broached. Teeth are provided on the opposite side and the two edges, so that the other three sides of each of the four holes are broached out true with the four surfaces already broached, thus cleaning the holes out on all four sides and insuring that the finished holes will be true with the central hole. Lubrication is provided through pipe *J* which enters the faceplate casting opposite the cutting point.

In broaching these parts, the entire lot is run through the first operation and then the broaches are changed and the second operation performed. The broaches are not removed from the machine after each pass, as is necessary in most broaching, for as they do not cut to the full width of the hole, and as they are spring-tempered and beveled at the ends, they may be pressed together and the forging slipped over them to the starting point. The broaches are made of slightly different lengths so that they do not all commence cutting at once. These pieces are broached at the rate of thirty-six operations, or eighteen completed pieces per hour. The tools used, as well as the broaching machine, were made by the Lapointe Machine Tool Co., Hudson, Mass. C. L. L.

* * *

ON FOLDING BLUEPRINTS

An engineering works using thousands of blueprints every year which go to practically every department in the plant, enforces rigorously a plan of uniform folding. The blueprints are made in standard sizes, and each of these sizes is required to be folded in a special manner. The first requirement is that when the folding is finished the folded sheet be approximately 8½ by 11 inches. The second requirement is that it be folded with the face out, the title corner being exposed. This title corner is always visible as a consequence, for filing purposes and by using the outside, or "face out," system, it is often possible to get the information required from the blueprint without unfolding it entirely. In this particular the old system of folding a blueprint so that the outside was the blank side, caused much waste of time.—*Things Technical.*

SEMI-AUTOMATIC INDEX-PLATE DRILLING MACHINE

The illustrations show an interesting machine designed and built by the Oesterlein Machine Co., of Cincinnati, Ohio, for drilling the holes in index plates used on the dividing heads of its milling machines. Inasmuch as this machine is entirely automatic in its operation and embodies some interesting mechanical features in its construction, a complete description will be given. Fig. 1, which shows a rear view of the machine, illustrates some of the principal mechanisms and indicates how the power for operating the machine is derived. It will be noticed that all of the movements of the machine—with the exception of the rotation of the drill spindle *A*—are controlled by power received from the pulley *B* which is belted to a countershaft. This pulley drives a "drop" worm *C*, which meshes with a worm-wheel on shaft *D*, the latter being connected to shaft *E* through bevel gears.

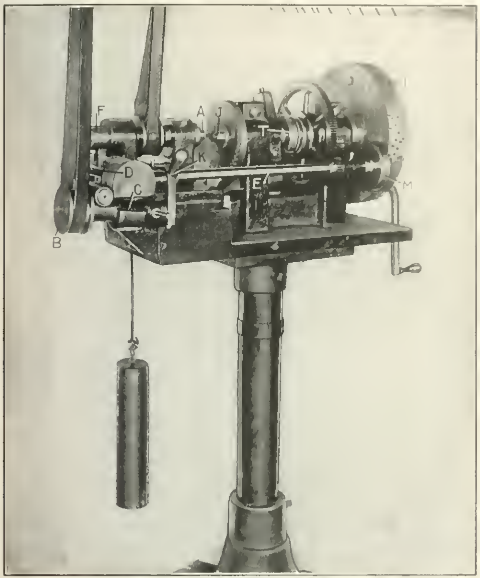

Fig. 1. Rear View of Special Index-plate Drilling Machine designed by the Oesterlein Machine Co.

The spindle *A*, in which the 1/8-inch flat drill is held, is rotated at about 1500 revolutions per minute, and is retained in a sliding sleeve *F*, the latter being forced forward by a cam on shaft *D*. This cam comes in contact with a lever *G* (see Fig. 2), which is fulcrumed at its lower end, and has teeth cut in its upper end that mesh with corresponding teeth in the sliding sleeve *F*. This sleeve is returned by the lever through the action of a spring, and the sleeve does not rotate, but is slidably keyed to the bearings in which it moves back and forth. The drill head *H* is machined on its lower face, fits over dovetailed ways on the bed of the machine, and is operated by a 4-pitch screw for changing the position of the drill for drilling the various rows of holes in the index plates. The manner in which this drill head is moved in toward the axis of the work spindle will be described in connection with the operation of the front shaft.

By referring again to Fig. 1, it will be noticed that the main or work spindle is driven by a pinion on the shaft *E*, which meshes with a large spur gear on the spindle. The hub of this large spur gear is held between friction collars by the stiff coil spring shown, the collar to the right of the gear being fastened to the work spindle, while the washer on the left-hand side is free to slide. The tension of the coil spring is controlled by the split nut *T*. The work spindle, in addition to carrying the index plate to be drilled, also carries the group of master index plates *I* of which more will be said later.

In order to illustrate how this machine operates, we will assume that an index plate has just been finished, and that the machine is inoperative. The first thing that the operator does is to wind up the wire rope on the front shaft, bringing the lever *L* and drill slide back to the starting positions, after which he removes the finished plate by unscrewing the cap-screw *J* and taking off the washer and index plate. A plate which is ready to be drilled is then put on the spindle and the screw tightened. The operator forces the lever *K*, see Fig. 1, to the right, thus bringing the worm *C* into mesh with the worm-wheel, whereupon the machine begins to operate. The drill now advances into the work, and as the sleeve carrying the drill spindle is about to retreat, the various indexing mechanisms come into play. The first movement which takes place is the releasing of the lock from the master index plates *I*. This is accomplished by lever *L*, which is fulcrumed on the front shaft and operated by the cam *M* located on the rear shaft *E*, the movement being transmitted through a plunger *N* coming in contact with an extension of the lever.

After the lever holding or locking the master index plates is forced back, the master plates are indexed, through the large gear and friction collars, into the position for drilling the next hole in the circle on which the drill is at work. When the master index plates have again been locked by the lever *L* through the medium of a compression spring located below the fulcrum of the lever, the drill sleeve is advanced and another hole completed, these operations being repeated until all the holes in that circle of the index plate have been drilled. After the work has made one revolution, the lever *O* is operated upon by a pin in the dog *P*, which is held on the work spindle and rotates with it. The position of this dog on the spindle can be changed, relative to the cam operating the lever holding the master index plates, so that the proper timing of the mechanism can be obtained. As soon as lever *O* is operated upon by dog *P*, its lower end is withdrawn from the cam on the front shaft, allowing the latter to make one complete revolution.

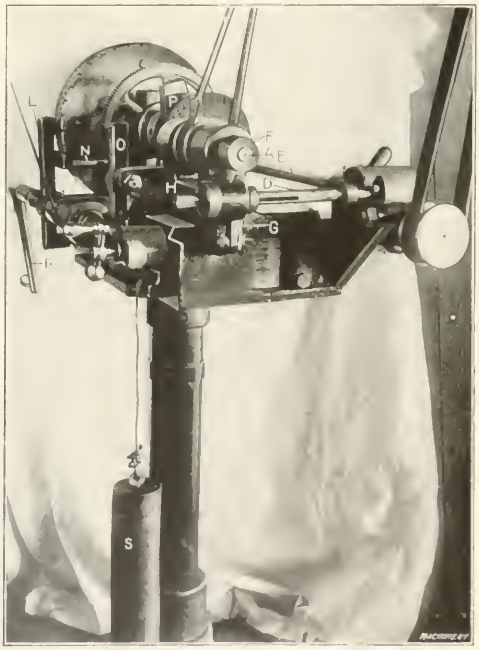

Fig. 2. End View of Index-plate Drilling Machine

It will be noticed that the front shaft, see Fig. 2, is rotated by a wire rope wound around it, to which a weight is attached. This wire rope, when "run down" at the completion of each plate, is rewound around the shaft by the handle *R*. Now as the front shaft, on which the lever *L* is held, is provided with a 4-pitch screw, it follows that as this shaft makes one revolution, the lever will be moved along the shaft in a lateral direction through a space of 1/4 inch, thus engaging with a notch in the next master index plate in the line. Again, as the front shaft is connected to the screw operating the drill slide, this also is given one revolution, and consequently carries the drill in ¼ inch closer to the axis of the work. The weight *S* is used to hold the drill slide back against the operation of the screw to prevent lost motion. The cycle of operations just described is continued until the last row of holes in the disk has been completed, when the drill slide upon reaching its final inward position, touches a lever which disconnects the worm from the worm-wheel, and thus stops the operation of the machine.

As the indexing of the work is accomplished by a cam on the shaft *E*, it is evident that an indexing takes place at every revolution of this shaft, but as this movement is controlled by friction, it will be seen that the number of indexings is dependent on the number of notches in the master index plates. The dog which operates the lever for releasing the front shaft is fastened directly to the spindle that carries the index plate, and hence, as one row of holes is completed, this dog comes into action to move the lever *L* over in line with the next master plate in the group, and also moves in the drill head towards the axis of the work a distance equal to one revolution of the screw—or ¼ inch.

The master index plates, which are made from a high carbon steel and left soft, are cut in an automatic gear-cutter. Each disk is made ¼ inch thick, and is provided with the same number of slots that are required in the circle of holes for which it is made. The group of index plates are bolted together as shown, and are keyed to the work spindle of the machine. The notches in all the disks start from the keyway, and the master plates are grouped together so that the disk having the greatest number of slots is located closest to the work, the number of slots gradually decreasing toward the outer end of the row. The drill begins operating on the row of holes on the largest circumference, and gradually works in toward the center. The work turned out by this machine is accurate enough for all practical requirements, and as all the movements are entirely automatic, it requires very little attention. One of the flat drills used produced 35,500 holes before requiring resharpening. D. T. H.

* * *

DIMENSIONS OF SPIRAL GEAR TEETH

BY ARTHUR C. MAXFIELD[*]

In cutting a coarse worm or spiral gear it is customary to make the tooth measurements smaller than the dimensions called for on the cutting card in order to have the gear run properly with its mate on the correct center distance. Workmen have found from experience that the spiral gears made with the correct size of teeth bind when they are set with the specified distance between centers. To compensate for this condition it is necessary to have a little "shake" when trying the tooth calipers over a tooth. There is no definite allowance for this operation and the workmen generally guess as to what is about the correct allowance to make. However, it is possible to determine exactly what correction should be made and when this is done the operator can follow his instruction card as closely as he would do when cutting spur gears.

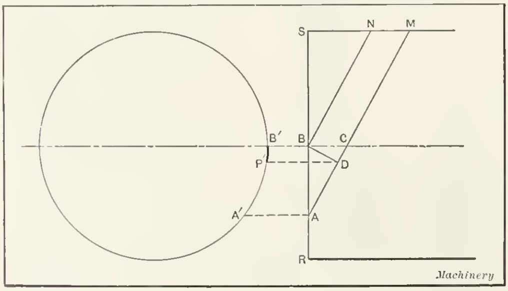

Diagram showing Method of deriving Dimensions of Spiral Gears

To avoid confusion the terms that are to be used in the following formulas may be defined as follows: The circular thickness of the tooth is its thickness measured on the circumference of the pitch circle. The axial thickness of the tooth is its thickness measured along a line on the pitch surface parallel to the axis of the gear. The normal thickness of the tooth is its shortest thickness on the pitch surface. In the accompanying diagram *RS* represents one end of the gear and the lines *BN* and *AM* are the sides of one tooth. In this diagram the distance *AB* represents the circular thickness of the tooth; the distance *BC* is the axial thickness of the tooth, and the distance *BD* is the normal thickness of the tooth. The angle *ACB* is the angle of the spiral and is equal to the angle *ABD*. It will be evident that the circular thickness is given by the following formula:

$$\text{Circular thickness} = AB = \frac{\pi R}{\text{No. of teeth}} \qquad (1)$$

The normal thickness is given by the following formula:

$$\text{Normal thickness} = BD = AB \cos ACB \qquad (2)$$

The axial thickness is given by the following formula:

$$\text{Axial thickness} = BC = \frac{BD}{\sin ACB} \qquad (3)$$

It will be evident that in measuring the normal thickness it is necessary to measure across an arc of the pitch circle equal to the arc *P′B′* shown in projection. This arc must be measured by its chord, which is the chord *P′B′*. There is also the height of the arc *P′B′* to be considered. To find the chordal thickness corresponding to the normal thickness of the tooth measured on the pitch surface, it is first necessary to determine the chordal thickness corresponding to the circular thickness of the tooth. The value of the chordal circular thickness is given by the following formula:

Chordal circular thickness = sine (90 degrees ÷ number of teeth) pitch diameter.

Chordal normal thickness = chordal circular thickness × cosine *ACB*.

Chord *P′B′* = cosine *ACB* × chordal normal thickness.

Let A = one-half of the angle subtended by the chord *P′ B′*

$$\text{Then } \sin A = \frac{\text{Chord } P'B'}{\text{Pitch diameter}}$$

$$\text{Height of arc} = \text{Radius } (1 - \cos A)$$

The method of using these values of the dimensions of spiral gear teeth in cutting teeth of this type will best be explained by carrying through the steps in a problem of this kind:

Example

Let us consider a gear having eight teeth with a spiral angle of 48 degrees and a pitch diameter of 3 inches. The circular thickness of the teeth is found to be 0.5891 inch and the chordal circular thickness 0.5853 inch. The normal thickness of the teeth is 0.3942 inch and the chordal normal thickness is 0.3916 inch. The axial thickness of the teeth is 0.5303 inch. The chord of the arc measured across is 0.262 inch.

$$\sin A = \frac{0.262}{3.0} = 0.08733$$

A = 5 degrees 1 minute

Cosine A = 0.99617

Height of arc = R $(1 - \cos A) = 1.5$ $(1 - 0.99617) =$ 0.0057 inch

Chordal correction necessary = 0.0025 inch

* * *

The imports of machinery into Japan are steadily increasing. The total value of machinery imported during 1912 aggregated over $14,000,000, which is nearly double the value of the imports during 1910. Of these imports, Great Britain supplied slightly over 50 per cent, and Germany and the United States nearly 25 per cent each, but a small percentage being imported from other countries. The total imports of metal- and wood-working machinery were nearly $2,000,000 in 1912, Great Britain supplying over 55 per cent of this, the United States 25 per cent, and Germany about 15 per cent. Practically all of the textile machinery used in Japan comes from England. Germany has a large share of the water turbine trade, and the steam turbine business is about equally divided between the United States, England and Germany. Pumping machinery comes largely from England.

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[*] Address: 224 Broadway, Providence, R. I.

TOOL STEEL FOR THE UNITED STATES NAVY*

PRESCRIBED SPECIFICATIONS AND TESTS RESULTING FROM PROTRACTED INVESTIGATION

Previous to 1909, each of the U. S. navy yards prepared requisitions for the purchase of tool steels for its own purposes. These requisitions either specified that proprietary material should be purchased or that the award of contract be based on information obtained by a test of some description on samples submitted by the bidders. By this method, there could be no uniformity in the specifications of the navy yards and in order to centralize purchasing and to standardize the tool steels, a tool steel board recommended that the Philadelphia Navy Yard be made the purchasing station. This action was taken in 1909 and at that time specifications were drawn up for one high-speed steel and three grades of carbon steel. The chemical composition required for the high-speed tool steel differed from that of any of the commercial brands, but the chemical composition of each grade of carbon steel corresponded to that of commercial tool steels. The three grades of carbon tool steel varied principally in their carbon content, in order to adapt them to the purposes for which such tool steels are generally used. The contracts were awarded to the lowest responsible bidder who was able to meet these specifications for tool steel of a chemical composition within the specified limits. The specifications required physical tests in addition to chemical analyses, as a part of the inspection, but these tests did not give decisive results and this proved conclusively that it was advisable to revise the existing specifications. This step was taken because these specifications did not provide a means of ascertaining the relative merits of the tool steels offered by the different bidders, or of learning whether there were other tool steels that were superior to those within the specified limits of chemical composition.

In order to overcome these objections, a set of specifications was finally drawn up which are presented in a later section of this article. These specifications require the bidders to submit samples of the tool steels which they offer for sale. The samples are manufactured into tools and subjected to physical tests devised to determine the relative merits of the different steels. The data obtained in this way constitute the basis for the award of contracts. In this set of specifications the chemical compositions are given the maximum and minimum limits, the purpose being to indicate to the bidder the kind of tool steel that is wanted, but the physical tests constitute the real basis for the award of contracts. The object of this provision is to introduce competition as to the quality of tool steels instead of simply having competition in price, to provide a means of learning something about the relative merits of the commercial tool steels, and to take advantage of the developments and progress made by the manufacturers in this industry. By this means, definite information can be obtained concerning the qualities of the different tool steels before the contracts are awarded for their purchase.

The study of tool steels which has been made possible by the adoption of this set of specifications is conducted under the direction of the engineer officer of the Philadelphia Navy Yard. The subject is divided into two general classes, one of which covers the high-speed or tungsten steels and the other the carbon tool steels.

Tungsten Steels

The limits of the chemical composition called for under the revised specifications were varied from those required by the original specifications in order to permit bidders to submit proposals on their commercial or standard tool steels, and the feature of a selective test was introduced. This selective test provides means for investigating the relative suitability of the different tool steels offered by bidders for the class of work for which the steel is required, and the recommendation for the award of contract is based on the information thus obtained. In order to obtain samples of tool steel for the selective test, the specifications require each bidder to furnish a sample bar of the tool steel which he offers. This bar is delivered to the engineer officer, under whose direction the selective tests are conducted. The heat-treatment of the tools, their chemical analysis, the condition of the physical test, and the computations necessary to determine the award of contract constitutes the selective test. A lathe tool selected for the physical test is kept cutting without lubricant until it fails by the sudden breaking down of the cutting edge, due to heating caused by friction of the chip. A record of the elapsed time of the run is made, which is the principal variable, other conditions being kept constant. After failure, each tool is reground, care being taken to remove the effect of the heat produced during the previous cut; the tool is then tested once more until it breaks down, as previously described. After the conclusion of this cut, the tool is reground and tested a third time.

During the test a voltmeter and ammeter are used to determine the power supplied to the motor which drove the test lathe. This is done in order to obtain a measure of the work done by the nose of the tool. The ammeter readings vary for the different tools, due principally to slight variations in depth of cut and cutting speed, which indicates that the work done by the different tools is not the same. In order to allow for this difference in computing the selective factor, a quantity was introduced called the "work value," which is the product of the mean elapsed time of run of all tools of a given sample and the mean watts required to drive the lathe minus the friction watts. The work value, therefore, is the watt-minutes of work done by the tool. The work values obtained from all of the samples of a given steel that were tested are then adjusted by the principles of least squares. The work value divided by the price per pound gives the "selective factor" for the test, the contract being awarded to the manufacturer of the steel having the highest selective factor.

In conducting the selective tests with tungsten tool steels, five tools made from the same sample bars are stamped with an index number which is assigned to each sample, and with consecutive numbers for the tools of each sample. The tools are hand-forged to the No. 30 lathe tool form of the Sellers system. The following day the tools are heat-treated. For this purpose, one oil furnace is maintained at a temperature of from 1600 to 1700 degrees F. and another furnace at from 2400 to 2450 degrees F. The cutting ends of the tools are preheated in the low temperature furnace and then transferred to the high temperature furnace. After the tools are removed from the heat-treating furnace, they are cooled by dipping the ends into oil. The oil is agitated by compressed air and is cooled to maintain it at as nearly an even temperature as possible. Oil is used for quenching because it is less noisy and less expensive than compressed air, and tests which have been made also appear to indicate that better results are obtained by using oil as a quenching medium. The tools are cooled in oil until they are black hot, when they are removed and placed on the cooling table. All the tools are tested on a single nickel-steel forging because the characteristics of nickel steel forgings vary. The depth of cut, feed, and cutting speed are kept constant throughout the selective test, thus making the cutting time the principal variable. All of the tools are tested to destruction after which they are reground and retested until each tool has been subjected to three tests. In regrinding it is found necessary to remove about 3/32 inch of the tool to get rid of the effects of heating.

Carbon Tool Steels

The information obtained from the selective tests conducted on samples of high-speed steel indicated that it was advisable to revise the requirements for carbon tool steels which were given by the original set of specifications, and a method of conducting selective tests, similar in character and purpose to those previously referred to, was adopted for use with this class of steels. Four classes of carbon tool steel were selected which varied principally in their carbon content. The specifications require the conditions of the selective test to be maintained as nearly constant as possible for each class of steel. The elapsed time of the run is the principal variable in the the test, the tools being operated until they break down. Milling cutters are used for the tests on steels of Classes 1 and 2 and the duration of the run consists of the total time that the cutters are operating, but it does not include the time required to return the milling machine table to the starting point and to set it for the next cut.

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* Abstract of paper presented by Lewis H. Kenney before the Society of Naval Architects and Marine Engineers, November, 1912.

A cape chisel is used for the selective test on carbon tool steels of Class 3. In some of the early tests, trouble was experienced through breaking the shank of the hammer end of the chisel. This trouble has been overcome so far as the selective tests are concerned—and also in shop work—by heat-treating about ½ inch of the hammer end of the body with the shank and quenching the tool by dipping about ¾ inch into brine for a few seconds and then the entire tool. The cutting end is treated at the same temperature as the hammer end, and the temper of both ends is drawn by submerging the chisel in a molten lead bath at the desired temperature. In making these tests, it has been found that the heat-treatment does not extend back far from the cutting edge and there is only a short distance on the tool where the maximum cutting life can be obtained. If the chisel shows poor results on the first test, indicating that the temper has not been drawn sufficiently, the second test usually gives more satisfactory results, while the third test may show that the chisel is too soft.

A button-head rivet set is used for testing Class 4 of carbon steel. The set is heated to the desired temperature and quenched in brine, after which the temper is drawn in a lead bath. Each set is used to drive a certain number of hot rivets and an observation of its condition is made after the test. This test is not carried to destruction, however, as in the preceding tests and consequently does not yield decisive results.

The results of the tests of carbon steels of Classes 1, 2 and 3 vary considerably. As a result, it has not been found advisable to adjust these results by principles of least squares. After the tests have been completed, the data are gone over and those results which vary widely from the average are rejected. The selective factor for the different steels is then calculated and the contract awarded to the manufacturer whose steel shows the highest selective factor.

Each sample of carbon tool steel submitted for selective test is tested to determine the decalescent point in order that it may be hardened at a suitable temperatnre. In heat-treating, the temperature of the tools is raised to a point slightly above the decalescent point and they are then quenched in brine. After quenching, the temper is drawn in a lead bath, after which the cutting tools are ground ready for the selective test. The proportions of the milling cutters used for making the selective tests for carbon tool steel were adopted from an article by A. L. DeLeeuw which appeared in the 1911 transactions of the American Society of Mechanical Engineers. The distinctive feature of these milling cutters is the small size of the teeth, thus providing a large clearance for the chips. The cutter is operated at a speed of 370 revolutions per minute with a feed of 20 inches per minute and a depth of cut of 0.080 inch through the full travel of the milling machine table. The table is run back to the starting point and reset as often as necessary until the failure of the cutter occurs. The cutter is run without lubricant, in order to make the tests as severe as possible.

Specifications for Tungsten Tool Steel

1. *Class* 1.—Lathe and planer tools, milling-machine tools, and in general all tools for which high-speed steel is used.

Specifications for Carbon Steel

2. *Class* 1.—Lathe and planer tools, and tools requiring keen cutting edge combined with great hardness, for finishing shrinkage dimensions on nickel-steel gun forgings, drills, taps, reamers, and screw-cutting dies.

3. *Class* 2.—Milling cutters, mandrels, trimmer dies, threading dies, and general machine-shop tools requiring a keen cutting edge combined with hardness.

4. *Class* 3.—Pneumatic chisels, punches, shear blades, etc., and in general tools requiring hard surface with considerable tenacity.

5. *Class* 4.—Rivet sets, hammers, cupping tools, smith tools, hot drop-forge dies, etc., and in general tools which require great toughness combined with the necessary hardness.

CHEMICAL COMPOSITION

Tungsten Tool Steel	Class 1, Per Cent Limit	
	Maximum	Minimum
Carbon	0.75	0.55
Chromium	5.00	2.50
Manganese	0.30	0.05
Phosphorus	0.015	....
Silicon	0.30	....
Sulphur	0.02	....
Tungsten	20.00	16.00
Vanadium	1.50	0.35
Iron	*	*

Machinery

* Remainder

Carbon Tool Steel	Class 1, Per Cent Limit		Class 2, Per Cent Limit		Class 3, Per Cent Limit		Class 4, Per Cent Limit	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Carbon	1.25	1.15	1.15	1.05	0.95	0.85	0.85	0.75
Chromium	†	†	†	†	†	†	†	†
Manganese	0.35	0.15	0.35	0.15	0.35	0.15	0.35	0.15
Phosphorus	0.015	.....	0.015	.....	0.02	....	0.02	.....
Silicon	0.40	0.10	0.40	0.10	0.40	0.10	0.40	0.10
Sulphur	0.02	.....	0.02	.....	0.02	.....	0.025	.....
Vanadium	†	†	†	†	†	†	†	†
Iron	*	*	*	*	*	*	*	*

Machinery

*Remainder † Optional

Physioal Tests of Tungsten Tool Steel

6. Class 1.—The sample bar will be forged into five tools, treated and ground to the No. 30 form of the Sellers system of lathe tool forms. Each tool will be tested on a nickel-steel forging of about 100,000 pounds tensile strength, with a cut ¼ inch deep, 1/16 inch feed, and a cutting speed of 50 feet per minute. Each tool will be twice reground and retested. A record will be made of the length of time each tool cuts without a lubricant or cutting compound before it is ruined.

Physical Tests of Carbon Tool Steel

7. *Class* 1.—Five 7/16-inch diameter, 4-tooth facing mills will be made from the sample bar and tested on a piece of ⅝-inch ship's plate without lubricant. Each mill will be run until it is so dull that it breaks either in the teeth or in the shank. The depth of cut will be 0.08 inch, the revolutions per minute of the mill will be 370, and the feed of material 20 inches per minute. A record will be made of the length of time each mill operates.

8. *Class* 2.—Same tests as *Class* 1.

9. *Class* 3.—Five ½-inch pneumatic chisels will be made from the sample bar. Each chisel will be tested on a nickel-steel plate with a cut 1/16 inch deep.

A record will be made of the distance each chisel cuts with a lubricant before it is ruined.

10. *Class* 4.—Two ½-inch rivet sets will be made from the sample bar. A record will be made of the condition of the sets after a certain nnmber of rivets have been driven.

11. *Modification of Tests.*—Any or all of the above tests may be modified at the discretion of the engineer officer.

General

12. *Method of Manufacture.*—The tool steels shall be made in either the electric or crucible furnace. The bars must be forged or rolled accurately to the dimensions specified, free from seams, checks, and other physical defects and of homogeneous composition. The tungsten tool steels shall be delivered unannealed, unless otherwise specified, and the carbon tool steels shall be delivered annealed unless otherwise specified. The bars shall be delivered in commercial lengths and short pieces will not be accepted unless so specified.

13. *Stamps on Material.*—Each bar or piece of tool steel, whether sample bar for "selective test," "acceptance test," or material delivered under contract, shall be stamped with the manufacturer's name, his trade name and temper index, and in addition identification stamps of the kind and class of tool steel as given in these specifications. The tungsten tool steel,

Class 1, shall be stamped T-1, and the carbon tool steels, Classes 1, 2, 3, and 4: C-1, C-2, C-3, and C-4; the letters to be about 3/16 inch high. If the bars are longer than about 4 feet, the above stamps should be placed at intervals of about 3 feet along the bar.

14. *Acceptance Test.*—Sample bars for "acceptance test" will be taken from the material delivered under contract to the general storekeeper, Navy Yard, Philadelphia, Pa., or if the material is inspected at the place of manufacture, the inspector will forward sample bars of the dimensions called for to the storekeeper, who will forward them to the engineer officer for him to arrange the tests indicated by these specifications and recommend the acceptance or rejection of the material. If the material does not prove to be equivalent to the sample bar furnished with proposal this will be considered sufficient cause for rejection. The contractor shall replace the shipment within two weeks, if practicable, after the receipt of notice of rejection. The sample bars used for this test will be credited the contractor if the material under test is accepted.

15. *Defective Material.*—If material, when being manufactured into tools, develops physical defects which could not be detected by inspection, such as "cracks," "pipes," etc., the manufacturer of this steel shall replace, without cost to the government, such defective material.

Proposals

16. *Reservation and Alternate Proposals.*—The right is reserved to reject any or all proposals.

Bidders may submit proposals on tool steel which differs from the composition and method of manufacture specified, provided this is clearly stated in their proposal, and provided they furnish the engineer officer with a statement of the exact chemical composition and method of manufacture of the tool steel. This information will be considered confidential by the engineer officer if the bidder requests it. The tool steel will be tested if, in the opinion of the engineer officer, it is considered suitable for the purpose intended.

17. The engineer officer will, after the prescribed tests have been made, recommend the award of contract for the steel or steels which, in his opinion, it is to the best interest of the government to purchase, due consideration being given to the cost of the material. The relation of the tests and the price of the material will be the basis for selection.

18. *Selective Test.*—Each bidder shall furnish with his proposal a sample bar of tool steel stamped as called for under heading "Stamps on Material" for the "selective test." The relation of the results obtained from the tests conducted as provided for under the heading "Physical Tests" and the price of the material determine the selective factor. The dimensions of the sample bars shall be as follows:

Tungsten Tool Steel

Class 1.—¾ by 1½ inch by 5 feet long.

Carbon Tool Steel

Class 1.—⅝-inch diameter rod, 2 feet long.
Class 2.—⅝-inch diameter rod, 2 feet long.
Class 3.—¾-inch octagon rod, 5 feet long.
Class 4.—2-inch diameter rod, 2 feet long.

19. *Treatment of Samples.*—Each bidder will state in his proposal, if he considers it necessary to do so, the treatment to which the material must be subjected in order to get, in his opinion, the best results.

20. *Delivery of Sample Bars.*—All sample bars stamped as called for under the heading "Stamps on Material" must be delivered to the general storekeeper, Building No. 4, Navy Yard, Philadelphia, Pa., prior to the time fixed for opening of proposals. Sample bars delivered late will not be received. Failure to comply with the above requirements will eliminate the proposal from consideration. All sample bars will be delivered by the general storekeeper to the engineer officer for the "selective tests."

* * *

BROACHING PIVOT HOLES IN SCALE PARTS

The J. N. Lapointe Co., of New London, Conn., recently made a fixture for use on one of its broaching machines whereby the seats for the knife-edge pivots used in scale work may be broached two at a time. Fig. 1 shows the machine with the work and fixtures, while Fig. 2 is a close-range view of the fixture, broaches and work. The brass castings which must be broached are of different lengths. The broached holes must be at exact distances apart; they are first jig-drilled to the body size, and then by means of a double broaching head, the two broaches are pulled through the drilled holes, finishing them to shape.

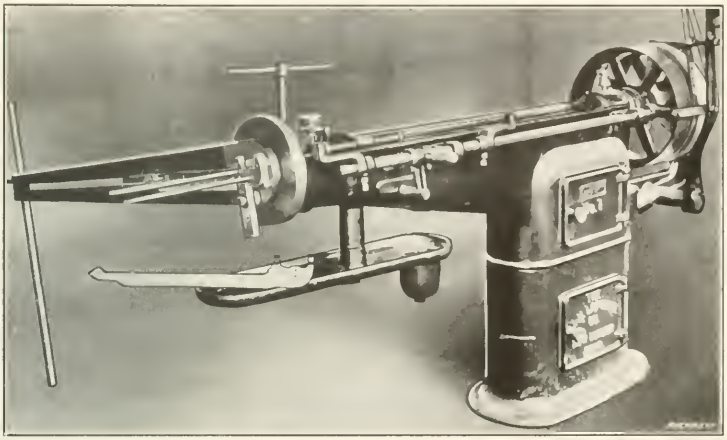
Fig. 1. J. N. Lapointe Broaching Machine fitted for broaching Scale Parts

Referring to Fig. 2, it will be seen that the fixture consists of a supporting plate which is slotted to receive the stud upon which the rear end of the broached piece rests. This stud is adjustable in its position to adapt it to the different lengths of castings which are to be broached. Upon the drip pan of the broaching machine may be seen one of the largest as well as one of the smallest pieces which are finished in this way. While being broached the piece is clamped against the face plate, and before commencing the stroke the two broaches are slipped through the drilled holes and clamped to the broaching head; then both broaching cuts are made at once. The old way of finishing these seats for the pivots was to file them, and it will be appreciated that broaching produces better work in less time. C. L. L.

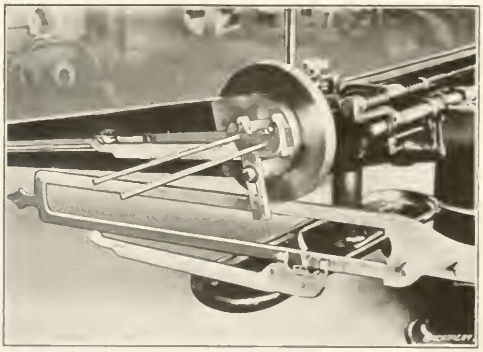
Fig. 2. Close-range View of Fixture and Work

AN ANALYSIS OF CRANKSHAFT STRESSES

DETERMINATION OF STRESSES IN TWO- AND THREE-BEARING, FOUR-CYLINDER CRANKSHAFTS

BY K. W. NAJDER

One of the most expensive and important parts of the automobile motor is the crankshaft. The machine work on this part must be extremely accurate and a high grade of material should be used as it is subjected to heavy strains.

The determination of crankshaft stresses can be done analytically or graphically, and it is a good practice to first use the analytical method and then check the results graphically. An adequate maximum pressure in the cylinder should be assumed, which should be taken as high as 20 to 25 atmospheres per square inch. All journals and crankpins should be dimensioned to withstand the surface pressure and friction in the bearings, and a liberal factor of safety allowed.

The material used is medium carbon steel with a tensile strength of 90,000 pounds per square inch, elastic limit 70,000 pounds, and an elongation of about 15 per cent in 2 inches. A far better material than medium carbon steel is a 3½ per cent nickel steel which has a tensile strength of about 120,000 pounds per square inch, elastic limit of 90,000 pounds and an elongation of about 16 per cent in 2 inches. Chrome-vanadium and chrome-nickel steels are very hard to machine; therefore these materials are very seldom used for crankshafts.

The allowable pressure on the journals and crankpins should not exceed 1000 pounds per square inch. One of the chief requirements of a crankshaft is stiffness, which depends upon the coefficient of elasticity of the material, and the value of this coefficient should be from 30,000,000 to 40,000,000. The arms of the crankshaft should be made of suitable thickness to give the required strength and stiffness, and here the bending stresses are of prime importance. The bending moment varies directly as the distance from the bearing, and the resistance to bending is directly proportional to the square of the thickness of the arms. However good a designer's judgment may be, and no matter what empirical formulas he has at his disposal, he must seek confirmation of his guesses in figures. This is absolutely necessary when the horsepower of the motor rises above 40, and in racing cars where the horsepower may vary anywhere from 70 to 200, calculations must be relied on in preference to judgment and empirical formulas. In the following, two problems will be completely worked out to illustrate the method of determining crankshaft stresses.

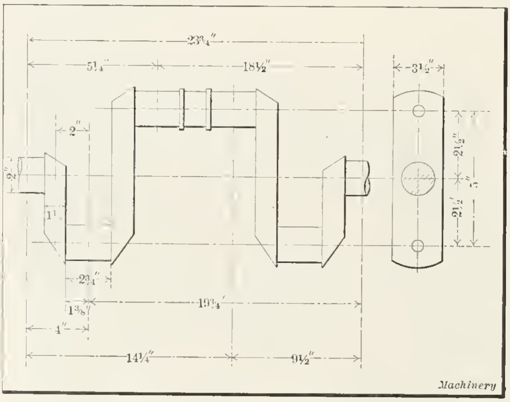

Fig. 1. Four-cylinder, Two-bearing Crankshaft

Four-cylinder Two-bearing Crankshaft

It will be assumed that the motor has a bore of 4 inches and a stroke of 5 inches, and that the maximum explosive pressure is 20 atmospheres per square inch. The maximum pressure on the piston is:

$$P_{\max} = \frac{D^2 \pi}{4} \times 20 = 250 \text{ atmospheres} = 3750 \text{ pounds.}$$

The connecting-rod pressure $\frac{P_{\max}}{\cos \beta}$ is composed of two components, a tangential force T, and a radial force R. (Hütte).

Let $\alpha = 30$ degrees and $\beta = 7$ degrees.

$$T = \frac{P_{\max}}{\cos \beta} \sin (\alpha + \beta)$$

$$= \frac{3750}{0.9925} \times 0.6018$$

$$= 2270 \text{ pounds;}$$

$$R = \frac{P_{\max}}{\cos \beta} \cos (\alpha + \beta)$$

$$= \frac{3750}{0.9925} \times 0.7986$$

$$= 3017 \text{ pounds.}$$

Each of these forces produces pressures on the crankshaft. The greatest pressures will be on the left crankshaft arm when cylinder No. 1 explodes.

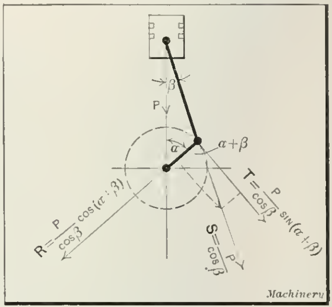

Fig. 2. Diagram showing Method of resolving Connecting-rod Thrust

Pressure due to tangential force $A_t = \frac{T \times 19\frac{3}{4}}{23\frac{3}{4}} = \frac{2270 \times 19\frac{3}{4}}{23\frac{3}{4}}$ $= 1880$ pounds;

Pressure due to radial force $A_r = \frac{R \times 19\frac{3}{4}}{23\frac{3}{4}} = \frac{3017 \times 19\frac{3}{4}}{23\frac{3}{4}}$ $= 2500$ pounds.

The maximum pressure is:

$$A_{\max} = \sqrt{A^2_t + A^2_r} = \sqrt{1880^2 + 2500^2} = 3125 \text{ pounds.}$$

The maximum pressure on the pin is:

$$\frac{3125}{2 \times 2\frac{3}{4}} = 568 \text{ pounds.}$$

The maximum bending moment on the extreme end of pin is:

$$M_c = 3125 \times 1\tfrac{3}{8} = 4300 \text{ inch-pounds;}$$

The section modulus of the pin is:

$$\frac{D^3 \pi}{32} = \frac{2^3 \times 3.14}{32} = 0.7856;$$

$$\text{Stress } S = \frac{4300}{0.7856} = 5470 \text{ pounds.}$$

Bending Moment of the Left Arm

$M_1 =$ moment due to radial force $= A_r \times 2 = 2500 \times 2 =$ 5000 inch-pounds;

Section modulus of arm $= \frac{Ch^2}{6} = \frac{3.5 \times 1.25^2}{6} = 0.90;$

$S_1 =$ stress due to radial moment $= \frac{5000}{0.90} = 5555$ pounds;

$M_2 =$ moment due to tangential force $= A_t \times 2\frac{1}{2} = 1880 \times 2\frac{1}{2}$ $= 4700$ inch-pounds;

$$\text{Section modulus} = \frac{hC^2}{6} = \frac{1.25 \times 3.5^2}{6} = 2.55;$$

$S_2 =$ stress due to tangential moment $= \frac{4700}{2.55} = 1840$ pounds;

$M_t =$ torsion moment $= A_t \times 2 = 1880 \times 2 = 3760$ inch-pounds;

Polar section modulus $= 2/9\, Ch^2 = 2/9 \times 3\frac{1}{2} \times 1.25^2 = 1.215;$

$S_t =$ stress due to torsion moment $= \frac{3760}{1.215} = 3090$ pounds.

The resultant of the tangential and radial bending moments is:

$$M_c = \sqrt{M_1^2 + M_2^2} = \sqrt{5000^2 + 4700^2} = 6860 \text{ inch-pounds.}$$

The resultant of the stresses due to tangential and radial bending moments is:

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*Address: 63 Franklin Blvd., Pontiac, Mich.

$$S_c = \sqrt{S_1^2 + S_2^2} = \sqrt{5555^2 + 1840^2} = 5850 \text{ pounds.}$$

The resultant of the bending and torsion moments is:

$$M_r = \tfrac{3}{8} M_c + \tfrac{5}{8} \sqrt{M^2_c + M^2_t} = \tfrac{3}{8} \times 6860 + \tfrac{5}{8} \sqrt{6860^2 + 3760^2} = 7450 \text{ inch-pounds.}$$

The resultant of the stresses due to bending and torsion moments is:

$$S_r = \tfrac{3}{8} S_c + \tfrac{5}{8} \sqrt{S^2_c + S^2_t} = \tfrac{3}{8} \times 5850 + \tfrac{5}{8} \sqrt{5850^2 + 3090^2} = 6330 \text{ pounds.}$$

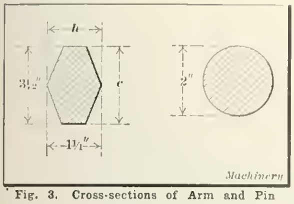


Fig. 3. Cross-sections of Arm and Pin

The maximum bending moment on the left journal is:

$M = A_{max} \times 4 = 3125 \times 4 = 12{,}500$ inch-pounds;

Section modulus $= \dfrac{D^3 \pi}{32} = \dfrac{2^3 \times 3.14}{32} = 0.7856$;

S = stress due to maximum bending moment $= \dfrac{12{,}500}{0.7856} =$ 15,900 pounds.

Stresses on Center Journals

The maximum stresses on both center journals will take place when cylinder No. 2 or No. 3 explodes.

The moment of the left center journal is approximately:

$$M = \frac{3750 \times 5\tfrac{1}{4} \times 18\tfrac{1}{2}}{23\tfrac{3}{4}} = 15{,}600 \text{ inch-pounds;}$$

Section modulus = 0.7856;

$$\text{Stress } S = \frac{15{,}600}{0.7856} = 19{,}900 \text{ pounds.}$$

The moment of the right center journal is:

$$M = \frac{3750 \times 14\tfrac{1}{4} \times 9\tfrac{1}{2}}{23\tfrac{3}{4}} = 21{,}300 \text{ inch-pounds;}$$

Section modulus = 0.7856;

$$\text{Stress } S = \frac{21{,}300}{0.7856} = 27{,}000 \text{ pounds.}$$

The bending moments and torsions of the center arms are figured in a similar manner to that used in connection with the left arm.

Pressure on the Pin

We have found $A_{max} = 3125$ pounds.

The maximum pressure on the pin is $\dfrac{3125}{2 \times 2\tfrac{3}{4}} = 568$ pounds.

The circumferential velocity of the pin is:

$$V = \frac{2}{12} \times \frac{\pi \times 1400}{60} = 12.21 \text{ feet per second.}$$

The motor runs at 1400 revolutions per minute and the coefficient of friction $\mu = 0.05$ (Hütte and Gülldner).

The work done by friction is 568 × 0.05 × 12.21 = 347 foot-pounds per second.

It will be remembered that one horsepower equals 550 foot-pounds per second; consequently, the lost power due to the friction of the pin is:

$$\frac{347}{550} = 0.63 \text{ horsepower.}$$

The deflection of the crankshaft is obtained from the formula:

$$\text{Deflection} = \frac{P l^3}{48 E I}$$

where

P = maximum explosive pressure;
l = length of crankshaft;
E = coefficient of elasticity = about 30,000,000 to 40,000,000;
I = moment of inertia.

Four-cylinder Three-bearing Crankshaft

We will now consider a four-cylinder, three-bearing crankshaft on a motor which has a bore of 4¼ inches, a stroke of 4½ inches and a flywheel weighing 70 pounds.

The forces on the crankshaft are:

Connecting-rod pressures = P_0, P_0', P_1' and P_1;
Weight of flywheel = P_2;
Reactions on bearings = T_0, T_1 and T_2;
Bending moments at bearings = M_0, M_1 and M_2.

Clapeyron's formula for a beam supported at three points is:

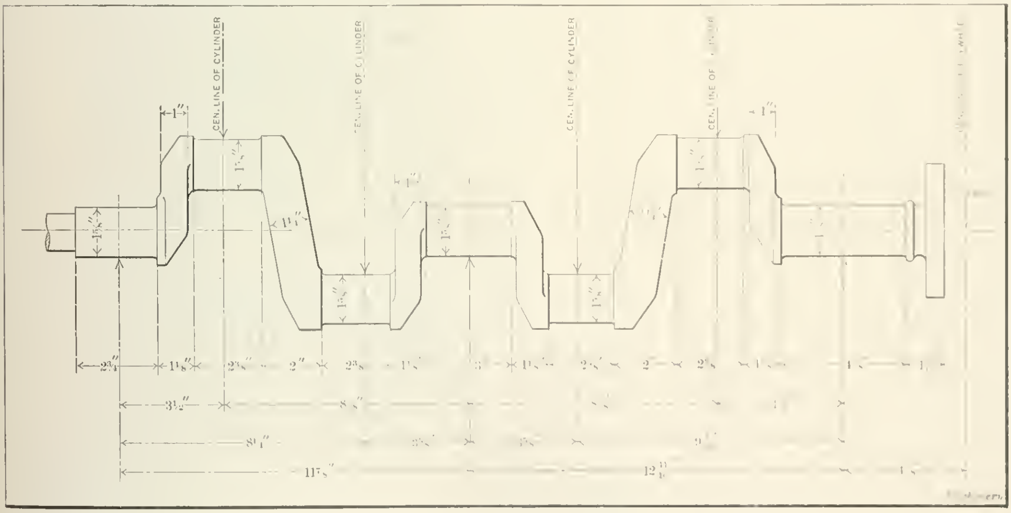


Fig. 4. Four-cylinder, Three-bearing Crankshaft

$$-M_0 l_0 - 2M_1(l_0 + l_1) - M_2 l_1 = \frac{P_0 a_0 (l_0^2 - a_0^2)}{l_0} + \frac{P'_0 a'_0 (l_0^2 - a'^2_0)}{l_0} + \frac{P_1 a_1 (l_1^2 - a_1^2)}{l_1} + \frac{P'_1 a'_1 (l_1^2 - a'^2_1)}{l_1}. \text{ (Hütte and Heller).}$$

To start with, we will put in the above formula:

$M_0 = 0$, $M_2 = P_2 l_2 = 70 \times 4\tfrac{1}{8} = 288$ inch-pounds.

To be safe, we also assume that there are explosions in two cylinders at a time.

$$P_0 = P_1 = \frac{D^2 \pi}{4} \times 25 = 354 \text{ atmospheres} = 5320 \text{ pounds;}$$

$$P'_0 = P'_1 = \frac{D^2 \pi}{4} \times 1.6 = 360 \text{ pounds.}$$

From the crankshaft drawing, Fig. 4, we obtain:

$a_0 = 3\frac{1}{2}$ inches; $l_0 = 11\frac{7}{8}$ inches;
$a'_0 = 8\frac{1}{4}$ inches; $l_2 = 4\frac{1}{8}$ inches;
$a'_1 = 9\frac{1}{16}$ inches; $l_1 = 12\frac{11}{16}$ inches;
$a_1 = 4\frac{5}{16}$ inches; $P_2 = 70$ pounds = flywheel weight.

Then:

$$-2M_1\left(11\tfrac{7}{8} + 12\tfrac{11}{16}\right) - 288 \times 12\tfrac{11}{16} = \frac{5320 \times 3\frac{1}{2}\left(11\frac{7}{8}^2 - 3\frac{1}{2}^2\right)}{11\frac{7}{8}}$$

$$+ \frac{360 \times 8\frac{1}{4}\left(11\frac{7}{8}^2 - 8\frac{1}{4}^2\right)}{11\frac{7}{8}} + \frac{5320 \times 4\frac{5}{16}\left(12\frac{11}{16}^2 - 4\frac{5}{16}^2\right)}{12\frac{11}{16}} +$$

$$\frac{360 \times 9\frac{1}{16}\left(12\frac{11}{16}^2 - 9\frac{1}{16}^2\right)}{12\frac{11}{16}}$$

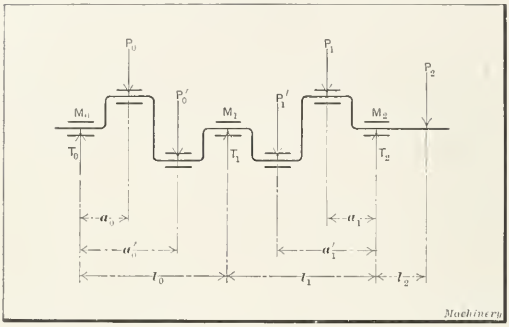


Fig. 5. Diagram showing Moments, Pressures and Reactions in Fig. 4

$$-M_1\,49.125 - 3654 = \frac{18{,}580\,(141 - 12.25)}{11\frac{7}{8}} + \frac{2970\,(141 - 68)}{11\frac{7}{8}}$$

$$+ \frac{22{,}942\,(161.2-18.5)}{12\frac{11}{16}} + \frac{3262\ 5\,(161.2-82)}{12\frac{11}{16}} - M_1\,49.125 - 3654$$

$$= \frac{2{,}614{,}135}{11\frac{7}{8}} + \frac{3{,}532{,}213}{12\frac{11}{16}} = 498{,}538$$

$$-M_1 = \frac{502{,}192}{49.125} = 10{,}222$$

$$M_1 = -10{,}222 \text{ inch-pounds.}$$

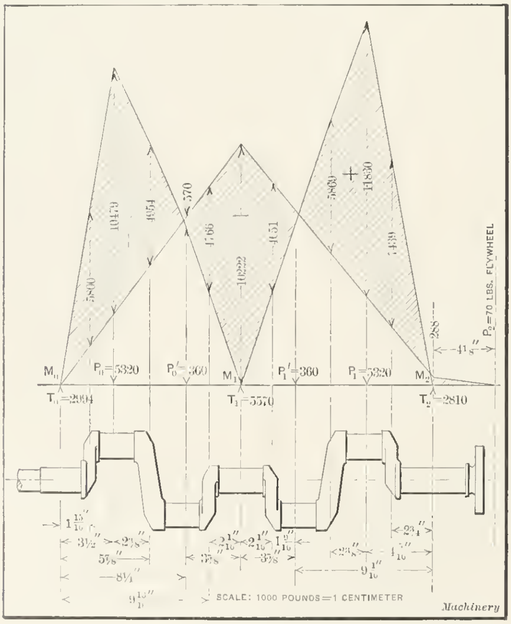


Fig. 6. Diagram of Bending Moments of Crankshaft when Cylinders No. 1 and No. 4 explode

Reactions T are a combination of part A to the right of any particular bearing, and part B to the left of this bearing. (Hütte.)

$T_0 = A_0 + B_0$;
$T_1 = A_1 + B_1$;
$T_2 = A_2 + B_2$.

Clapeyron's formula is:

$$A_0 = \frac{M_1 - M_0}{l_0} + \frac{P_0\,(l_0 - a_0)}{l_0} + \frac{P'_0\,(l_0 - a'_0)}{l_0};$$

$$B_0 = 0; \qquad 0{,}786$$

$$T_0 = \frac{M_1 - M_0}{l_0} + \frac{P_0\,(l_0 - a_0)}{l_0} + \frac{P_0'\,(l_0 - a_0')}{l_0};$$

$$A_1 = \frac{M_2 - M_1}{l_1} + \frac{P_1 a_1}{l_1} + \frac{P'_1 a'_1}{l_1};$$

$$B_1 = \frac{M_0 - M_1}{l_0} + \frac{P_0 a_0}{l_0} + \frac{P'_0 a'_0}{l_0};$$

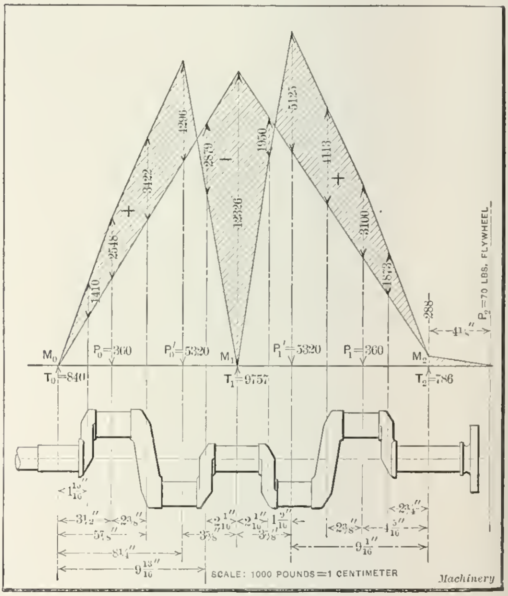


Fig. 7. Diagram of Bending Moments of Crankshaft when Cylinders No. 2 and No. 3 explode

$$T_1 = -\frac{M_1}{l_0} - \frac{M_1}{l_1} + \frac{M_2}{l_1} + \frac{M_0}{l_0} + \frac{P_1 a_1}{l_1} + \frac{P'_1 a'_1}{l_1} + \frac{P_0 a_0}{l_0} + \frac{P'_0 a'_0}{l_0}$$

$$A_2 = P_2$$

$$B_2 = \frac{M_1 - M_2}{l_1} + \frac{P_1\,(l_1 - a_1)}{l_1} + \frac{P'_1\,(l_1 - a'_1)}{l_1};$$

$$T_2 = \frac{-M_2}{l_2} + \frac{M_1}{l_1} + \frac{P_1\,(l_1 - a_1)}{l_1} + \frac{P'_1\,(l_1 - a'_1)}{l_1} + P_2;$$

In the case under consideration, we have:

$$T_0 = -\frac{10{,}222}{11\frac{7}{8}} + \frac{5320\,(11\frac{7}{8} - 3\frac{1}{2})}{11\frac{7}{8}} + \frac{360\,(11\frac{7}{8} - 8\frac{1}{4})}{11\frac{7}{8}} =$$

2994 pounds;

$$T_1 = \frac{10{,}222}{11\frac{7}{8}} + \frac{10{,}222}{12\frac{11}{16}} + \frac{288}{12\frac{11}{16}} + \frac{5320 \times 4\frac{5}{16}}{12\frac{11}{16}} + \frac{360 \times 9\frac{1}{16}}{12\frac{11}{16}} +$$

$$\frac{5320 \times 3\frac{1}{2}}{11\frac{7}{8}} + \frac{360 \times 8\frac{1}{4}}{11\frac{7}{8}} = 5570 \text{ pounds;}$$

$$T_2 = -\frac{288}{4\frac{1}{8}} - \frac{10{,}222}{12\frac{11}{16}} + \frac{5320\,(12\frac{11}{16} - 4\frac{5}{16})}{12\frac{11}{16}} +$$

$$\frac{360\,(12\frac{11}{16} - 9\frac{1}{16})}{12\frac{11}{16}} + 70 = 2810 \text{ pounds.}$$

Then we have:

$T_0 = 2994$ pounds, $T_1 = 5570$ pounds, $T_2 = 2810$ pounds.

Crankshaft Turned Forward 180 Degrees

In the same way, we can find the moments when the crankshaft is turned forward 180 degrees.

Then:

$P_0 = P_1 = 360$ pounds;

$P'_0 = P'_1 = 5320$ pounds.

As in the preceding case, we assume $M_0 = 0$, $M_2 = 288$ inch-pounds.

By Clapeyron's formula:

$$-2\,M_1\left(11\tfrac{7}{8} + 12\tfrac{1}{16}\right) - 288 \times 12\tfrac{1}{16} = \frac{360 \times 3\frac{1}{2}\left(11\frac{7}{8}^2 - 3\frac{1}{2}^2\right)}{11\frac{7}{8}} +$$

$$\frac{5320 \times 8\frac{1}{4}\left(11\frac{7}{8}^2 - 8\frac{1}{4}^2\right)}{11\frac{7}{8}} + \frac{360 \times 4\frac{5}{16}\left(12\frac{1}{16}^2 - 4\frac{5}{16}^2\right)}{12\frac{1}{16}} +$$

$$\frac{5320 \times 9\frac{1}{16}\left(12\frac{1}{16}^2 - 9\frac{1}{16}^2\right)}{12\frac{1}{16}} = 12{,}326;$$

$M_1 = -12{,}326$ inch-pounds;

$$T_0 = -\frac{12{,}326}{11\frac{7}{8}} + \frac{360\left(11\frac{7}{8} - 3\frac{1}{2}\right)}{11\frac{7}{8}} + \frac{5320\left(11\frac{7}{8} - 8\frac{1}{4}\right)}{11\frac{7}{8}} = 840 \text{ pounds;}$$

$$T_1 = \frac{12{,}326}{11\frac{7}{8}} + \frac{12{,}326}{12\frac{1}{16}} + \frac{288}{12\frac{1}{16}} + \frac{360 \times 4\frac{5}{16}}{12\frac{1}{16}} + \frac{5320 \times 9\frac{1}{16}}{12\frac{1}{16}} +$$

$$\frac{360 \times 3\frac{1}{2}}{11\frac{7}{8}} + \frac{5320 \times 8\frac{1}{4}}{11\frac{7}{8}} = 9757 \text{ pounds;}$$

$$T_2 = -\frac{288}{4\frac{1}{5}} - \frac{12{,}326}{12\frac{1}{16}} + \frac{360\left(12\frac{1}{16} - 4\frac{5}{16}\right)}{12\frac{1}{16}} + \frac{5320\left(12\frac{1}{16} - 9\frac{1}{16}\right)}{12\frac{1}{16}} +$$

$70 = 786$ pounds;

$T_0 = 840$ pounds, $T_1 = 9757$ pounds, $T_2 = 786$ pounds.

Knowing the reactions T_0, T_1 and T_2, the bending moments at any point of the crankshaft can be easily figured out. We see that the maximum bending moment of the center journal will occur when there are explosions in the second and third cylinder; this moment is 12,326 inch-pounds. The maximum bending moment of the arms takes place when the first and fourth cylinders explode, and is equal to 7439 inch-pounds, which is the bending moment of the right arm. The combined bending moments and torsions are figured in a similar way to that followed with the four-cylinder, two-bearing crankshaft in the first example. From this discussion, we see what a small influence the flywheel has upon the crankshaft.

* * *

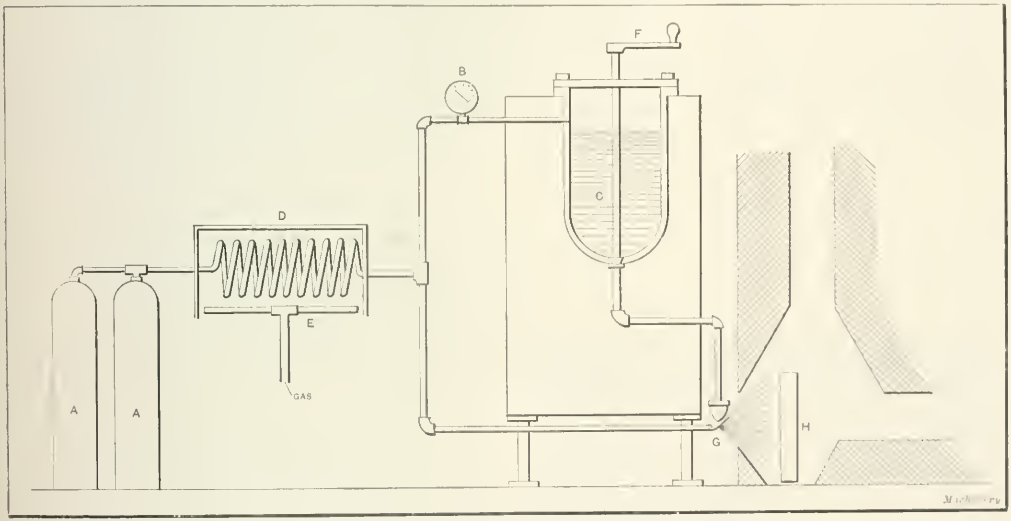
Electrical baths will be one of the features of a new club house of the Association of Employes of the New York Edison Co. which has recently been opened in New York City.

THE SCHOOP SYSTEM OF METAL PLATING*

The process of plating or depositing metal in a layer of any required thickness, invented and perfected by M. Schoop, has finally come into practical use. The principle was described before the French Academy of Sciences in 1910. It consists in projecting molten and atomized metal upon the surfaces to be plated.

Like most inventions the Schoop process resulted from the observation of a very simple phenomenon. M. Schoop, who is a Swiss engineer, well known by his works on electrochemistry and accumulators, was one day watching his children shooting against a wall with an air gun. He noticed that the shot deposited upon the wall a very adherent coat of lead. From this he conceived the idea of metal plating by projection which he has finally worked out.

The experiments made since 1910 have shown the best methods of giving a plating of the required composition and appearance with any given metal. The inventor uses two modes of operation: one using the metal in fusion and the other as a powder. The apparatus employed in using molten metal is shown herewith. At *A* are reservoirs of gas or air under pressure; *B* is a pressure gage; *C* is the crucible of molten metal; *D* is a heater with gas burner *E*; *F* a handle controlling the valve which allows the escape of the metal; *G* is an atomizer; and *H* the object to be plated. With this arrangement the pressure of the flowing metal and that of the current of air or gas producing the atomization are equal, and on account of the heating the gas arrives at the surface of the metal warm, notwithstanding its expansion.



Showing General Principle of the Schoop Apparatus for Metal Plating

The installation is usually stationary, but for objects which cannot be moved a portable arrangement is used. In this case the metal is first reduced to a very fine powder by means of the stationary apparatus. The powder is placed in a strong vessel, in which it can be subjected to pressure: a flexible tube serves as a means of conveying the spray to the different parts of an object. Connected with the discharge tube is a gas torch, and as the fine powder strikes the flame it is converted into a metallic cloud. It is found that a coating of any desired thickness may be applied by this method, and it is being extensively used in France for plating with zinc, lead and copper.

* * *

The exports of automobiles from France amounted, in 1912, to about $40,000,000, an increase of about 25 per cent over the exports during 1911. The imports of automobiles into France do not exceed $2,500,000.

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* See also "New Method of Metal Coating," April, 1911.

AUTOMOBILE MANUFACTURING METHODS*

INTERESTING DRILLING, BORING AND MILLING JIGS AND FIXTURES USED IN PRODUCING THE REO MOTOR CAR

BY DOUGLAS T .HAMILTON†

The Reo Motor Car Co., Lansing, Mich., builds only one type of chassis on which different bodies are mounted, and hence gives its entire attention to the production of parts which, to a large extent, are standard. This makes it necessary for this company to devise jigs and fixtures to handle the work in the most efficient manner, owing to the large number of interchangeable parts made. In the following, a few of the most interesting operations, as well as the jigs and fixtures used in manufacturing certain parts will be illustrated and described.

Machining Brake Supports

One of the many interesting operations is the machining of brake supports, a detail view of which is shown in Fig. 2. These supports are made from malleable iron castings and are machined practically complete in Baker vertical drilling machines. Fig. 1 shows the row of four vertical drilling machines used for performing the boring, reaming and facing operations—one man attending to two machines. In the first operation the holes *A* and *B* are bored and reamed, and the top face *C* and inside shoulder *D* are rough-faced. The boring is accomplished in the first machine (see Fig. 1) with an inserted high-speed steel boring tool which rough-bores the diameter *A* to 2.558 inches. The casting is then removed and placed in the jig under the second machine, where it is finish-reamed to 2.5655 inch diameter. The partly machined brake support is now passed to the next operator who inverts it and places it in the jig under the third machine in the row. Here the largest diameter *E* is bored to 3.960 inches, and at the same time the end *F* is rough-faced. The next operation is finish-reaming, which is accomplished in the last machine in the row. Here, in addition to reaming the hole to 3.990 inches, the top face and the inner shoulder are faced, bringing the casting to the correct depth and length. This finishes the boring and reaming operations on the brake support.

The brake supports are now taken to the vertical drilling machine shown in Fig. 3, where the hub end is machined, as indicated on the casting shown at *A*. The brake hub is located from the previously reamed hole on a fixture fastened to the table of the machine, and is prevented from rotating by a stop which comes in contact with the arm. The large hollow mill used for performing this operation is of the inserted blade type, the blades being held in place by two adjusting ring nuts which clamp them in grooves provided in the body of the mill. It is also provided with a hardened and ground leader which fits in the previously reamed hole in the hub end, thus making the external diameter concentric with the bore. The total depth turned is 3.03 inches, and 3/8 inch of material is removed from the diameter, bringing the hub end of the brake support to 2.9350 inches. This operation is handled at such a rapid rate that a product of 200 finished castings in nine hours is obtained.

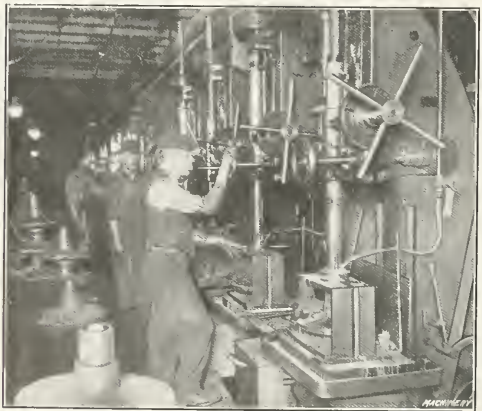

Fig. 1. Boring, Reaming and Facing Brake Supports in Baker Vertical Drilling Machines

Boring and Tapping Transmission Cases

An operation which is seldom accomplished on a drilling machine of the vertical type is the boring and tapping of transmission cases. The Reo Motor Car Co., however, performs this operation on a Baker vertical drilling machine, illustrated in Fig. 4, with satisfactory results. A special jig, a view of which is shown in Fig. 5, and in detail in Fig. 6, is used for this purpose. Referring to Fig. 6 it will be seen that the jig consists of a base *A* provided with lugs which are used in clamping the jig to the column of the vertical drilling machine —this having been provided with T-slots for the purpose. The bracket *B* carrying the jig proper which holds the work, is free to rotate in the base *A* when the handle *C* is operated, withdrawing the locking plunger. This locking plunger fits in bushed holes in the bracket, and thus provides for indexing the jig and enabling the holes in each end of the transmission case *A* to be machined.

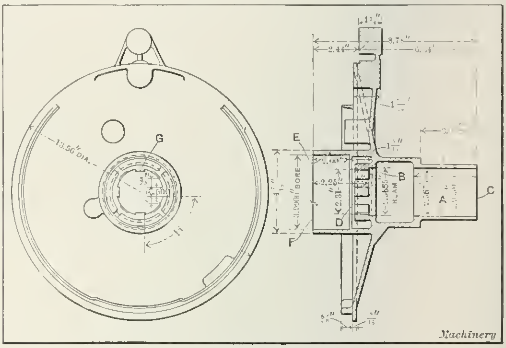

Fig. 2. Brake Support machined in Baker Drilling Machines illustrated in Figs. 1 and 3

It will be noticed in Fig. 4 that the transmission case *A* has two holes in each end, so that to machine both holes in this jig it is necessary that means be provided for rotating the jig *D* around its vertical axis. This is accomplished by having the axis of the trunnions on jig *D* out of line with the axis of the spindle an amount equal to half the distance between the two holes in the end of the work. The arms of bracket *B* carrying the trunnion are split as shown, and provided with a clamping bolt for giving the proper tension on the rotating member of the jig. To rotate the jig around its vertical axis, the handle *E* is operated, withdrawing the locking plunger (see Fig. 6) and thus permitting the jig to be rotated to bring the two holes alternately in line with the spindle of the machine. The transmission case is located in the jig by the machined arms and is held up against the finished surface on the jig by two swinging clamps *G*. The operations performed consist in rough-reaming the first hole with a stepped reamer to 3.490 and 3.3917 inches. The jig is then indexed on its vertical axis and the operations repeated on the other hole. This hole is then tapped 0.010 inch under size (3½ by 12 pitch). The jig is then indexed back and the other hole tapped. After this, it is indexed on its horizontal axis and the operations repeated. The 0.010 inch finish is removed by hand after the cases have seasoned. By the use of this jig thirty-three finished transmission cases can be turned out in nine hours.

Jig for Drilling and Reaming Automobile Drive Shafts

The type of jig used in drilling and reaming the holes in the bosses of automobile drive shafts is shown in Fig. 7. This consists of a cast-iron body *A* which is fastened by bolts and dowels to one end of the base *B*, the other end of the base carrying the support *C* for holding the shaft parallel while the hole in the opposite end of the shaft is being drilled and reamed. The work is prevented from swinging around in the jig by a stop *D*.

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* For information previously published in MACHINERY on automobile manufacture, see "Methods, Machines and Fixtures for Automobile Manufacture," December, 1911, and other articles there referred to.

†Associate Editor of MACHINERY.

The clamping mechanism is interesting and works on the cam principle. It consists of a sleeve *E* having a tapered hole in it that fits over the boss on the end of the drive shaft, which is operated by a two-handle clamping nut *F*. The flange of the clamping nut is cut away to clear the locking straps *G*, so that the sleeve *E* can be withdrawn in order to remove the work. As soon as the pressure is relieved from the sleeve *E*, it is raised automatically by two open-wound coil springs *H*. The sleeve is prevented from coming entirely out and rotating by the headless screw *I*, which works in a groove in the sleeve.

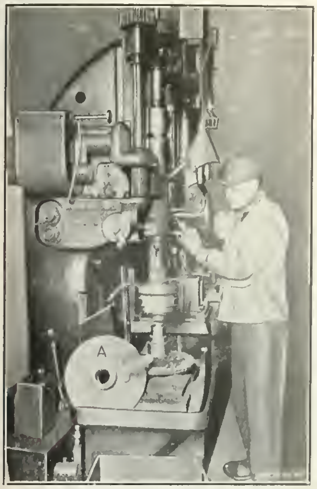

Fig. 3. Hollow-milling Hub End of Brake Support in Baker Drilling Machine

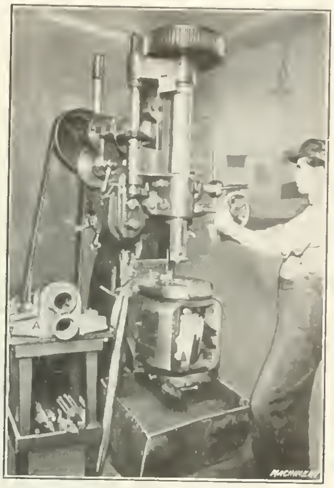

Fig. 4. Boring and Tapping Transmission Cases in Baker Drilling Machine

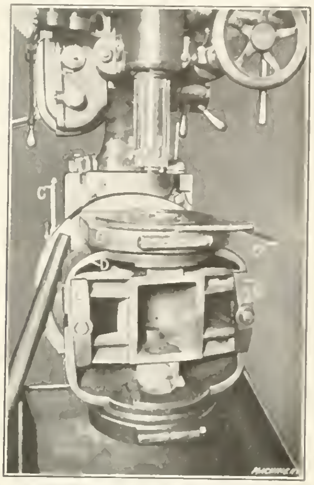

Fig. 5. Close View of Jigs and Work illustrated in Fig. 4

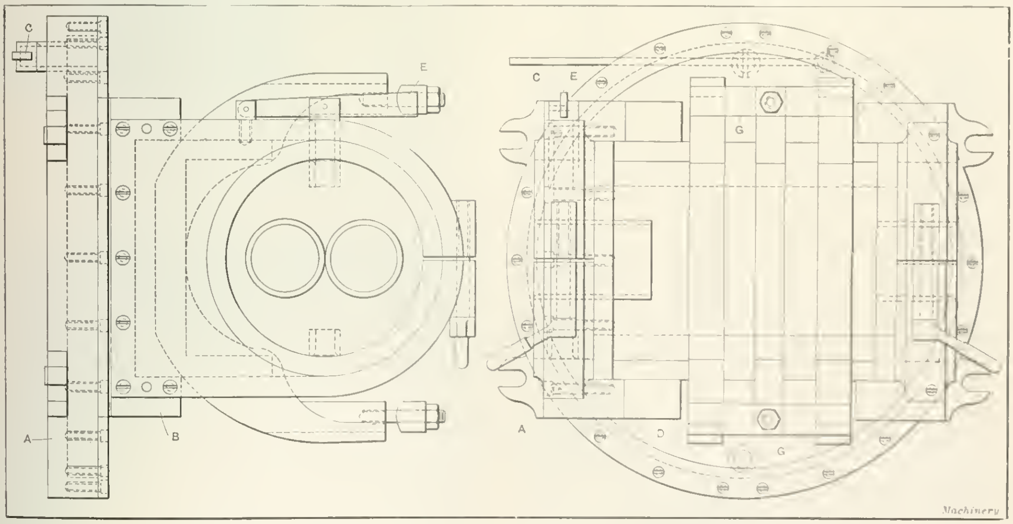

Fig. 6. Details of Rotating Jig used in boring and tapping Transmission Cases shown in Figs. 4 and 5

The bushing used for guiding the drill and reamer is carried in this sleeve, which is tightened on the work by giving the handle a quarter turn, bringing the cam portions under the two blocks *G* fastened by screws and dowels to the main casting. The clamping nut *F* is held down on a seat on the sleeve by the nut *J*. A pipe *K* for supplying lubricant to the drill or reamer is inserted completely through the sleeve, an elongated slot being cut in the latter for this purpose. Through this pipe, oil or any cutting lubricant can be supplied directly to the cutting tool when it is at work in the hole. This type of jig can be operated very quickly and forms an efficient device for machining work of this kind.

Drilling Crank-cases in Multiple Spindle Drilling Machines

The drilling of holes in the crank-case is an operation which the majority of automobile manufacturers accomplish in a multiple spindle drilling machine, but there are a diversity of methods employed in this work. An interesting and efficient type of drilling jig which is applied to a National multiple spindle drilling machine is shown in Fig. 8. This jig is so arranged that it is possible for the operator to keep the machine in practically continuous operation. To the left of the machine table is a track arrangement *A*, similar in construction to that shown at *B* at the right of the machine. These two stands, in conjunction with the "track" jig *C* on the table, enable the work to be handled in a rapid manner.

The method is as follows: A casting is placed on the jig *C*, the machined arms of the crank-case resting on the four hardened locating plates *D*, but before placing the casting in this position the bushing plate *E* is put in place. Now while the machine is in operation (using the automatic feed) on the casting on the table, the operator places another casting on the stand to the left and puts the extra bushing plate *F* in place. Then when the casting on the table of the machine has been drilled, the operator drops the table down quickly and slides the casting over into position on the track to the right at *B*. Then he removes the casting from the stand to the left placing it in a position under the drills and starts the machine in operation again. It will be noticed that the tracks at both sides of the table of the machine are lower than the drill jig; this is due to the fact that the drills are in operation and the table is raised. When the table is down all the tracks are in line.

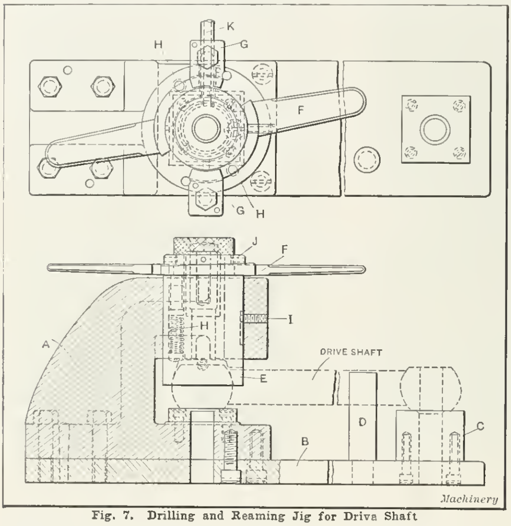

Fig. 7. Drilling and Reaming Jig for Drive Shaft

It is astonishing how quickly these cast-iron crank-cases can be drilled when handled in the manner illustrated in Fig. 8. There are twenty-five holes in the crank-case varying in diameter from 13/64 to 27/64 inch, and the greatest depth is ¾ inch. With the arrangement illustrated it is possible for one operator to turn out an average of 210 completed crank-cases in nine hours, which means a total of 5250 holes to his credit. It is easily seen that such a remarkable production would be utterly impossible were this means of arranging the work not employed.

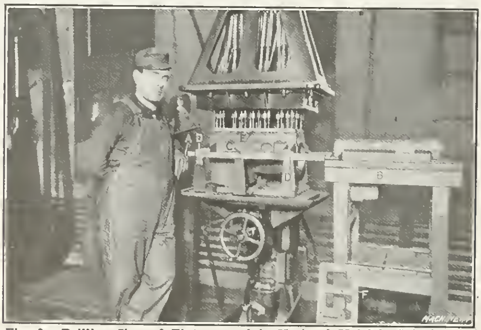

Fig. 8. Drilling Jig and Fixture used in National Multiple Spindle Drill for drilling Twenty-five Holes in the Top Faces of Crank-cases

Tapping and Studding Crank-cases

The studs which are used in conjunction with nuts for holding the engine cylinders on the crank-case are made in screw machines and are inserted with an Errington stud setter. The fixture and method employed in tapping and studding the crank-case is worthy of special mention. Referring to Fig. 9, it will be seen that the fixture consists of a casting *A* having four arms to which two rails or tracks *B* are fastened. These are machined on their top faces and guide the crank-case by the machined face of the arms on the latter. The machine used is a W. E. Gang high-speed radial drilling machine supplied with a tapping attachment. The operator first taps all the holes, which are twenty-six in number and are of the following sizes: Five ⅜ by 16, eight ¼ by 20, twelve ½ by 13 and one ½ inch pipe tap. The actual time for tapping the twenty-six holes in this crank-case is four minutes and the twenty-five studs are inserted in approximately three minutes.

The stud setter is a small tool somewhat similar to a threading tool and carrying a two-piece jaw shaped like a split die. This is brought in contact with the work, the stud hitting a shoulder on the tool, whereupon the jaws close tightly on the work and screw the stud into the crank-case. As soon as the proper depth is reached, it releases from the stud automatically and is drawn up by the handle as shown in the illustration. The crank-case is slid back and forth on the track and the arm of the radial drilling machine is swung around so that it is a simple matter to line up the stud setter or tap with the holes. Some idea of the rapidity with which these operations are accomplished is obtained from the production—the tapping and studding of sixty-four of these crank-cases in nine hours.

Keyseating Live Shafts for Rear Axles

The keyseats in the propeller shafts which form a means for connecting the universal joint on each end are produced in Kempsmith-Lincoln type milling machines as shown in Fig. 10. These propeller shafts, which are made from Carpenter Sampson steel, are held four at a time in special fixtures. A detail of the fixture used in holding the four live shafts while cutting the keyway in the tapered end is shown in Fig. 11. Referring to this illustration, it will be seen that the clamping mechanism used for gripping the shafts is unique and very effective. Fastened to the top part of the fixture are five strips *A* which are machined out, as indicated, to fit the tapered ends of the four live shafts. The main body of the fixture is also machined to a similar shape and is provided with a slot in which four clamping blocks *B* work. These are fastened by screws to two rocker blocks *C*, the latter being pinned to a cross-bar *D*. Cross-bar *D* is operated by a cam *E* which forms an integral part of the shaft *F*, the latter being provided with an operating handle *G*. Cam-shaft *F* works in two eccentric bushings *H* which are provided with small circular grooves in their peripheries that fit the head of fillister head screws. This enables the bushings to be rotated and held in the desired posi-

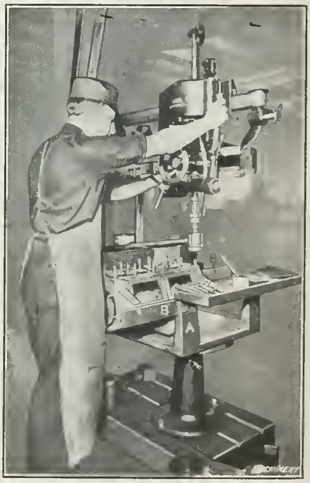

Fig. 9. Tapping and Studding Crank-cases in a W. E. Gang Radial Drill

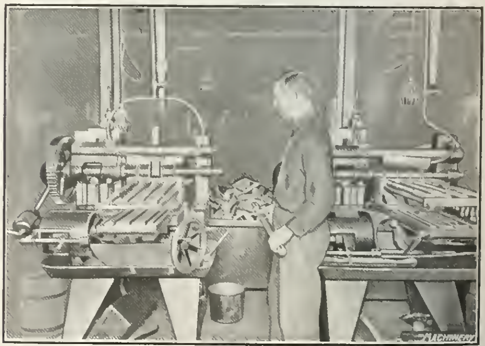

Fig. 10. Keyseating Live Axle Shafts in Kempsmith-Lincoln Type Milling Machines

tion, in order that the handle will clear the cutters of the milling machine and also be in the most convenient position for the operator.

In operation, the shafts mentioned are placed in the grooves of the fixture and rest on a bar *I* in which a groove is cut forming a guiding means for the endwise position of these live shafts. Pins, as shown in Fig. 10, are driven into the cross strip *I* so that the proper location of the shaft on this strip can be quickly obtained. When the shafts are placed in position, the operator grips handle *G* and turns it around until the work is clamped. The action, it will be seen, is as follows: As handle *G* is rotated, the cam on shaft *F* raises the cross-bar *D* and through the swinging members *C* forces up the four blocks *B* holding the work rigidly against the strips *A*. Having the members *C* pinned in this manner makes it possible to distribute the pressure equally on all four shafts and thus hold them rigidly in position. The fixture used for holding the propeller shafts when cutting the keyway in the straight end is shown to the right in Fig. 10, and is similar to that just described, except that it holds the shafts in a parallel position.

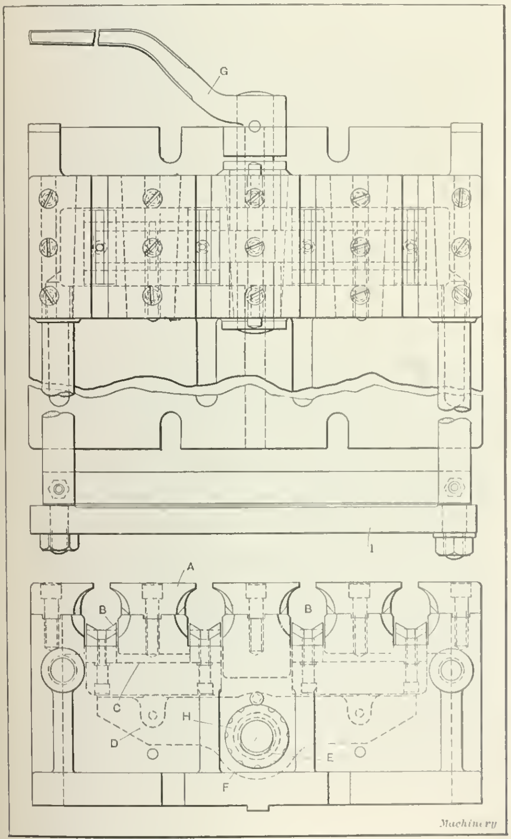

Fig. 11. Details of Keyseating Fixture used in holding Live Axle Shafts for cutting the Keyway in the Tapered End

Milling Fixture for Inlet Valve Levers

Another interesting type of milling fixture which is used for cutting the slot *A* in inlet valves is shown in Fig. 12. This fixture consists of a cast-iron base *B* held to the table of the milling machine and provided with two projecting bosses on each end. These are machined to fit jaws *C* that are operated by a shaft *D* provided with right- and left-hand threads, respectively. The work is held in the manner indicated, being gripped by the jaws over the part of the valve lever in which the slot is to be cut. To prevent springing the work, a stud *E*, which also serves the additional purpose of guiding the work from the hole, comes against one of the jaws being held in the other. This acts as a stop and prevents the jaws from squeezing the work too tightly and thus springing the lugs formed by the slot. The fixture is operated quickly and forms a very effective means of holding work of irregular contour.

Machining Transmission Ends for Drive Shaft Universals

A good example of the important function filled by engine lathes in the automobile factories is shown in the manufacture of transmission ends for universal drive shafts, Fig. 15. This part is made from 15 point carbon open-hearth steel and is drilled and reamed before being brought to the engine lathe shown in Fig. 13. It is held on an expanding air chuck, being gripped from the hole, and the small end is reduced to approximately the correct diameter in one cut. This means a reduction of $1\frac{1}{2}$ inch in diameter—a depth of cut of $\frac{3}{4}$ inch on a side—the actual time to complete this roughing operation being 31 seconds. This first cut is made on all the pieces and they are afterwards finished to the sizes given in the illustration Fig. 15, which, of course, are the rough dimensions, sufficient material being left for grinding all over.

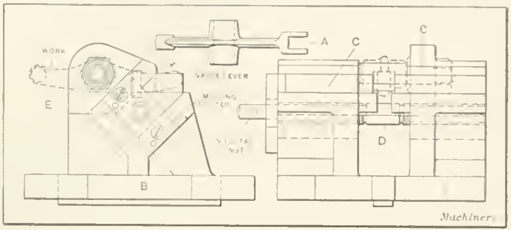

Fig. 12. Milling Fixture for slotting Inlet Valve Lever

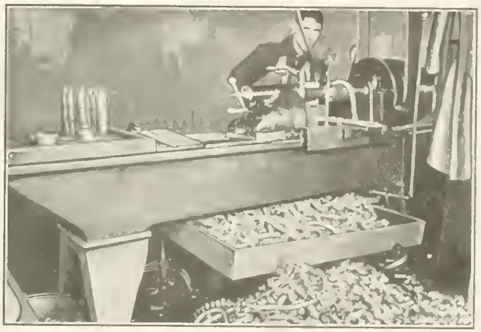
Fig. 13. Machining Transmission End of Drive Shaft Universal in R. K. LeBlond Engine Lathe

Fig. 14 gives a better idea of the depth of cut taken on this machine and also gives a better view of the method of holding the work. The expanding air chuck *A* is provided with a shank fitting the largest diameter of the piece and is reduced slightly more than the smaller diameter; it is also threaded on the end for the reception of the hardened nut *B*. This is provided with a center, and is guided by the tailstock center in order to prevent the thrust of the tool from springing the arbor of the air chuck, which would certainly occur in taking such a tremendous cut.

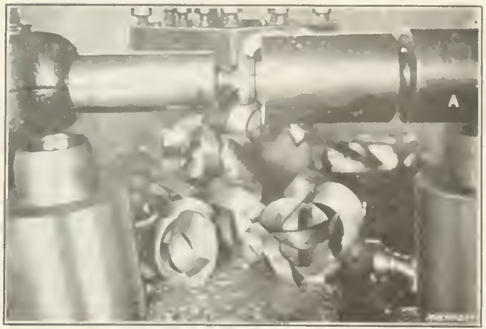

Fig. 14. A Closer View of the Operation showing the Extreme Depth of Cut taken

Machining Valve Plunger Guides

The valve plunger guide shown in Fig. 17 is a good example of the work which can be handled in the automatic chucking machines of the type shown in Fig. 16. The work is held in specially formed chuck jaws fastened to the head which is provided with one more position than the number of spindles on the machine. The manner of holding the work and applying the tools to it differs from the usual method of handling work on automatic screw machines. In this case, the work is held stationary (except for being traversed longitudinally and indexed) and the cutting tools are rotated. This machine is provided with four spindles which are rotated at a speed most suitable for the proper working of the tools that they carry.

The order of operations on this piece is as follows: first, drill a 63/64-inch hole half way through, and rough-turn outside diameter with a hollow mill; second, drill hole completely through and take finishing cut from outside diameter with hollow mill; third, counterbore; fourth, ream completely through. It is evident, of course, that the reamer has to travel twice as far as the other tools in the work, so that the reamer head is operated by a separate cam to provide for this additional amount of travel. The machine works practically automatically but, of course, requires the attention of the operator to insert and remove the finished work. The machine is provided with one more chuck than spindles; hence there is always one vacant position from which the operator can remove a finished casting and insert a rough one. It is evident from this that the production from a machine of this type must be great, and this example is a case in point—130 of these finished castings being turned out every hour.

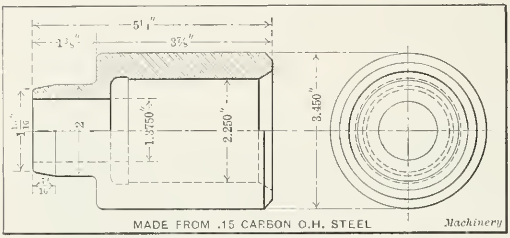

Fig. 15. Transmission End of Drive Shaft Universal which is completely turned in R. K. LeBlond Engine Lathe

Broaching Brake Supports

The brake support shown in Fig. 2 which is attached to the housing enclosing the rear axle is subjected to considerable torsional strain, and hence it is necessary that a suitable means be supplied for holding it rigidly in place. This is accomplished by broaching a series of grooves, four in number, in the brake support, thus forming tongues *G* and by cutting corresponding slots in the housing enclosing the rear axle. The operation of broaching is handled as shown in Fig. 18 in a La Pointe broaching machine which is provided with an arm on the faceplate carrying a stud for locating the brake support in the proper position, and also preventing it from turning. The broach, as shown, is provided with teeth equal in circumference to the space indicated by the distance *H* in Fig. 2, as it is from this point of the brake support that the metal is to be removed to form the tongues. This hole is completed in one pass of the broach and at the rate of 200 per day of nine hours.

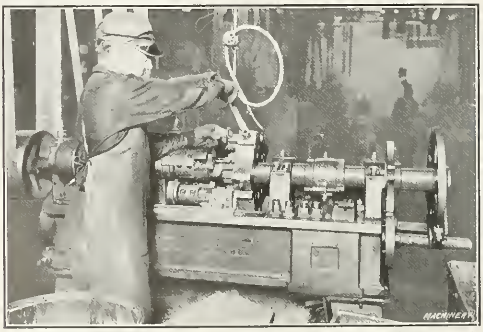

Fig. 16. Machining Valve Plunger Guides in the New Britain Automatic

Riveting Main Drive Gears to Differential Case

In the automobiles built by the Reo Motor Car Co., the main drive gear instead of being bolted is riveted to the differential case, and this operation is handled very quickly by the Chicago pneumatic riveter, illustrated in Fig. 19. This riveter is provided with a lower "anvil" having a lug that fits around the stem of the differential case and a riveting punch of the proper size and shape held in the ram. The main drive gear is first assembled on the differential case and held in position by three bolts, which are removed as the riveting progresses. The operator then brings the assembled members to the machine shown in Fig. 19, and the 3/8-inch cold-rolled steel rivets are placed in the holes. As the rivet heads are not exactly square, a hardened collar is placed over them in order to enable the upsetting of the lower end of the rivet to be accomplished without distorting the projecting part. As soon as the lower end of the rivets have been upset all around, the operator removes these hardened nuts and then by one operation of the arm for each rivet, completes the formation of the rivet heads—thus binding the differential case and main drive gear solidly together. This operation is handled much more quickly than is possible by tapping, inserting bolts and screwing nuts onto them, as is the usual practice.

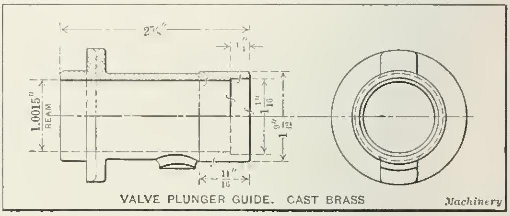

Fig. 17. Valve Plunger Guide which is machined in the New Britain Automatic shown in Fig. 16

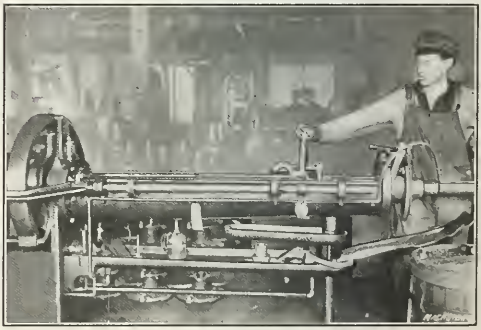

Fig. 18. Broaching Brake Supports in Lapointe Machine Tool Co.'s Broaching Machine

Testing Motors and Completed Cars

The practice followed in testing motors and completed cars differs to a considerable extent in the various automobile factories. The motors, as a rule, are all tested on a stand by belt power and then run on their own power for three or four hours to see that everything is working properly. The practice followed by the Reo Motor Car Co. is as follows: The motors are run on a stand by belt for from four to six hours and are then taken apart and the bearings readjusted. After this they go to the inspection department where the cylinders are removed and the pistons, rings and bearings, examined. When everything has been examined, the motors are installed in the complete chassis. After the motor has been fastened to its proper place in the chassis, it is run on its own power on special "Sirocco" blowers. Pulleys *A* (see Fig. 20) are put on the rear axles instead of wheels, and these are belted to the blower, which is to be rotated at a rate of 35 miles per hour, requiring 30 horsepower to drive—this tests the engine at its rated capacity. The air from the blower is used to cool the motor, being brought down through the pipe *B*. After the motors have been subjected to the test outlined, the chassis with motor in place is taken to what is known as the load test. Here the pulleys on the axles are set up and belted as before, but in this case to a rotary pump. Then by means of a heavy spring valve, a full load at any speed can be imposed on the motor so that its efficiency is tested in a more accurate manner than if the car were taken out for the regular road test.

The road test which is still employed by some manufacturers has several disadvantages. In the first place, the wear and expense of tires is enormous, and in the second place, unless the automobile company has especially prepared tracks of their own, it is difficult to obtain permission from the community to allow them to drive their automobiles at a high rate of speed up and down the public streets. There is also the additional trouble of bringing the car in, washing and cleaning it, and the still further objection that if many cars are produced in a day, it is practically impossible to find a place to test them out. The means of testing employed by the Reo Motor Car Co. subjects the motor to just as rigid a test as it receives on the road, and even more so, and has the advantage of being accomplished in a more scientific and much more rapid manner. Of course before the car is sold, it is taken out and run around for a short time; this is not done to test the engine or any of the working parts, but just to see that the other mechanical movements of the car are perfect in every respect.

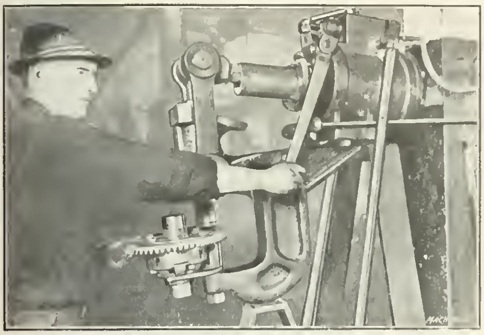
Fig. 19. Attaching the Main Drive Gear to the Differential Case by Means of a Pneumatic Riveter

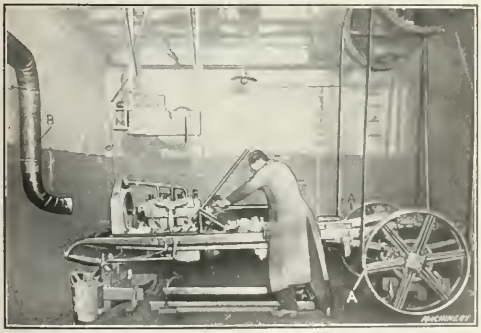

Fig. 20. Subjecting Completed Motors to what is used as a Substitute for the Road Test

* * *

An English automobile manufacturer has brought out a motor car to meet the peculiar requirements of some of the British colonies. This car can be driven for miles through water four or five feet deep without difficulty. All electric conduits, magneto and batteries are protected by special insulations, and extra lengths of pipe are attached to the exhaust pipe and to the intake manifold. When a car of this type is driven through five feet of water, only the top of the radiator and the seats are located above the water surface.

DONT'S FOR DRILL GRINDERS*

BY JAMES E. COOLEY†

Don't fail to tighten the back-stop screw.

Don't run the lip rest against the wheel.

Don't put your oily hands on the wheel.

Don't forget to grind both the drill lips alike.

Don't let the drill extend too far over the lip rest.

Don't place the fingers on the drill too near the wheel.

Don't have your face directly over the wheel when grinding.

Don't shut the grinder off and continue grinding on the wheel.

Don't start to grind the drill until the wheel has fully started.

Don't grind a drill by hand when there is a drill grinder in the shop.

Don't use the grinder wheel for any other purpose but grinding drills.

Don't swing the drill over the wheel too quickly; give it a chance to grind.

Don't remove the drill from the holder until the wheel has stopped running.

Don't lean on a drill when grinding; it is likely to tip up and gouge into the wheel.

Don't make several trips to the grinder; do all the grinding you can in one trip.

Don't fail to try all the screws to see if they are tight before you attempt to grind.

Don't try to grind off too much at one time or you will take the temper out of the drill.

Don't turn the feed-screw around too far after each cut or you will burn the drill.

Don't kick the shipper treadle over as if it were a foot-ball; push it over carefully.

Don't attempt to turn the drill over in the holder unless you are sure the arm is clear back.

Don't let the point of the drill become too thick; narrow it down on a small emery wheel.

Don't attempt to grind a drill in a drill grinder, unless you have first been shown how.

Don't forget to set the drill for the correct angle before placing it in the drill holder.

Don't grind a drill half way up the lip but grind over the entire length of the cutting edge.

Don't get nervous the first time you use a drill grinder; keep a cool head and grind slowly.

Don't swing the arm forward by pushing it with the fingers, but grasp it with the whole hand.

Don't forget that when you burn the end of the drill it must be ground further back or it will not cut well.

Don't fail to clean out the emery dust from the drill holder before putting in a drill but don't do it while the machine is running.

* * *

According to the *Brass World*, the source of metallic iridium is the powder left after the platinum has been extracted from the ore by the wet method. Iridium powder cannot be smelted alone but must be converted into a phosphide in order to melt it and obtain it in a reguline mass. The iridium powder is heated in a silica crucible and pieces of phosphorus added to it until enough has been absorbed to convert it into the phosphide and render the mass liquid. The phosphorus must then be removed, and this is accomplished by heating the iridium phosphide with lime. When the phosphorus is extracted a white, brittle and very hard mass of metallic iridium is left, which cannot be filed or cut, but in order to obtain it in small pieces it is broken by hammering. The small pieces are used for the points of gold pens and are fused by means of gold solder to the points of the pens, after which they are ground with carborundum to shape and polished. It is said that the iridium thus produced is about as hard as the ruby. The use for the points of gold pens is the chief one. The manner of applying this metal to pen points was described in the article: "Fountain Pen Manufacture," in the January, 1912, number of MACHINERY.

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* For "Don'ts" previously published in MACHINERY, see "Don'ts for the Manager," November, 1912, and the "Don'ts" there referred to.

† Address: 46 Wyllys St., Hartford, Conn.

MAKING A SMALL TURNBUCKLE

BY A. M. ROCHESTER

On adding machines, typewriters, and other small machines, a number of small turnbuckles are used. They are screwed on threaded wires to adjust the tension of coiled springs attached to them. Nearly one hundred of these turnbuckles are used on one of the well-known makes of typewriters. One of these turnbuckles is illustrated in Fig. 1.

The turnbuckles are made of a special grade of annealed wire, 0.103 inch in diameter, and some interesting tools are used in manufacturing them. Blanks of the proper length are cut from the wire and the order of operation is then as follows: First, bending; second, swaging; third, trimming; fourth, drilling; and fifth, tapping.

The Bending Operation

The punch and die used for bending over the end *A* of the turnbuckle are shown in Fig. 3. The wire is laid in the groove *B* and pushed along until one end reaches the edge of the stripper-plate *C* and the other end projects from the die. The work is stopped at the right place by the tool which is used to push it along striking against the edge of the stripper. To prevent the work from being drawn out of the die in bending, the spring plunger *D* is provided.

The edge of the die has a semicircular groove cut in it and so has one side of the square punch *E*. When this punch descends, it bends the wire at right angles, and when the bending is completed the finished part is pushed out of the die by the next one that is pushed into place. The finished parts fall through a hole in the base and are caught in a pan placed to receive them. Bending dies of this type are largely used in the factory referred to for producing a number of different parts made from wire and have proved to be very satisfactory.

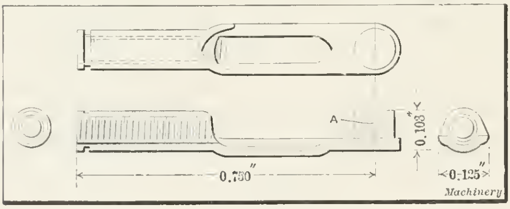


Fig. 1. Turnbuckle used to adjust Spring Tension

The Swaging Operation

The punch and die shown in Fig. 2 are employed for the next operation which consists of swaging the work to the shape shown in Fig. 1. It will be seen that this punch and die are designed to handle four pieces at a time. The bent-over ends are inserted in the holes *F* and the work is held in place between the pins as shown. Pieces of hardened drill rod *G*, which form the shape to which the work is swaged, are soldered to the face of the die in the position shown. This construction makes it an easy matter to renew these parts as they become worn. The punch is a square block of hardened tool steel, having the proper shape for producing the opposite sides of the work. When the swaging is completed, the parts are ejected by pins that are raised in the holes *F* by the action of an eccentric roll operated by the lever at the right of the die.

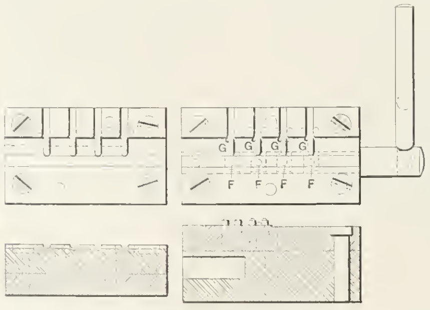


Fig. 2. Punch and Die for the Swaging Operation

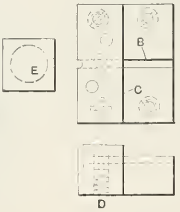


Fig. 3. Bending Punch and Die

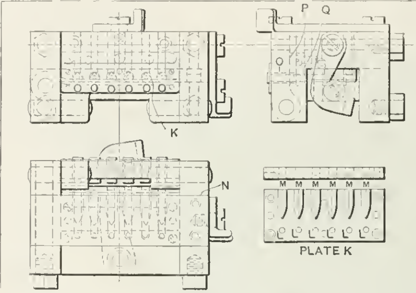


Fig. 4. Jig for the Drilling and Tapping Operations

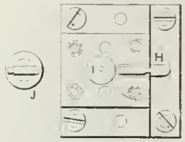


Fig. 5. Trimming Punch and Die

Trimming the Work

Trimming away the surplus stock or "flash" from the swaged portion is the next operation. The punch and die shown in Fig. 5 are used for this purpose. The work is located by inserting the bent-up end in the hole *H* and pushing it along into contact with the locating pin *I*. When the punch *J* descends, it trims off the "flash" and forces the work down through the die.

Drilling and Tapping

The jig shown in Fig. 4 is used for drilling the hole in the end of each piece. This jig takes six pieces of work at a time. Reference to the detail view of the plate *K* will show the design. The bent-up ends are inserted in the holes *L* while the body of each piece lies in one of the grooves *M*. The parts are held in the jig by the leaf *N*, which is clamped in position by a suitable latch as shown. The drilling operation is done through the bushings *O* that are carried by a leaf *P*. This leaf has a hardened protection plate to prevent it from being damaged by the drill. After the drilling operation is completed the leaf *P* is raised ready for the tapping operation. The tap is now guided by holes in the plate *Q*, which is fastened to the body of the jig just beneath the leaf.

* * *

DECISION ON FIXING RESALE PRICES

The U. S. Supreme Court handed down a decision May 27 of great importance to manufacturers who establish and maintain resale prices of their products. The practice of fixing resale prices of patented articles by making a violation of the contract between the manufacturer and the dealer an infringement, has become common during recent years. The Supreme Court has decided in the case of Bauer Chemical Co. vs. James O'Donnell, a druggist in Washington, D. C., that while the patent law gives the owner exclusive right to make and sell patented articles, it does not give the right to fix the price at which they shall be sold. The decision apparently upsets the Dick mimeograph case, which virtually gave a patentee absolute control of his inventions after they had been sold and paid for. The decision apparently removes all legal control of resale prices of patented manufactured goods. The fixing of resale prices by agreement is in violation of the Sherman law which states that there shall be no restraint of trade.

* * *

One of the troubles with some cost-keeping systems, says one of our contemporaries, is that they cost too much to keep up.

SYSTEM FOR THE DRAFTING OFFICE, PATTERN SHOP AND FOUNDRY

OUTLINE OF METHODS OF MANAGEMENT THAT SAVE TIME AND ELIMINATE MISTAKES

BY F. TISSINGTON*

One of the most frequent causes of trouble in a foundry making a miscellaneous assortment of castings is due to the necessity of hunting up an old pattern for a repeat order some time after the original castings were made. It seems to be the practice of many shops to put these patterns away in any convenient place in the store rooms, and this usually entails a general search before the required pattern is found. Moreover, some of the patterns are likely to be similar in shape and general dimensions, only varying in minor details which are apt to be overlooked by anyone not entirely familiar with the particular reasons for such variations. Then again, if the foreman of the pattern shop has a rush job on hand and cannot find the pattern that is required, he is likely to look up an existing pattern and remodel it to suit the work in hand without making any record of what he has done. A repeat order for the original casting will then be executed from the altered pattern, without anybody being the wiser until the customer starts to "kick." Mistakes of this kind are always likely to happen in a shop where too much is left to the memory of a few men who may leave the establishment at any time, and it is at these periods that the necessity for a reliable and permanent system is most keenly felt. Too much system is, of course, as bad as not enough, but the following scheme has been tried out and found to work well with patterns of a miscellaneous character and, therefore, it should be easier to apply it to specialized work. The writer wishes to say that he believes those people are wrong who think anything in the shape of system will increase the working costs, for his own experience has shown that a system that is carefully thought out and properly operated will materially reduce the working costs and also get more intelligent and efficient work from the men.

One system, however, will not suit every factory, and it is probably owing to lack of careful thought and preparation that so many schemes fail. This article is simply intended to give the general outline of a system, and modifications should be made to suit the particular circumstance. First of all, the writer will ask a few pertinent questions which will indicate the usual weak places in an organization.

The Drawing Office

(1) If there is no easy and sure method of locating any pattern that may be required, what are the chances that the designing staff will be in a position to use it again instead of making a new pattern?

(2) If no systematic record is kept of alterations to patterns, how are repeat orders carried out and is it possible to tell the foreman how to do the job in the most economical way?

(3) How many times a week or month does a member of the designing staff hunt around the store looking for a pattern that he has an idea should be there?

(4) Are records kept of what each casting weighs for use in making future estimates?

The Factory

(1) Can the foreman turn up a particular pattern at a moment's notice?

(2) Is a drawing required every time to locate the pattern for a repeat order or is the reference number enough?

(3) How many times does the foundry supply too many castings or not enough to complete the order?

(4) How many patterns are made in the course of a year that would be unnecessary if accurate records were kept?

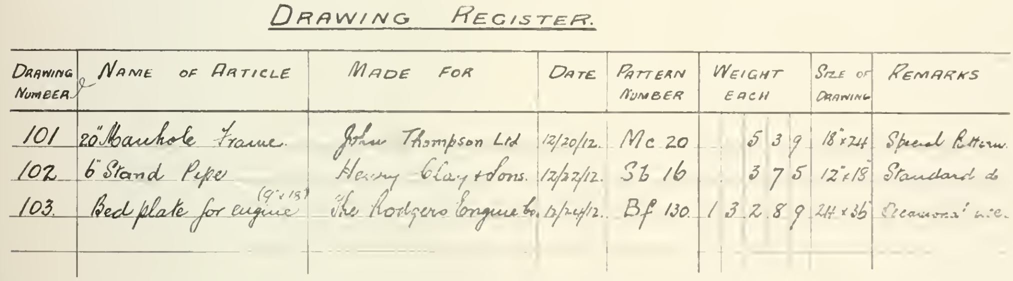
These are a few instances when working costs may be considerably higher than is strictly necessary, because it will not cost as much to do the thing right as it will to make a mistake, do unnecessary work, and run the risk of offending customers.

The System

Starting in the drawing office, the first step is to standardize drawing sizes. A very good combination is 12 by 18 inches, 18 by 24 inches and 24 by 36 inches. The first is one fourth and the second one half of the last size given, and, therefore, a distinct economy is effected from the possibility of using 36-inch drawing, tracing and blueprint paper which will cut up without waste. If anything else is made besides castings, the better course to adopt is to provide a separate filing cabinet and register for the castings. The system should be laid out on the following plan. Number all the drawings in the sequence in which they are made, irrespective of the size of the drawing or class of the casting; and file the drawings away in drawers in numerical order. The three sizes should be kept separately, otherwise the smaller ones are liable to get lost among the largest sizes. It will be easy to find where the drawing may be from its number and size, as the latter information should be entered in the register.

Each pattern should be the subject for a separate drawing, and the title of the drawing should state the nature of the article which is illustrated. The name of the purchaser should be filled in and also the pattern number, actual weight of one casting, and the date when the drawing was made. A card index will be found useful, if the quantity of the work warrants it, and would be used more for the sake of cross indexing than anything else. The card index can be designed to meet the needs of a particular case. The pattern number will be obtained from a second register run conjointly with the drawing register, and in making up this second register, it is absolutely necessary to name the article correctly, as the pattern mark is dependent upon its name. The different patterns may be designated by the letters of the alphabet in the following manner. Suppose, for instance, the pattern is for a column bracket. Now this should be entered under letter *B* and not *C* because it is essentially a bracket. If this idea is carried out faithfully in indexing and marking the drawings and patterns, there will be little trouble in finding them again. The important point is to decide what the article should really be called.

Fig. 1 gives a general idea of a page of the drawing register and Fig. 2 shows a typical example of a sheet from the pattern register. It will be found more convenient to arrange the pattern register on a loose leaf book so that it can be added to when necessary. The alphabetical divisions will meet the requirements of most small factories, but if desirable these



DRAWING REGISTER.

Drawing Number	Name of Article	Made for	Date	Pattern Number	Weight each	Size of Drawing	Remarks
101	20" Manhole Frame.	John Thompson Ltd	12/20/12.	Mc 20	5 3 9	18"×24	Special Pattern.
102	6" Stand Pipe	Henry Clay + Sons.	12/22/12.	Sb 16	3 7 5	12"×18	Standard do
103.	Bed plate for engine (9'×18')	The Rodgers Engine Co.	12/24/12..	Bf 130.	1 3 2 8 9	24×36	Occasional use.

Fig. 1. Sample Page from the Drawing Register

may be subdivided again. Each particular letter will indicate perhaps a number of patterns of different sizes, shape, etc., and where any great variation occurs a small letter should be added to indicate the class of pattern as in the following: *C a* 2 may designate a pattern for a grease cup; *C b* 3 a cap for a bearing; *C c* 4 a cylinder cover; and *C d* 5 a column. The second letter merely denotes the approximate size of the pattern, and is used principally for storing the patterns in groups of the same relative size. In the pattern register, an outline sketch of the pattern with overall dimensions should be drawn, as this will save turning up a lot of drawings before the correct pattern is found. Alterations should be decided upon in the office, and a new drawing filed showing the differences. These additional drawings can often be easily produced by taking a blueprint and noting alterations on it. By this means the state of the pattern at the present time is known.

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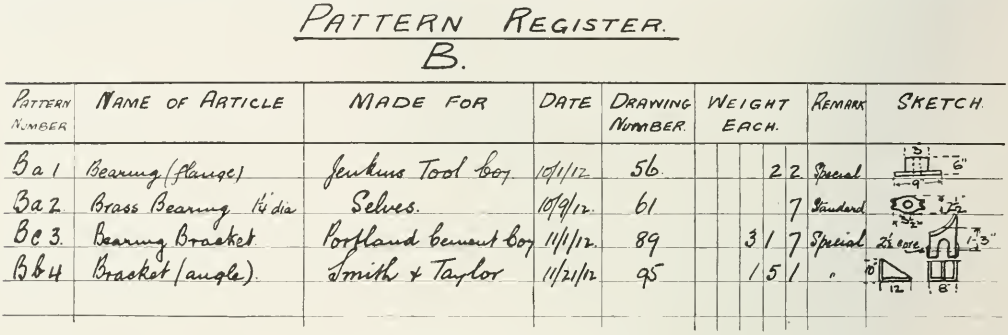
* Address: 79 Drummond Road, Sherbrooke, Quebec, Canada.



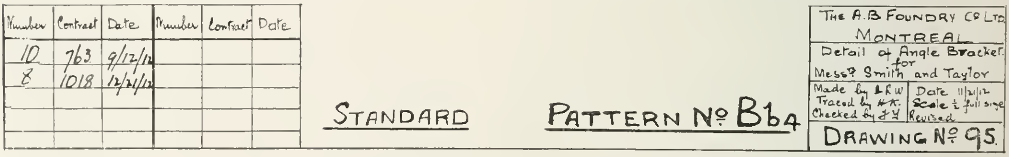
PATTERN REGISTER.
B.

PATTERN NUMBER	NAME OF ARTICLE	MADE FOR	DATE	DRAWING NUMBER.	WEIGHT EACH.					REMARK	SKETCH.
Ba 1	Bearing (flange)	Jenkins Tool Coy.	10/1/12	56.				2	2.	Special	
Ba 2.	Brass Bearing 1¼ dia	Selves.	10/9/12.	61					7	Standard	
Bc 3.	Bearing Bracket.	Portland Cement Coy	11/1/12.	89			3	1	7	Special	
Bb 4	Bracket (angle).	Smith + Taylor	11/21/12	95			1	5	1	"	

3
6"
9"
1"
2½
3½"
2½ core
1-3"
10
12
8"

Fig. 2. Sample Page from the Pattern Register

The date when the pattern was originally made will be found useful in deciding to a large extent whether it is worth while altering it or if an entirely new pattern should be made. A further help in this direction is the insertion of a small table on each drawing, as shown in Fig. 3, as the condition of a pattern can be judged with a fair degree of accuracy from the number of castings that have been made from it, thus avoiding the necessity of looking up the pattern. This record also forms a useful reference as to the actual pattern used on a particular contract, in case the purchaser requires a repeat order and other records cannot be turned up. Another good plan to adopt is to mark each drawing plainly with the words "Standard," "Occasional use" or "Odd job," according to the requirements known at the time. This will enable the pattern shop foreman to decide what kind of pattern is the best to make and what class of wood will be most suitable. Other details will naturally develop themselves to suit particular cases.



Number	Contract	Date	Number	Contract	Date
10	763	9/12/12			
8	1018	12/21/12			

STANDARD

PATTERN No. Bb4

THE A.B FOUNDRY Co. LTD.
MONTREAL
Detail of Angle Bracket for Mess^{rs} Smith and Taylor
Made by L.R.W. Traced by H.K. Checked by J.Y.
Date 11/21/12 Scale ½ full size Revised
DRAWING No. 95.

Fig. 3. Lower Portion of Drawing showing Useful Data that is included

Pattern Shop and Foundry

All patterns should be clearly marked with the pattern number shown on the drawing. For standard patterns or those that are likely to be used frequently, raised letters and figures are the best. The remainder can be marked with a set of metal punches so that a clear impression is left in the wood. The marks should all be located in a position where they are clearly visible, and patterns of a similar nature should bear the marks in approximately the same place, so that no difficulty is experienced in finding them. As these marks will be reproduced in the castings, they will be found useful in other departments, owing to the fact that similar castings will be readily distinguished by the difference in the marking, and if these numbers are used on the detail drawings it will save the use of quite a lot of descriptive matter. The purchaser will also be in a position to quote a few letters and figures, when ordering replacements, which will at once convey to the manufacturer what is desired.

In issuing patterns to the foundry, it will be found useful to place a gummed ticket on the pattern stating the contract number and the number of castings that are required. This method is used in addition to the usual order sheet supplied to the foreman, and is more for the purpose of avoiding verbal instructions to the molder which are often forgotten; it also saves the foundry foreman a great deal of work in fitting a particular pattern to the corresponding item on his order sheet. Sometimes it is necessary to make a pattern do for several sets of similar castings, and in a case of this kind the pattern has to go back to the pattern shop for alteration after the first order is finished. In such cases, a note might be inserted on the gummed ticket reading either "Return to Pattern Shop" or "Return to Store." On completing his order, the molder would rub the ticket off to indicate that the job is finished, and put the pattern in one of two places according to whether it is to go to the store or pattern shop. These places would be kept cleared by the storekeeper on his rounds. As patterns become worn out, the foreman should send written notice to the office giving all necessary particulars, and he should be advised whether it is considered desirable to replace the pattern or not. The records in the drawing office should at once be amended to suit the decision arrived at.

The most desirable plan for obtaining the weights of the castings is to make this work entirely distinct from the operation of the foundry, as there are too many interests involved to enable accurate figures to be obtained, particularly if the shop is on a piecework or bonus basis. The shipping clerk appears to be the right man for this work, as he can weigh up the castings, check up the quantities supplied and, in a general way, make sure that they are all sound. The result of his work will go through the office in the usual course, but a duplicate sheet of the weight of each casting should be made, and this will go direct to the drawing office so that the necessary entries can be made without delay.

The Pattern Store

It is desirable for the work of finding and storing the patterns to be done by one man, as there is a possibility that two or more men would not put the same interpretation on the same marking, and one man will generally be able to say from memory whether the pattern required is to be found in the store, foundry or pattern shop. An "understudy" can be employed if the size of the place warrants it, but one of the men should be made responsible for the custody of the patterns. Most stores are arranged with tiers of shelves of various kinds, and it is suggested that metal plates or boards, marked with the letter of the alphabet representing each division, should be placed in a conspicuous position. If the system is of the double letter type, previously mentioned, the top shelves would be used for the smaller patterns and the lower shelves for patterns of larger sizes. The largest patterns may be placed on the floor or leaned against an adjacent wall. Each of the shelves should be marked with the small letter indicating the style of the pattern, and it ought to be quite a simple matter to find any pattern that is required at a moment's notice if the men are to be relied upon to do this conscientiously. Unless core-boxes are "specials" for a particular job, they should all be stored together according to their size and shape, as it is often possible to use the same core-box on a great many patterns. Special core-boxes should be stored away as part of the pattern and marked with the same number. The drawing office is too often at fault with regard to the necessity of making new core-boxes, as it is frequently possible to make slight variations in the design in order to utilize an existing core-box. If the particular work warrants it, the expenditure of a little time and trouble on the registration of core-boxes in a similar way to that outlined above would be the means of effecting quite a large economy.

* * *

BRITISH VIEWS ON PUBLICITY

All the world is akin, and apparently the experience of our British friends with those who have mechanical information to give out, is not very different from that sometimes met with on this side of the pond. In the good old days, says the *Practical Engineer*, a manufacturing firm would have thought it sheer madness to communicate to the general public any technical information acquired as the result of tests, and it was only when the information had ceased to have much value in the way of being something new that it was given out for popular consumption. This idea of the fitness of things still prevails in some old-established machine shops, and it is not an infrequent occurrence for a would-be contributor to say, "It's more than my job's worth to write for the technical press." These old firms will readily send you a photograph of a machine and tell you that it has ball bearings, forced lubrication, massive base of box form, eight speeds, power feeds, etc., etc., all of which may mean something or nothing, but to suggest that a few sectional views would be of greater value would cause serious misgivings as to whether you were not, indeed, a spy about to encompass the firm's ruin by stealing its trade.

One readily admits that there are many processes of manufacture which have been evolved at great expense, and which it would be bad policy to give to rivals; but so far as the products are concerned—that is, the machines themselves it is difficult to see how secrecy can help. The machines must be sold and placed upon the open market. Comparative tests as to production, power consumption, etc., must be made if anything like success is expected. Why, then, should one hesitate to communicate the results of the tests to the world? If they will not stand close scrutiny one can understand that they must be kept in the dark and only used where ignorance prevails. If, however, the figures are fair and *bona fide* and the machine does give the twenty-five per cent increased production with the same power consumption which is claimed, why hesitate to give the reasons and convince even your opponents that they have something to meet?

* * *

DRILLING HOLES IN GLASS

The following method for drilling holes in glass is recommended in a German contemporary: Use a pipe having an outside diameter equal to the hole to be drilled, and squared off at the end. Revolve the pipe at a speed of about 2000 R. P. M. and use emery and water between the end of the pipe and the glass. By this method it is claimed that from 30 to 40 holes of a diameter of ½ inch can be drilled in ordinary thin glass per hour.

BORONIZED COPPER*

As is well known, it has been practically impossible to cast copper which is mechanically sound and of high electrical conductivity, on account of the porous metal that is obtained. By an addition of boron, however, this can be accomplished. Boron has a high affinity for oxygen, nitrogen, and oxygen-containing gases, which cause the difficulty in copper casting. On the other hand, boron has no affinity for copper, and is, therefore, a natural deoxidizer for copper. One per cent of boron suboxide flux (equivalent to 0.08 to 0.1 per cent of boron suboxide) is added to the copper, and a casting that is commercially sound is obtained. Any material that contains boron in a state of oxidation below that of boric anhydride may be used as a flux for copper casting, as, for instance, boron carbide or any alloy of carbon and boron. Owing to this new development, cast copper is rapidly replacing forged copper in many electrical apparatuses. The advantages derived from the use of cast copper are the saving of cost, and also, in many cases, a better apparatus. It is possible, when casting, to eliminate a number of joints which always are a source of loss in efficiency. In the case of current transformers, for instance, a better apparatus is obtained at a reduced cost and a saving of space.

The boron suboxide flux can be added to the copper in a number of ways which are equally good. In the Lynn foundry (General Electric Co.), the pots contain about 125 pounds of metal, and up to the present coal furnaces have been used. The method consists in mixing half of the boron flux to be added with charcoal, putting it on the bottom of the pot and melting down the copper. When the copper has reached the necessary temperature (the copper can be heated too low but not too high) the pot is taken out, the slag skimmed off and the second half of the boron flux added and thoroughly stirred in. After a minute or so the slag comes up to the surface in the form of fused lumps and is skimmed off and the melt is cooled down by adding gates or risers until the proper pouring temperature is obtained. In case a reverberatory furnace is used, the procedure usually followed is to put the flux in the ladle pot on the bottom, pour the copper over it and stir thoroughly. The skimmer and stirrer should not be of iron, as it is difficult to avoid a solution of a slight amount of the iron in the copper and a resulting lowering of conductivity. If done very carefully, the amount of iron would probably be very small, but it has not been found practicable to trust the foundrymen with an iron skimmer or stirrer. Heavy stirrers and skimmers, made of Acheson graphite, have proved sufficiently rigid and are being constantly used in the foundry.

The boronizing process delivers a good metal, and the production of a good casting depends now on the same factors as in other metals. The copper shrinks considerably, about ¼ inch to the foot, and this must be taken into consideration. The casting must be well fed and the sand mold must be rammed very lightly. Where iron molds are used, the iron must, of course, be covered with soot and in some cases it is desirable to use a graphite plate where the hot metal first strikes. When these precautions are taken, no more difficulty is experienced in casting copper than in casting ordinary brass. The electrical conductivity obtained can be as high as 97 per cent of the Mathiessen standard, but in the foundry, using scrap which is not always as clean as could be desired, it is not feasible to guarantee more than 90 per cent conductivity. The mechanical properties are as follows: Tensile strength, 24,350 pounds per square inch; elastic limit, 11,450 pounds per square inch; elongation, 48.5 per cent; reduction in area, 74.49 per cent.

* * *

Cast-iron gages are being used to some extent by manufacturing firms. The cost is much less than steel gages, and when properly made the cast-iron gages answer all practical requirements. The castings are machined approximately to size and are then annealed and again machined to within a few thousandths of the finished size. They are then case-hardened, and ground and lapped to exact size. A cast-iron gage made in this manner is said to be practically unchanging in shape and quite durable in use.

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* Abstract of a paper presented before the American Institute of Metals, by Dr. E. Weintraub.

BALL BEARINGS—THEIR CONSTRUCTION AND APPLICATION[*]

ADVANTAGES OF BALL BEARINGS AND THEIR APPLICATION ON INDUSTRIAL EQUIPMENT

The results of extensive tests which have been performed with the view of determining the relative coefficients of friction for various types of ball, roller and sliding bearings, show a marked superiority of the ball bearing as regards the coefficient of friction. These tests also show that the coefficient of friction for ball bearings varies between very close limits at different loads and speeds, while the coefficient of friction for sliding bearings extends through a very wide range for even small changes in speed or load. The friction in sliding bearings is dependent upon the bearing surfaces, the lubricant, the method of lubrication, the load to be carried, and the pressure per unit of measurement, together with the speed and temperature.

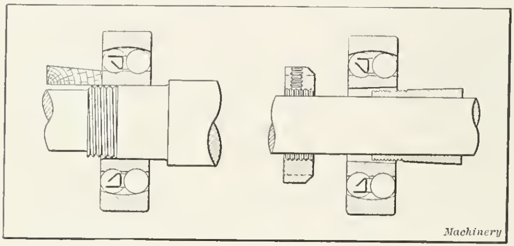

Fig. 1. Methods of securing the Inner Race to the Shaft

It would seem that a roller bearing would be more efficient than a ball bearing, on account of the larger contact surfaces between the outer and inner races, but this is not the case, inasmuch as it is almost impossible to obtain pure rolling motion in a roller bearing. The reasons for this are as follows: 1. It is extremely difficult to commercially produce hardened rollers which are exactly cylindrical. 2. Straight rollers will not carry an end thrust. 3. If there is any tendency for the shaft to twist, or if there is any deflection in the shaft due to the load, there is a tendency for the rollers to twist out of their normal path, and this leaves only a short part of the roller under actual load. To help the roller bearing out, however, there are combinations of annular and thrust roller bearings, but they have not found as wide application as ball bearings have.

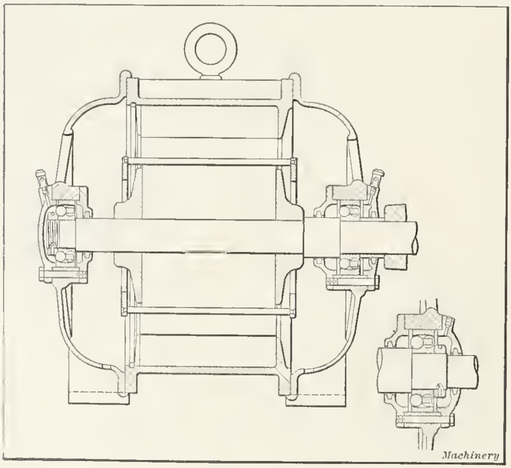

Fig. 2. Electric Motor equipped with Ball Bearings

Ball bearings are used principally for the following reasons: 1. There is less loss of power on account of the lower coefficient of friction. 2. The friction of a ball bearing is independent of the viscosity of the lubricant, or of the temperature thereof. 3. The frictional resistance at starting is very much lower than in sliding bearings. 4. The scraping of bearing linings and fitting them to the shaft is not necessary. 5. There is practically no danger of the bearings running hot. 6. The bearing housings mounting ball bearings are very much shorter than sliding bearings. 7. A ball bearing of proper construction can adjust itself to deformations of the shaft, or strains in the housings.

The reason why a larger ball can take less load than a smaller ball can readily be understood. It is because with an increased volume it is harder to obtain a thoroughly hardened ball. In the matter of speed, the reduction of capacity of the larger ball is due to the tiring out or "fatigue" of the material. Other tests have shown, however, that the tiring out of the steel is caused by the number of load applications and not by the rapidity with which they change. From actual tests with balls, Professor Goodman of the Institute of Civil Engineers in England, derived a formula for the allowable load, in which he took into consideration the velocity of the balls. These tests have shown that the carrying capacity of a ½ inch ball, for example, while it is much greater than that of a ¼ inch ball under static load decreases very much more rapidly than a smaller ball under a given increase in speed for each size.

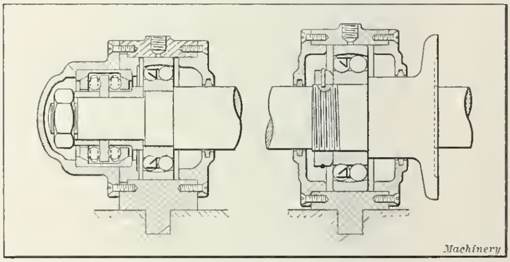

Fig. 3. Ball Bearing Applications for Combined Radial and Thrust Load

It is of great importance for all the balls in a bearing to be finished absolutely spherical, and as nearly of the same size as possible. A large ball in a bearing will take more than its share of the load and thus become overloaded; and at the same time, it will have a different velocity from the smaller balls, which will result in sliding friction either between the ball and the retainer, or if there is no retainer, between the balls themselves. First-class balls can now be manufactured within spherical limits of 0.022 millimeter (0.00008 inch) and are sorted in classes in which the diameter of the balls does not vary more than this amount.

A ball bearing of the right design must comply with the following requirements: The balls must have pure rolling motion, and the races must be so designed that without increasing the friction under load, they give a maximum bearing surface. To fulfill the first requirement, the tangents to the balls at their points of contact with the races must be parallel to the axis of rotation of the balls. This rule, however, is frequently neglected. Efforts have been made to solve this problem by designing ball races with three or four contact points for the balls, but the increased number of points of contact for the balls developed considerable additional friction, and practically all bearings in general use have two point contact.

In the construction employed by the S. K. F. Ball Bearing Co., which is dealt with in this article, the contact surfaces on both the inner and outer races are practically equal, and in addition to this the bearings have the following distinct advantages: Increased reliability because of the fact that the bearings, though made to standard dimensions, have a double row of balls, and because the method of having the outside race spherically ground allows the bearing to automatically adjust itself to any deflection of the shaft or inaccuracy in the mounting or machine frame structure. Furthermore, both rows of balls are loaded evenly, and it is possible to assemble and disassemble the bearing, if necessary, without destroying it. This last feature may seem extremely simple, yet it is important for the reason that it does away with the slots in the inside and outside rings, and the races are thereby made continuous.

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[*] Abstract of a paper read by Mr. F. H. Poor before the American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y.

We now come to the discussion of the material from which the bearings are made, which must have the greatest possible hardness in conjunction with toughness after hardening. Furthermore, the steel must be free from slag, and be perfectly homogeneous. Some ball bearing factories are using casehardened races, but aside from the danger of the hardening not being even, there is also the danger in this construction of the races being permanently deformed. It is absolutely impossible to caseharden steel balls because the main requirement to prevent a ball from permanent deformation is through and through hardening. Accordingly, we have to use a material for both balls and races which, in addition to the above-mentioned qualities, has also the quality of being easily and uniformly hardened throughout. The steel must be forged or rolled so that the grain is as close as possible.

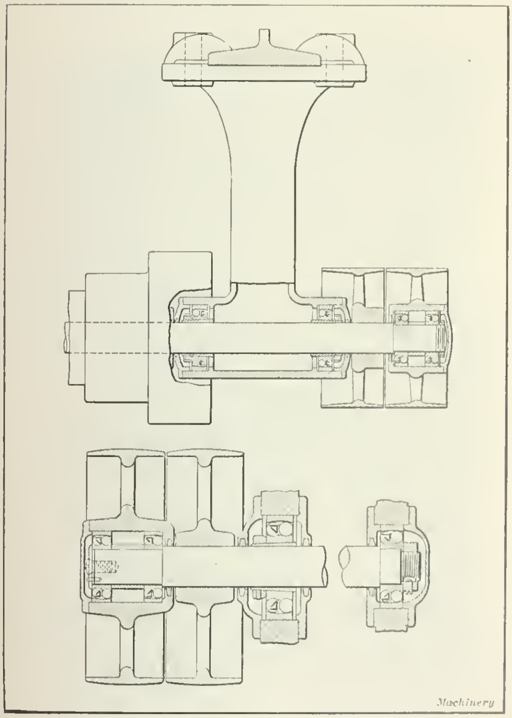

Fig. 4. Radial Bearings on Loose Pulley Countershaft

It may be said that the use of ball bearings in rotating machines is practically unlimited. The following points must be observed in their design if ball bearings are to work at their full advantage. 1. We must consider, as we do in other types of machines, whether the load or speed is variable, and the conditions which are to determine the selection of a heavy enough bearing to meet the machine requirements. 2. The bearings must be mounted so that the outside race cannot squeeze out of true. 3. When the shaft is revolving, the inside race of the bearing should be fastened securely to the shaft, making it practically an integral part thereof. The best means of doing this is to drive the bearing upon the shaft and hold it securely between a shoulder on the shaft and a lock-nut, or by using an adapter sleeve made with a taper to fit in the bearing. By using bushings over a shaft between the bearing inner races, several bearings can be held on the shaft by one nut. In no case should there be any play between the inside race and the shaft because of the possible danger that the ball bearing race will peen down the shaft and ruin it. 4. Only one bearing should be held sideways to take up lateral movement of the shaft, the other bearings being mounted free to move laterally in their housings. This is to allow for elongation or contraction of the shaft, due to changes in temperature or other causes. 5. Ball bearings must be lubricated, although the amount of lubrication required is very small. The lubricant must be chemically neutral, and for general applications, a mixture of vaseline and vaseline oil, or a good mineral oil is recommended. 6. The bearings must, in all cases, be protected from dirt, dust, dampness, and oxygen.

Ball bearings have been applied on electric motors with excellent results, a typical mounting being shown in Fig. 2. For this class of machinery the medium type bearings should be selected, and it is important for all of the bearings to be secured to the shaft on account of the high speed and vibration of the machine. It will be noted that the bearing on the left-hand side has a very small lateral clearance in order that it may take up any possible lateral movement of the shaft. The bearing nearest the pulley is left free to adjust itself, and attention is drawn to the two types of mountings for the bearing next to the pulley. The bearing in one case is held securely against the shoulder by a sleeve between the pulley and the inner bearing race, and in the other case by a locking-nut.

Fig. 3 shows a ball bearing mounting for a circular saw spindle. It will be seen that this application of ball bearings is designed for a combined radial and thrust load. In considering ball bearings of various types of machines, it was not definitely stated that the load conditions are of material importance in determining the proper selection of bearings for different duties. As a general practice in bearings selected for belt driven machines, it is customary to allow a factor of safety of approximately 5, that is, the ball bearings must be selected of such a capacity that the catalogue ratings are practically five times the normal figured load to which the bearings are to be subjected. This factor of safety may seem extremely large, but all of us appreciate that in many cases the tension of the belt is subject to the careless handling of inexperienced workmen, and one cannot foresee to what extent the belts themselves, or the bearings, may be subjected to abuse. In addition, it may be pointed out that belts running at high speeds are usually heavy, and in addition to the pressure to which they subject the bearings, there is every likelihood that pulleys will suffer the constant pound and shock of heavy belt lacing, joints, or the possible accumulation of lumps of grit, sticks of wood, or other materials which may be caught between the belt and the pulley. This is particularly true in train lighting service, woodworking machines, etc.

In the matter of selecting bearings for woodworking machines, we have found that it is necessary to allow a wide factor of safety, particularly on band saws. These saws, in operation, are usually adjusted to a certain tension by means of levers or balancing weights. If the saw becomes heated there is bound to be expansion in the blade, and while the adjusting levers or balance weights may compensate for the increased length of saw, due to heating, the bearings are liable to be cramped after the machine is shut down due to the contraction of the saw blades. On gear drives it is customary to allow a factor of safety very close to three times the normal driving power of the gears, this factor being used for the purpose of allowing for backlash, sudden shocks, or reversals.

* * *

A New York daily newspaper runs a department, presumably for the edification of its readers, called "A Pocket Encyclopedia." Question and answer No. 341 are as follows: "What are the uses of cast iron and steel? Ans.: Cast iron being brittle, is used chiefly for stoves, furnaces, etc. Steel's superior hardness and flexibility renders it useful for making springs, tools, etc!" The idea that because cast iron is brittle it is used chiefly for stoves, furnaces, etc., is interesting but hardly accurate. Newspaper information on technical subjects is quite likely to be misleading, but there is no valid excuse for such flagrant mistakes as this.

ROTATING JIG FOR DRILLING CONNECTING-RODS

An interesting type of rotating or indexing jig which is used for holding connecting-rods while drilling the cap bolt holes is shown in the accompanying illustrations. This jig is used by the Nordyke & Marmon Co. in the automobile manufacturing department of its plant at Indianapolis, Ind., and is shown in Fig. 1 set up on a William Gardam & Son, twelve-spindle drilling machine.

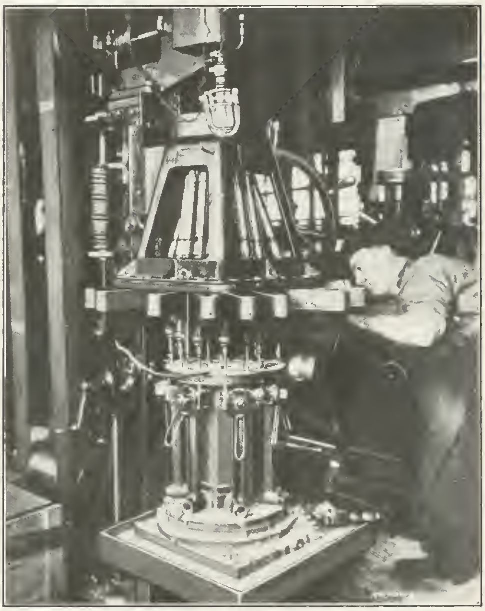

Fig. 1. Drilling Machine equipped with an Indexing Jig for drilling and reaming Six Connecting-rods at One Setting

The body of the jig to which the connecting-rods *A* are held is heptagonal in shape and is provided with studs which locate the connecting-rods by the holes in their ends. The upper studs are threaded to receive the nuts *B*, which, in conjunction with the split washers *C*, clamp the connecting-rods tightly against the heptagon faces of the jig. Bent wire handles *D* are attached to these washers to facilitate their insertion and removal. The lower part of the jig is circular in shape and rests on a circular table to which it is pivoted. The fixture is free to rotate and is locked in the correct positions (seven) by a spring-actuated locking plunger. The operating handle for this plunger is located at the right-hand side of the fixture directly under the "loading position" (see Fig. 2), and is not shown in the illustrations.

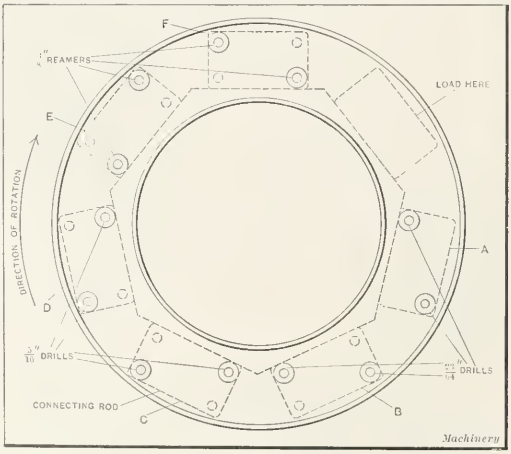

Fig. 2. Diagrammatic View of Bushing Plate showing Arrangement of Drill and Reamer Bushings

The drill bushings for guiding the eight drills and four reamers, *E* and *F*, are held in a circular plate *G*, which, in turn, is fastened by bolts to the top face of the fixture. The arrangement of the bushing holes for the drills and reamers is more clearly indicated in Fig. 2, which shows a top diagrammatic view of the bushing plate. Upon referring to this illustration, it will be seen that while the body of the jig is heptagon in shape, the drills and reamers are in operation on only six connecting-rods. This leaves one position vacant for loading and unloading, allowing these operations to be performed while the tools are at work on the remaining six connecting-rods.

The drilling operation starts at *A* after the jig has been indexed one-seventh revolution. Here two of the 23/64-inch holes are drilled in that portion of the connecting-rod head which when sawed in two forms the cap. At *B*, the remaining two 23/64-inch holes in the connecting-rod are drilled. At *C* and *D*, the four 5/16-inch tap drill holes are drilled completely through the connecting-rod head, and at *E* and *F* the holes in the top portion of the connecting-rod head are reamed to ⅜ inch diameter. This completes the drilling and reaming on the six connecting-rods, and while these operations have been described separately, it is evident that in actual operation, the eight drills and four reamers are all at work on the six connecting-rods at the same time. It is also evident that the product obtained from a fixture of this type is considerable; in this case, twelve finished rods are completed per hour, the total drilling depth being 1⅞ inch, and the material 20 point carbon steel drop-forgings. D. T. H.

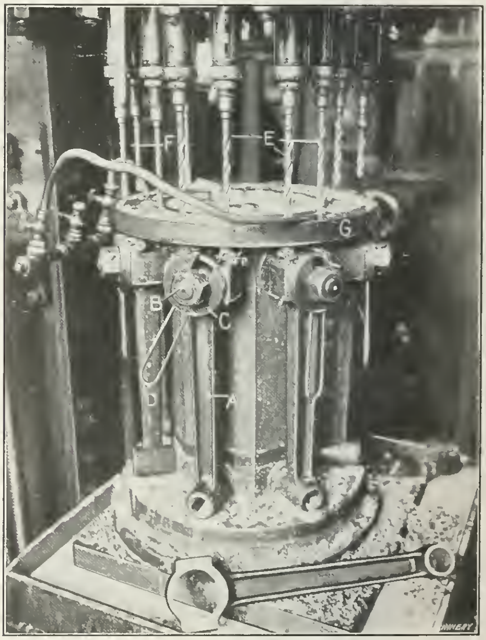

Fig. 3. Closer View of the Rotating Connecting-rod Jig shown in Fig. 1

* * *

A cheap white metal alloy containing a large percentage of iron has been patented in England. The proportions claimed are as follows: Iron, 50.3 per cent; nickel, 19.2 per cent; copper, 29.1 per cent; aluminum, 1.4 per cent. It is claimed in the patent application that the mixture is almost non-corrosive and white, and that it resists the action of vegetable acids and the atmosphere exceedingly well. If a harder alloy is required, one to two per cent of tin may be added.

MACHINE FORGING—4

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON[*]

Possibly the greatest advance made of late years in forging is the application of machine methods to the production of engine, machine parts, etc. It is now possible to produce many parts from steel and wrought iron, which a few years ago could only be made from castings. This means a great saving of time and expense, as not only are machine forged parts much stronger than those made from cast iron or steel, but they also cost considerably less to manufacture in large quantities. In the following article interesting examples of different types of upsets, bending and forming operations, etc., will be illustrated and described, together with a general description of the dies and tools used. This will show to a slight extent the remarkable possibilities of the upsetting and forging machine in its present-day development.

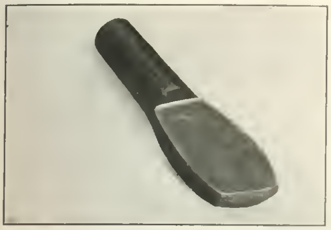

Fig. 46. Extent to which a Bar is flattened between Gripping Dies of "National" Forging Machine before Relief operates

The Upsetting and Forging Machine

The upsetting and forging machine might be considered to a certain extent as a further development of the bolt and rivet making machine, which as was explained in the previous articles, originated almost a century ago. These machines are built much heavier than bolt and rivet machines and are designed especially to meet the demands required of them in the production of difficult-shaped and heavy forgings. For the heavier types of machines the base or main frame, as a rule, is made from one solid steel casting, and a cast-iron base is very seldom used; semi-steel castings, however, are also used to a large extent.

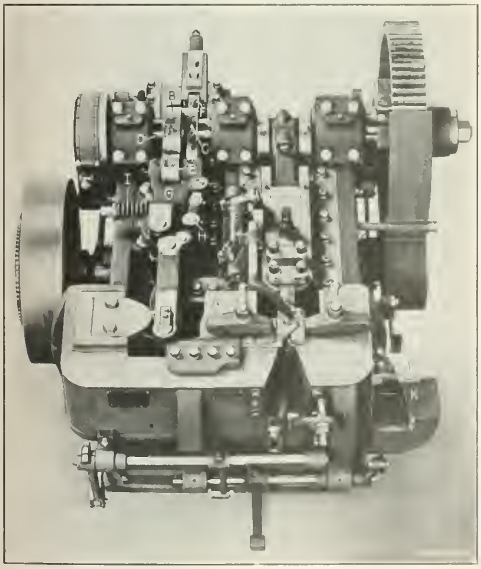

Fig. 47. "National" Upsetting and Forging Machine having a Safety Relief Mechanism for operating the Gripping Dies

A typical upsetting and forging machine designed for heavy service is shown in Fig. 47. The bed of this machine is made from one solid casting of semi-steel and the gripping die mechanism is operated through a by-pass toggle joint of interesting construction. In order to provide against breakage caused by accidentally placing work between the dies, upsetting and forging machines are usually furnished with various safety devices to prevent serious damage to the machine. The safety device in this machine consists of a toggle-joint mechanism for operating the movable gripping die slide.

As shown in Fig. 47, the gripping die slide *A* is operated by two cams *B* and *C* on the main crankshaft *D*. Cam *B* serves to close the dies which grip the work, whereas cam *C* effects the opening of the dies. These cams contact with chilled cast-iron rolls *E* and *F* carried in the toggle slide *G*. The automatic grip relief is controlled by the by-pass toggle *H* and heavy coil spring *I*. This toggle does not come into play until the strain is such that it would cause damage to the working mechanism of the machine, or in other words until the maximum power required to hold the movable die from springing away, is attained. The relief resets automatically on the back stroke of the machine, thus making a second blow possible without any delay.

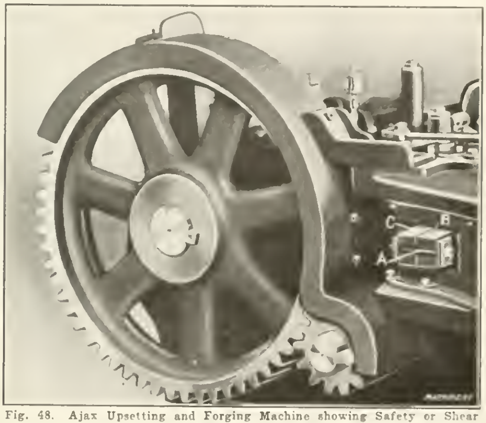

Fig. 48. Ajax Upsetting and Forging Machine showing Safety or Shear Bolt, providing a Safety Relief for the Gripping Dies

Some idea of the enormous gripping pressure secured before the relief mechanism operates is indicated in Fig. 46. This piece, which has been flattened between the opposing faces of the gripping dies, is a 2-inch round bar of 10 to 15 point carbon steel $9\frac{5}{8}$ inches long. The flattened portion is $3\frac{5}{8}$ inches wide by 5 inches long and 23/32 inch thick. The piece, of course, was heated to a forging temperature before being placed between the opposing faces of the dies and was flattened to the condition shown in one squeeze. This illustrates a fea-

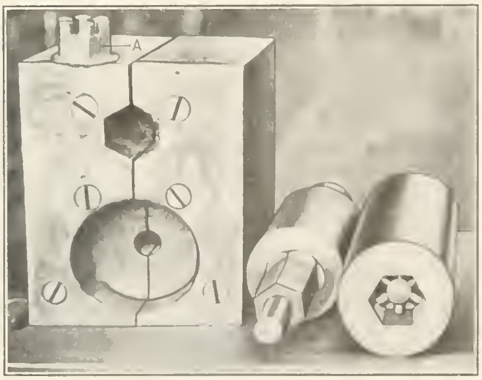

Fig. 49. Dies and Tools used in making a Castellated Nut in an Ajax Forging Machine in the L. S. & M. S. Railway Shops at Collinwood, Ohio

ture peculiar to this type of machine in that it can be used for squeezing or swaging operations, these being carried on between the opposing faces of the gripping dies. In many cases this allows work to be handled that is generally formed or flattened by the side shear *J*, which is operated from the movable die slide, being a continued arm of the same casting.

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[*] Associate Editor of MACHINERY.

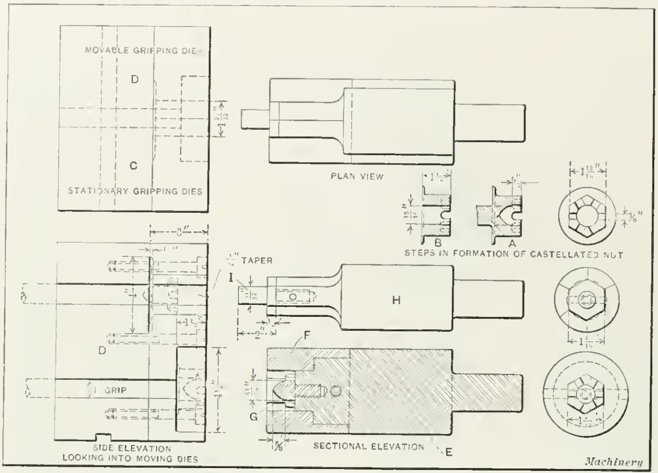

Fig. 50. Details of the Dies and Tools used for making the Castellated Nut shown in Fig. 49

As a rule, the side shear is used for cutting off stock, and it is sometimes used for bending operations, suitable dies or cutting tools being held in the movable slide *J* and stationary bracket *K*, for this purpose.

Another type of upsetting and forging machine in which the working mechanism of the machine is protected from serious injury in a different manner, is shown in Fig. 48. In this machine the safety device consists of a bolt *A* connecting the die slide *B* and the slide *C* operating it. Now when any foreign body intercepts the gripping dies, the bolt *A* is sheared off, thus providing for a positive grip and at the same time furnishing a safety device that protects the working mechanism of the machine against serious injury.

Examples of Upset Forgings—Making Castellated Nuts, etc.

A good example of an upset forging operation which can be handled successfully in an upsetting and forging machine, is the castellated nut shown at *A* in Fig. 49. This type of nut is produced practically without waste of stock in from two to three blows. The gripping dies and tools used are shown in Fig. 49, and also in detail in Fig. 50, where the construction of the tools can be more clearly seen. Referring to the latter illustration, it will be noticed that the dies *C* and *D* are made in two pieces. This is done in order to facilitate the machining operations, and in many cases it enables the dies to be made much cheaper because of the simplicity in construction. These dies are made from scrap driving-axle steel which contains about 60 points carbon, and are hardened in the usual manner, the temper being drawn to a light straw color.

The plunger *E* which upsets the end of the bar into the lower impression in the dies, is made in three parts; this facilitates its construction and the method of manufacture. The body is made from a piece of soft machine steel, on the front end of which a hardened bushing *F* is held by a pin. This, as can be seen, is of a hexagon shape to form the sides of the nut. Screwed into the body of the punch is a former *G* which is machined to such shape that six "wings" as shown, are formed around its periphery, these producing the castellated grooves in the head of the nut. The former *G* is pointed, and rough-forms the hole in the nut. The top punch which is used for completely punching the hole in the nut and at the same time severing it from the bar is also made from a machine steel body *H* in which is screwed a hardened steel punch *I*, this being prevented from loosening by a pin driven through it.

The method of producing a hexagon castellated nut in a forging machine is as follows: A bar of the required size (which must not exceed the root diameter of the thread in the finished nut) is heated in the furnace to a temperature of from 1400 to 1600 degrees F., depending upon the material, and is then brought to the forging machine and placed in the lower impression of the gripping dies. Then as the machine is operated, the lower plunger advances, upsetting the end of the bar and forming the excess metal into a nut of the required shape. The bar is now quickly removed from the lower impression, placed in the upper impression, and the machine again operated; whereupon the top plunger advances, completing the hole in the nut and attaching the metal thus removed to the end of the bar. These two operations are indicated at *A* and *B* in the illustration. This interesting method of making castellated nuts was secured in the Collinwood shops of the L. S. & M. S. Railway, the dies and tools being designed by George A. Hartline, master smith. The only material wasted in the production of a castellated nut of this character is the slight excess of stock formed into a fin, which must be removed, of course, in a subsequent operation.

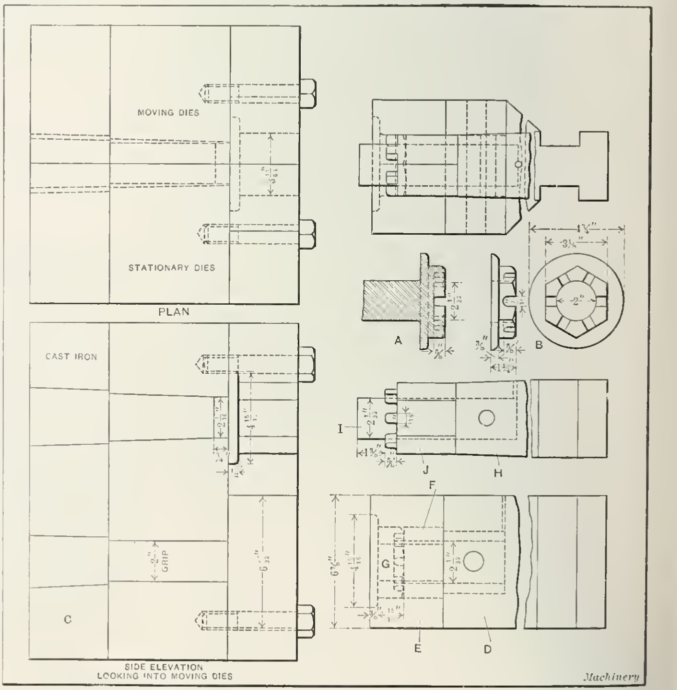

Fig. 51. Dies and Tools used for making a Combination Washer and Castellated Nut which is produced without any Waste of Stock

Another interesting example of castellated nut forging in which the excess metal is used in the formation of a washer on the nut and thus eliminates all waste of material, is shown in Fig. 51. The construction of the tools here illustrated is almost identical with that shown in Figs. 49 and 50 with the exception of the punches and also the utilization of a cast-iron block *C*, for partly completing the construction of the gripping dies. This part of the gripping dies which is made from cast iron is not used at all as a gripping medium and hence does not need to be made from steel to provide for wear. The lower punch *D* in this case is made from machine steel and is provided with a tool-steel head *E* which is bored out and formed to a hexagon shape. Inserted in this is a sleeve *F* for forming the castellated portion of the nut, in which is fitted a punch *G* for rough-forming the hole in the nut. The upper plunger *H* carries a punch *I* which completely forms the hole in the nut by punching the bar back, and by means of the castellated washer *J* finish-forms the castellated grooves in the nut. The steps followed in the production of this combination castellated nut and washer are shown at *A* and *B* in the illustration. A 2-inch bar of wrought iron is used, and it requires a length of 4 inches to form the nut and washer.

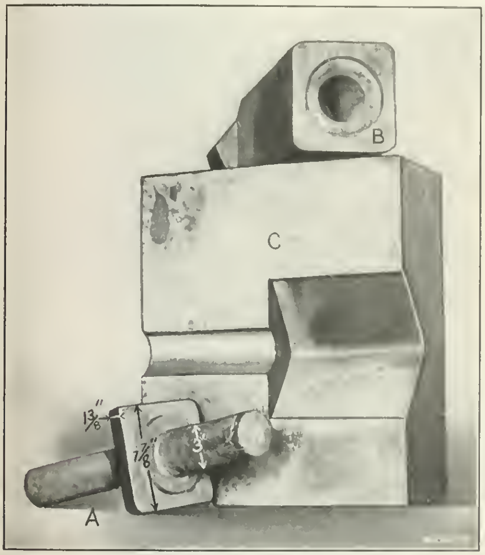

Fig. 52. Dies and Tools used in making an Enormous Upset in a 6-inch Ajax Universal Forging Machine

Dies and Tools used for Making a Locomotive Trailer Pin

The locomotive trailer pin shown at *A* in Fig. 52 represents about the maximum amount of upset which can be satisfactorily made in a forging machine, and in fact, is much greater than that usually recommended as being practical. This example which is supposed to be the largest upset ever made by machine methods was accomplished in the Chicago shops of the C. & N. W. Railway, on a 6-inch Ajax universal forging machine, the dies and tools used being designed by T. E. Williams, master smith. This trailer pin is made from a 3-inch round wrought iron bar 26 inches long, and an excess amount of stock equal to $10\frac{3}{4}$ inches in length is put into the upset in one blow. The dimensions of the upset square flange are $7\frac{7}{8}$ inches across the flats and 10 5-16 inches across the corners by $1\frac{3}{8}$ inch thick. The circular flange is $5\frac{7}{8}$ inches in diameter by $\frac{5}{8}$ inch long. After the work is given the first blow with the plunger *B*, a reheat is then taken and the work is again placed between the gripping dies *C*, only one of which is shown. The machine is again operated and the part given another blow which serves to close up the texture of the steel and eliminates the defects caused by the structure of the steel pulling apart during the upsetting operation. The production of this enormous upset gives a slight idea of some of the possibilities of machine forging in making engine parts, etc.

Bending and Forming Operations

The making of ladder treads for freight cars is a good example of bending and forming operations that can be handled successfully in the upsetting and forging machine. Fig. 53 shows three of the steps followed in the production of a ladder tread which is completed to the shape shown at *C* in five operations. Two of these operations, which will not be described in detail, are accomplished in the bulldozer, and consist in bending the ladder tread to its final shape.

The dies and tools used for forming the feet of the ladder tread are illustrated in Fig. 54. The first operation is indicated at *A* and consists in cutting off a bar of $\frac{5}{8}$-inch iron to the required length. This is heated on one end, placed in the lower impression in the gripping dies *G* and *H* and given a blow by the plunger *I* which forms the end of the rod into the shape shown at *B*. In this operation, the stock is upset just far enough so that it will not buckle in front of the dies.

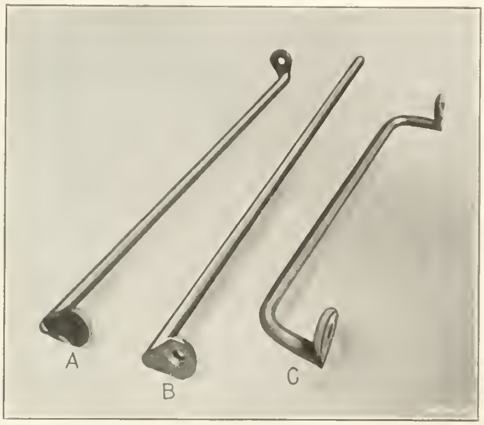

Fig. 53. Three Steps in the Formation of Ladder Treads for Freight Cars, accomplished in a "National" Forging Machine

The second operation bends and forms the stock back into a solid forging as indicated at *C*, this being accomplished in the second impression in the gripping dies in conjunction with plunger *J*. The final forging operation, the result of which is shown at *D*, completes the foot, the upper impressions in the dies being used for this purpose; these are made the exact shape of the foot, and the plunger *K* has a pin in it which punches the hole in the foot to within 1/16 inch of passing through the 9/16-inch stock. The final operations which are performed in a bulldozer or other bending machine consist in bending both ends of the tread to the required shape. This requires two operations, which are indicated at *E* and *F*, respectively. Before the final bending, the forging is taken to an emery wheel to remove the burrs formed when forging the feet.

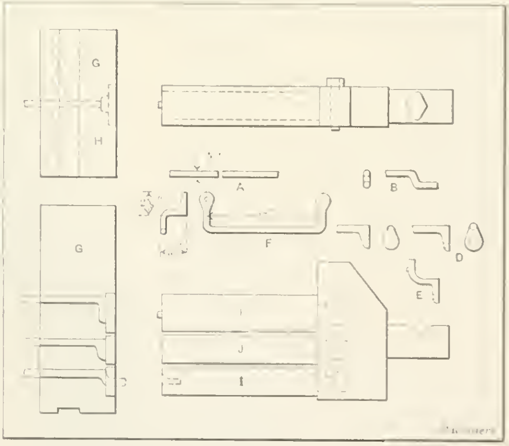

Fig. 54. Dies and Tools used in forming the Feet of Ladder Treads

The eye-bolt shown in two stages of its formation, at *A* and

B in Fig. 55, is another example of a bending and forming operation accomplished in a forging machine. This eye-bolt is made from a 1¾-inch round wrought-iron bar, and is completed in two blows in a 3-inch Ajax forging machine, using the dies and tools illustrated. The construction of the gripping dies is rather unusual and hence interesting. The lower impression in the dies consists of two movable members *C* which slide on four rods *D* and are provided with tongues *E* which fit in corresponding grooves in the movable and stationary gripping dies. The pins, of course, act as mediums for holding these sliding members *C* in the gripping dies. The blocks *C* are kept out against the adjustable lock-nuts *F* by open-wound coil springs *G*.

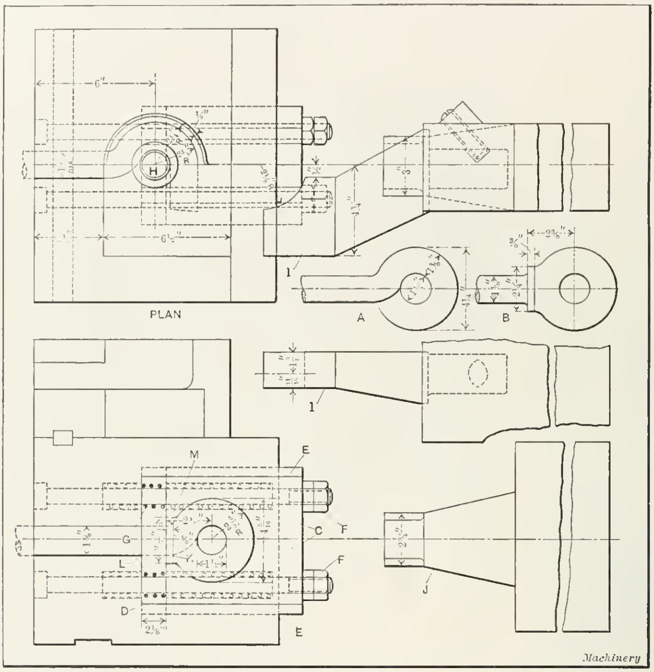

Fig. 55. An Interesting Set of Dies and Tools used in a 3-inch Ajax Forging Machine for forming Eye-bolts in Two Blows

The method of operation is as follows: The stock is first heated for a portion of its length to the correct temperature, then placed in the upper impression of the stationary die, being located in the correct endwise position by the stop of the machine. The machine is then operated and when the movable die closes on the work, it grips it and at the same time forces the heated end of the stock around the pin *H* held in the stationary die. Just as soon as the dies close tightly on the work, the punch *I* comes in contact with the bent end of the bar and forms it around the pin *H*, bending the work into the shape shown at *A*. The dies now open and the work is removed and placed on the pin forming the center portion of the impression in the blocks *C*. The machine is again operated and as the dies close, the ram *J* advances and forces the blocks *C* forward, carrying the "eye-end" of the work along with it.

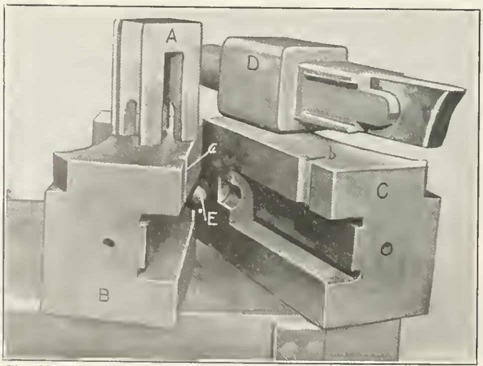

Fig. 56. Dies and Tools used for forming a Driver Brake Adjusting Rod Block in a 5-inch Ajax Forging Machine

Now as both parts of the bar—"eye-end" and body—are rigidly held in the gripping dies and movable blocks *C*, it is evident that the part of the bar between the points *K* and *L* must be upset. The result of this displacement of the stock causes the formation of a shoulder on the bar at the base of the eye, formed by the circular impression *M* in the blocks *C*. The amount of stock required to form the boss at the base of the "eye" is governed by the position of the lock-nuts *F*. The ram *J* and gripping dies are made from steel castings. The four compression springs *G* are 10¾ inches long when extended, of ¼ pitch, and 5/32 inch diameter wire is used, the outside diameter of the spring being 1 3/16 inch.

Dies and Tools for Forming a Driver Brake Adjusting Rod Block

A difficult forming operation accomplished in the forging machine is shown in Fig. 56. The part *A* which is called a driver brake adjusting rod block is used on freight cars and is produced by the L. S. & M. S. Railway Shops, at Collinwood, Ohio. It is made of wrought iron and is completed in two blows in a 5-inch Ajax forging machine. The method of procedure in making this piece is to first cut a piece of rectangular bar iron to the required length and then bend it into a U-shape in the bulldozer. It is then taken to the furnace where it is heated to the proper temperature, and a "porter" bar which is simply a bar of iron, about ¾ inch in diameter, is also heated. This is stuck to the bent piece (which is to form the block) and the latter is placed between the gripping dies, the bar being used simply as a means of handling. The dies shown at *B* and *C* are provided with half-round impressions shown at *a* and *b* through which the "porter" bar projects. As the machine is operated, the front end of plunger *D* which, as can be seen, is of shear shape, cuts off the "porter" bar and forces the bent piece into the impressions in the gripping dies. While the piece is still held in the dies, the machine is again operated and the work given a second blow this, of course, all being accomplished in the one heat. The round ended plug *E* at the end of the impression in the

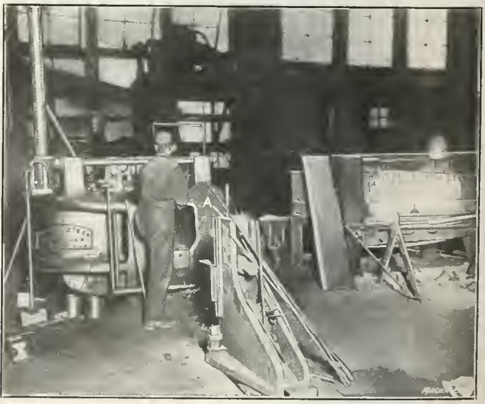

Fig. 57. 5-inch Ajax Forging Machine at Work in the Collinwood Shops of the L. S. & M. S. Railway, set up for making Coupler Pocket Filling Blocks for Freight Cars

stationary die forms an impression in the end of the block and serves as a spot for a subsequent drilling operation.

Fig. 58 shows a forging accomplished in practically the same manner as that illustrated in Fig. 56. This part, which is called a coupler pocket filling block, is used on a freight car and is made from scrap arch bars cut up into pieces of the desired length. These pieces are first formed into a U-shape in a bulldozer and are then brought to the furnace shown to the right in Fig. 57. Here they are heated to the desired temperature, then gripped with the tongs and placed on the shelf of the back stop *A*. The forging machine operator then by means of a "porter" bar, as before, lifts the piece from the shelf and places it between the gripping dies, where the forging is given two blows and then thrown down in the sand to cool off. Fig. 58 gives some idea of how this coupler pocket filling block is produced. The piece of arch bar which has been formed to a U-shape in the bulldozer still forms the end of the block, the sides or webs being formed by bending in the arch and lapping up the open ends. This can easily be seen by referring to the piece *A* in the illustration, where the joint formed in this manner is clearly shown. The burrs formed on these pieces are removed in a subsequent operation.

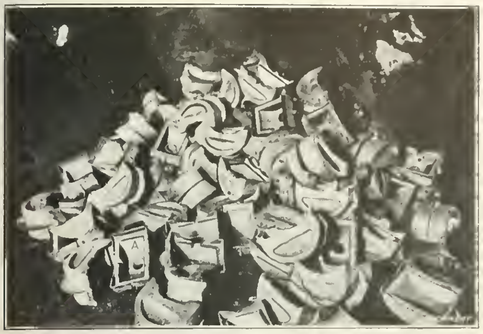

Fig. 58. A Heap of Finished Forged Coupler Pocket Filling Blocks

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DEPOSITING COPPER ON PLASTER OF PARIS

A method for depositing copper on plaster of Paris is described in the *Chemical News*. The plaster article is thoroughly dried and then warmed, after which it is introduced into a bath of melted paraffine, heated to about 150 degrees F. The article is then removed and allowed to cool. The paraffine permeates the plaster and makes it waterproof. The article is now coated with a thin layer of collodion, diluted with ether and alcohol and allowed to dry. The surface is then coated with electrotypers' plumbago, the copper wires for conducting the electricity are attached, and a second coating of plumbago is given it. The plaster article is now placed in a ten per cent solution of aluminum sulphate for a few minutes, and then in the copper plating bath made of sulphate of copper and sulphuric acid. This solution should contain from five to eight per cent of sulphuric acid. A current density of one ampere to each sixteen square inches is used at three volts. Aluminum sulphate is of assistance in producing a rapid copper deposit all over the surface.

* * *

THE PRECISION LATHE AS A GENERAL PURPOSE MACHINE TOOL

The bench lathe is generally regarded as a machine tool adapted only for light turning, boring, milling and grinding, and one particularly suited to work required to be finished within close limits—hence the common designation of "precision" lathe. Of course this generalization is not strictly true, inasmuch as there are engine lathes made with short legs and pan for use on benches. These are lower-priced than regular bench lathes of the precision class and are not regarded as being so well suited for finishing small parts with speed and accuracy as the special type of lathes.

The fact that the so-called "precision lathe" is a machine tool of wide adaptability which can be made highly efficient for certain classes of manufacturing as well as for a wide range of tool-room work, is not as well appreciated as it should be. The factors in favor of the bench lathe are compactness, light weight of moving parts and the possibility of running the spindle at high speeds continuously without serious heating. The high speeds with the cuts and feeds possible with the best high-speed steel tools enable an expert operator to show a chip production in a day's work that compares favorably with the average production of a fourteen-inch or sixteen-inch engine lathe working on much heavier pieces.

The modern precision lathe can be employed efficiently in the tool-room for such work as making jig bushings. This is a job requiring accurate turning and boring, grinding after hardening, and lapping as a finishing operation. Other jobs such as making small hardened and ground steel washers can be handled on a bench lathe fitted with a grinding attachment.

The illustration Fig. 1 shows a Cincinnati precision lathe being used as a grinding machine for finishing some hardened washers which were turned and bored on this machine. The washers are about $2\frac{1}{2}$ inches outside diameter, the hole diameter being $\frac{7}{8}$ inch. The lathe has a swivel headstock which may be readily set for face grinding at such positions as are most convenient for the operator. Fig. 2 shows an example of grinding done on a hardened washer. The claim is made that with the spindle construction and bevel gear drive employed, unusually smooth work can be produced—that a surface for most practical purposes equal to a lapped surface can be ground in a fraction of the time required for grinding and lapping with the common means and methods.

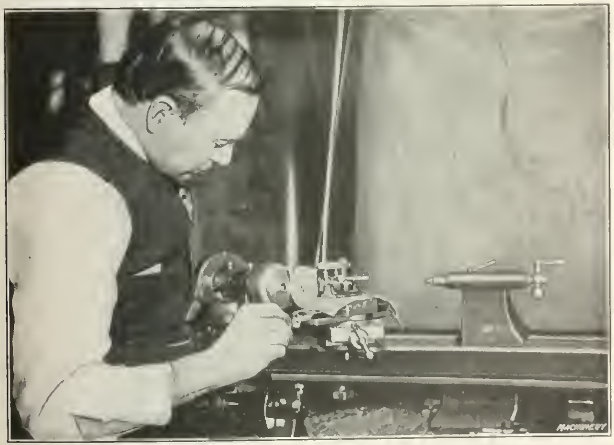

Fig. 1. Cincinnati Precision Lathe being used as a Grinding Machine on Hardened Steel Washers

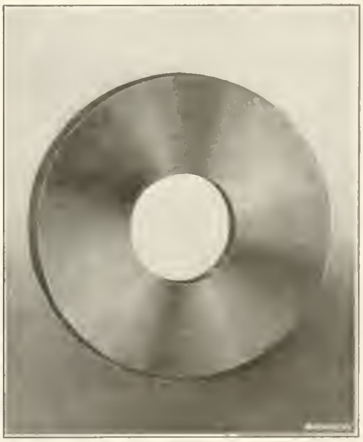

Fig. 2. Hardened Steel Washer ground on Precision Lathe

LETTERS ON PRACTICAL SUBJECTS

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MACHINING THIN WORK WITHOUT DISTORTION

In the everyday process of manufacturing, the problem frequently comes up of machining a thin metal pot or shell of some sort without undue distortion. When the work is of small size like that shown in Fig. 1, for instance, it is not especially difficult, but when the diameter runs up to twenty-five or thirty inches, and the thickness of the wall still remains one-eighth inch, or thereabouts, the problem is more serious.

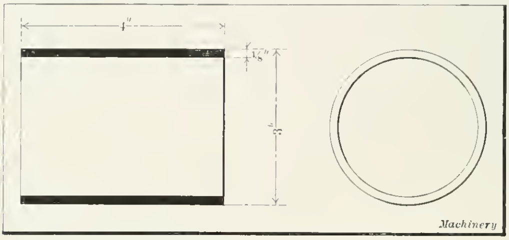


Fig. 1. Example of Thin Work not particularly Difficult to machine accurately

Fig. 2 shows an annular forged steel ring, from which the automobile clincher rim shown in Fig. 3 was to be machined, and it will be noted that the thickness of the shell is only one-eighth inch when finished. This piece was successfully handled as follows: The rough-forged ring was first placed on the bed of a drill press, and a one-half inch hole drilled at *A*, Fig. 2, after which a short piece of steel was inserted to act as a driver.

The work was then placed with the driver side down on the table of a Bullard vertical turret lathe, and the chuck jaws brought into contact at *B*, allowing the driver to thrust against the side of the jaw. Using the main head and side head simultaneously, the work was roughed out to within about one-sixteenth inch of the finished size and a groove or shoulder cut at *C*. The tension on the jaws was then released to a minimum, and hold-down straps inserted in the groove, bolting them down in the table T-slots, and allowing the driver to do practically all the work. After this had been done, it was a simple matter to complete the turning and inside finishing to the required dimensions, and finally cut off just above the straps, leaving the piece free from distortion.

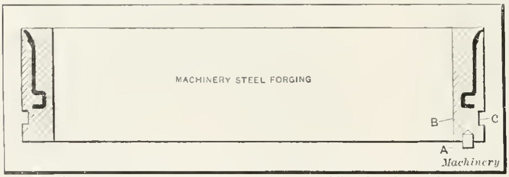


Fig. 2. Forged Steel Ring for Automobile Clincher Rim

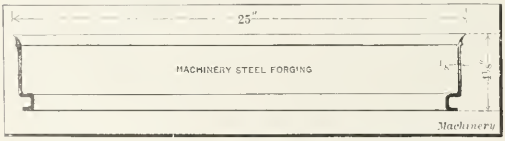


Fig. 3. Automobile Clincher Rim finished without Distortion

This particular job consisted of four pieces only and therefore did not warrant the expenditure of much money in the line of special holding devices. Shortly after this job was done, however, a lot of one hundred pieces came along, and it was deemed advisable to adopt another method of handling in order to facilitate production. A set of special jaws, as shown in Fig. 4, is the main feature of the improved method. The hole *A* extends through the body of the jaw, and permits a floating action to the hook-bolt shown in the illustration. In using this method, the face of the jaw *B* was brought up lightly against the work until it was just possible to detect its contact, after which the hook-bolts were brought to bear against the inner surface and securely tightened with a wrench. The freedom from distortion in this method of holding naturally permitted more rapid removal of stock, with a resulting gain in production, and while not by any means a new idea it is one not frequently made use of.

Bridgeport, Conn. ALBERT A. DOWD

THREE-DISK METHOD OF LOCATING HOLES

The foreman toolmaker of a shop engaged in the manufacture of a line of small machinery requiring the greatest accuracy, recently showed the writer how he located holes in jigs by the use of three disks of such diameters that when they were placed touching one another, their centers would be at the required distances. There is nothing new about the use of this method, either on work held on the lathe faceplate, in which case the disks have hubs *D* for the indicator, or for cruder work which is handled on the drill press where each disk has its central hole large enough to hold a jig bushing to guide the drill.

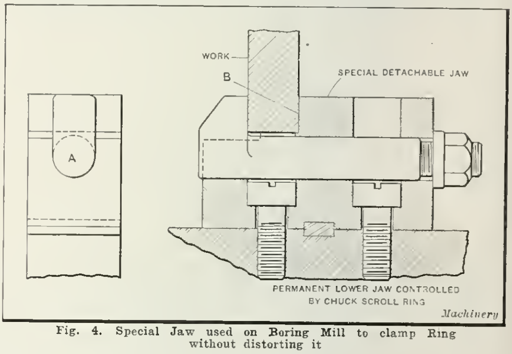
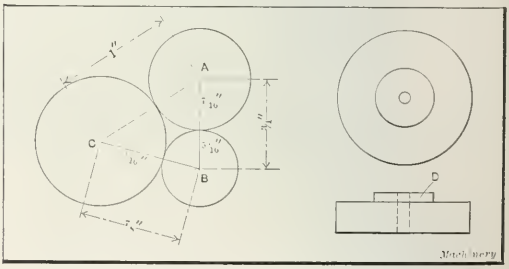


Fig. 4. Special Jaw used on Boring Mill to clamp Ring without distorting it

The only novelty of the explanation of this method which was given by the foreman lay in his statement that he could not use it as often as he wished because of the labor involved in determining the diameters of the required disks. In proof of this statement he produced a mass of "algebraic looking" calculations. As a matter of fact, the problem is usually so simple that nine times out of ten it can be solved mentally. Referring to the case shown in the accompanying illustration, it will be obvious that the radius of disk *A* must exceed one-half of the distance *A-B* by one-half of the difference between the distances *C-A* and *C-B*. This also gives the required diameters of disks *B* and *C*. For the case shown, it will be seen that the required radius of disk *A* is 7/16 inch, the radius of disk *B* is 5/16 inch and the radius of disk *C* 9/16 inch.



Three-disk Method of locating Holes and Detail of Disk

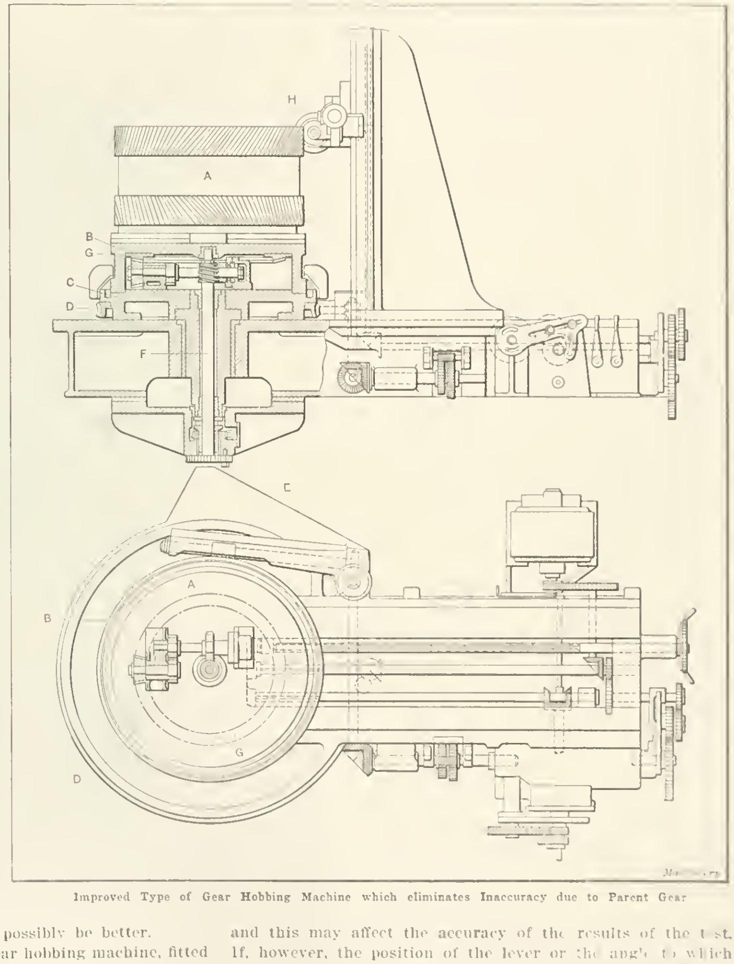
New London, N. H. GUY H. GARDNER

IMPROVEMENT IN GEAR CUTTING

The English engineer, Sir Charles A. Parsons, has developed an ingenious and scientific method of cutting the teeth of gearing used in connection with steam turbines for the propulsion of ships. For efficient operation, turbine speeds are much higher than the most suitable speeds for propellers and, consequently, some form of reduction gearing should be used between the turbine and the propeller. Double helical gearing is usually employed to accomplish the speed reduction because high speed and smoothness of action are essential, but even with this type of gearing considerable noise has been experienced. Careful investigations were made by Mr. Parsons to determine the causes producing noise, and its source was traced to the large worm-wheel which rotated the table of the gear hobbing machine. This worm-wheel is known as the "parent" gear.

By means of the hobbing machine tooth-faces are automatically and continuously generated by a hob which is nothing more than a worm with slots running lengthwise to form cutting edges. The gear to be cut is mounted on a horizontal table which is rotated by proper change gears. The hob cuts by its rotative action and must be set at the proper angle to the axis of the gear. After making careful measurements, inaccuracies of the cut gear were found to occur at the same time as those of the parent gear and at definite intervals, the errors lying in planes through the axis of rotation. The idea occurred to Mr. Parsons that if the speed of rotation of the work were given a small but steady advance in relation to that of the table driven by the parent gear, these errors, instead of lying in planes through the axis of the gear wheel, would lie in spirals around it. Consequently, the periodicity of the errors would be destroyed.

In order to obtain this result, an existing type of gear hobbing machine was fitted with a secondary table which was mounted on the original table. The secondary table is driven by suitable gearing at a speed of one per cent faster than that of the original or lower table, thus giving it a creep. The original table is driven through the parent wheel. The main worm operating the original table was then driven at one per cent less speed, so the work was given practically the same rotational speed as before the creep was introduced. Later developments have led to the conclusion that a creep of five per cent might possibly be better.



Improved Type of Gear Hobbing Machine which eliminates Inaccuracy due to Parent Gear

The general arrangement of the gear hobbing machine, fitted with the creeping table, is shown in the illustration reproduced from *Engineering* (London), March 14, 1913. The work *A* is mounted on the secondary or creeping table *B*, which, in turn, is mounted on the original or lower table *C*. The worm-wheel or parent gear is shown at *D* and is driven by the worm *E*. The creeping table is driven by means of the vertical shaft *F*, which transmits its motion through a worm and wheel to suitable gearing engaging with the circular rack *G* on the under side of the secondary table. The hob for generating the teeth is shown at *H*.

The most important effect of this method of cutting gears is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing. At the same time the errors themselves have been considerably reduced. Gears cut by Mr. Parson's new method have been tried and found to run very quietly.

Scranton, Pa. T. W. HOLLOWAY

TESTING THE HARDNESS OF METALS

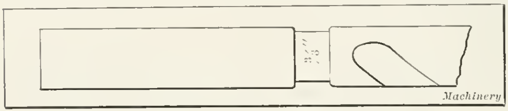
An important factor seems to have been overlooked by Mr. H. M. Nichol's method of testing the comparative hardness of metals, which was described in the April issue of MACHINERY. It appears to the writer that the results obtained by this method are dependent upon the "personal factor" and he would like to know what regulates the tightness to which the vise is screwed up. Suppose, for instance, that twice the power is exerted by the man in screwing up the second piece—what happens? Certainly a deeper impression will be made, and this may affect the accuracy of the results of the test. If, however, the position of the lever or the angle to which the vise screw has been turned is observed and subsequent pieces are tested by tightening the vise to the same point, it would then appear that the test should offer a fair indication of the comparative hardness of the different metals which were tested. The following outlines the reason for this assumption. 1. The vise screw is in effect a powerful spring, and by always tightening it up to the same point, the same amount of tension will be produced. 2. The reaction of this tension, which is effective while the vise is being screwed up, will vary with the hardness of the material which is being tested, the ball making a deeper impression in soft than in hard material. 3. The comparative tests must be made on pieces of the same thickness or else allowance must be made for variations in thickness. In making such allowance, it would be necessary to use a vise fitted with a precision screw or some other means of measuring the amount which the vise is screwed up after the ball has just been engaged.

It appears to the writer that this method, at best, affords too many loop-holes through which errors may be introduced. A much more reliable test may be employed in any shop where there is an arbor press fitted with a pressure gage. In using such a machine, the test sample may be put on the table and the ball pressed down into it until a specified pressure is indicated. The ball could be supported in a depression in a piece of hardened steel provided for the purpose. In testing all pieces under the uniform conditions obtained in this way, the writer believes that more reliable results would be obtained.

Manchester, England. Francis W. Shaw

NUMBERING MACHINERY AND TOOLS

I was interested in reading Mr. James E. Cooley's article on "Numbering Machinery and Tools," which appeared in the April issue of Machinery. There is another case of very bad practice in numbering tools which was not touched upon in this article, *i. e.*, of placing the size of a straight shank drill on the shank. The trouble in this case is not with the size of the numbers that are used, but with their location. It frequently happens that a drill is not held tight enough and, therefore, turns in the chuck. This results in wearing the shank down sufficiently so that the numbers are no longer legible. This is a difficulty that could be avoided by providing each drill with a small central groove between the shank and the twisted section, and placing the numbers representing the drill size in this groove. This practice would save a lot of time which is now spent in measuring and remeasuring drills, where the number has become so badly worn that it cannot be read with any degree of certainty.

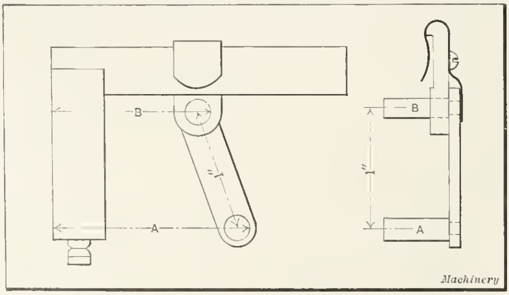


Method of marking Size on Straight Shank Twist Drills

Detroit, Mich. Hermann Mueller

TOOL FOR MEASURING ANGLES AND TAPERS ON SMALL WORK

The tool illustrated in this article is simply a "sine protractor" with the buttons *A* and *B* set exactly one inch apart. These buttons are carried by a spring clamp which is secured to the blade of a small square in the manner shown in the illustration. In using this tool to measure the angle on a piece of work, the latter is set between the stock of the square and the two buttons of the sine protractor. A micrometer is then used to measure the distance of the buttons *A* and *B* from the bottom of the stock of the square. As the buttons are exactly one inch apart, the difference of the two micrometer readings gives the sine of the angle, and by referring to a table of sines the angle can be obtained. One of the particularly useful applications of this tool is in measuring the angle of tapered round pieces which, as is well known, cannot be accurately done with a vernier protractor because the smaller part of the taper drops further into the grooved blade than the larger part.



Sine Protractor for measuring Angles and Tapers on Small Work

New London, N. H. Guy H. Gardner

FAILURE OF A JAW CLUTCH

An engineer once told the writer that he had never yet seen a case in which the dimensions of a part that failed figured out to show it capable of carrying the required load. One must sometimes have a failure or two, however, before the proper method of figuring is learned, as a part of adequate strength may fail because some unforeseen condition arises. When this "unforeseen something" could have been anticipated the designer is at fault, and the "man on the job" who observed the failure is more than likely to come out with some severe criticism, although he himself did not anticipate the occurrence of the condition until it actually happened.

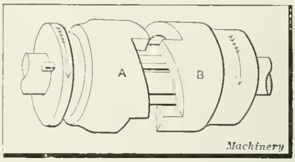


Fig. 1. Type of Clutch with Spiral Jaws that caused Levers to be broken

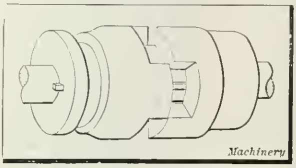


Fig. 2. Clutch with Square Jaws that eliminated the Difficulty

In a recent installation which came to the writer's attention, the clutch shifting levers failed repeatedly, although they were apparently of ample strength. The clutches in question were of the spiral jaw type, as illustrated in Fig. 1, and the shifter lever was held in or out of engagement by a latch engaging a quadrant. More careful observation of the operating conditions showed the trouble to be as follows: When the speed of the driver was checked, either by overload of the adjacent machines, by two or more machines being thrown in simultaneously, or by cutting off the source of the power too quickly, the driven member *B* moved faster than the driving member *A*, owing to inertia. The clutches thus parted and caused the shifting lever to be broken. These clutches were replaced by the square jaw type, as shown in Fig. 2, and the trouble was thus eliminated.

Philadelphia, Pa. John S. Myers

A NOVEL SUGGESTION SYSTEM

It will be found profitable for any factory to adopt the plan of encouraging workmen to express their ideas on methods of improving operating conditions. Many managers recognize the benefits to be derived from such a plan, but find their time so completely occupied that they cannot give this department the necessary amount of attention.

The writer's idea of the proper method of conducting a "suggestion box" differs somewhat from that outlined by Mr. F. W. Harris in the April issue of Machinery, engineering edition. Our factory had better success than Mr. Harris appears to have had, although we also encountered a little trouble in certain directions. Our method of conducting the suggestion box differs somewhat from that which is customarily used and shop men will probably be interested in reading the following description. A list of prizes, ranging from $5 to $25, the total amount being $100, was offered for valuable suggestions, and any employe of the factory was eligible to compete for these prizes, no restriction being placed upon the nature of the suggestion. The "contest," as it was known, was open for a period of three months, at the end of which time a committee was appointed by the men who had offered suggestions to award the prizes. None of the contestants were eligible to serve on this committee. The benefit derived from such a plan lies in securing the cooperation of the men, in addition to the actual value of the ideas which they offered, although in many cases, the ideas were really of very considerable value.

Suggestion boxes were installed in the factory several years ago, but only one or two suggestions would be received each month. The contest revived interest in the plant to such an extent that there were nearly three hundred suggestions handed in to compete for the prizes. Some of these were neatly prepared and others were in the form of rough sketches on dirty pieces of paper. Nevertheless, the ideas were prepared with sufficient care to make them readily understood in most cases. As previously mentioned, trouble was encountered in certain directions, but it was never great enough to overbalance the benefit which was derived. At the present time, another contest has been started and seems to be arousing quite as much interest as the first one did.

Springfield, Ohio HAROLD G. SMITH

ANALYZING STRENGTH OF CYLINDER HEAD BOLTS

Many young mechanics are puzzled by the fact that the bolts which hold a cylinder head in place are not broken by the pressure in the cylinder, when the bolts themselves are tightened up to practically the point at which rupture occurs. For example, suppose there are six bolts holding the head on the cylinder which is shown in Fig. 1, and each bolt is tightened up nearly to its ultimate strength. Assuming the strength of each bolt to be 20,000 pounds, this would mean that a total pressure of about 120,000 pounds is applied to the cylinder head by the bolts.

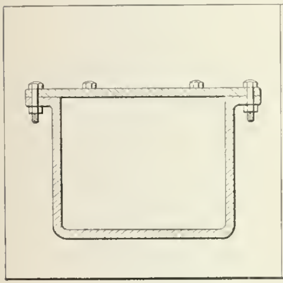


Fig. 1. Section through Cylinder

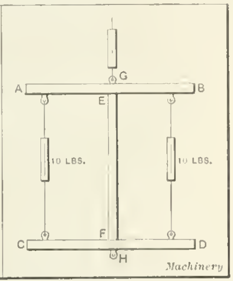


Fig. 2. Showing Strength of Bolts

When the steam is admitted to the cylinder, pressure is applied to the cylinder head from the inside, and it would seem as though the bolts would have very little strength to withstand this seemingly additional strain. The diagram Fig. 2 shows the reason why the bolts do not break. In this diagram, we will consider the rod *AB* to represent the cylinder head and the rod *CD* to represent the opposite end of the cylinder. The transverse piece *EF* is placed between these two rods and secured by means of two 25-pound spring-balances attached in the manner shown in the illustration. These balances are adjusted to indicate a tension of 10 pounds each and this corresponds with the stress in the cylinder head bolts. Now if a third spring-balance *G* is secured in the position indicated in the diagram, and the lower rod is fastened at *H* to some rigid support, it will be found that any pull of less than 20 pounds, which is registered by the balance *G*, will not be indicated by the two spring-balances which hold the rods *AB* and *CD* in place. The same conditions exist in the case of cylinder head bolts, it being necessary to apply a pressure which exceeds the total tension of the bolts before this pressure is effective in causing them to break.

Lynn, Mass. J. P. FARNSWORTH

AN INTERNAL CHUCK OF WIDE RANGE

It was necessary to hold the cylindrical steel casting, shown in Fig. 1, by the internal surface while the outside surface was being roughed off. A common mandrel or expanding ring chuck, although able to hold the work, did not have sufficient range to make up for errors in the castings resulting from poor molding. It was decided that an internal chuck was best for this operation and the design shown in Fig. 2 was developed, which not only meets all requirements, both in scope and strength, but is quite inexpensive as well. It consists of a casting *A* which, acting as a faceplate, is fitted to the lathe. The core of the chucking mechanism *B*, which consists of a tapered flange *Z*, and a projecting stud *Y* are turned out of one piece of tool steel and fastened to this faceplate. Segments *C*, *D*, and *E* are assembled to engage in the grooves *X* in the core. These segments were made from a ring turned to the same angle as that of the core *B*. The surfaces of the pads *W* which engage with the work are checked like the jaws of a chuck to give them a firm grip. The tapered collar *F*, which also has a groove that engages the extension on the segments to prevent them from falling out, is assembled over the stud. The washer *G* is now placed on the stud and when the nut *H* is screwed up, the chuck is made a unit which will expand or contract as desired. It will be noted that each segment has two pins projecting from its lower surface which engage a keyway *V*. These pins are used to prevent the segments from falling together. Although it is not absolutely necessary, a flat spring may now be sprung over the three segments as shown at *J*; this spring will tend to contract the segments readily when the nut is loosened, and also prevent them from falling off if the nut is unscrewed too far.

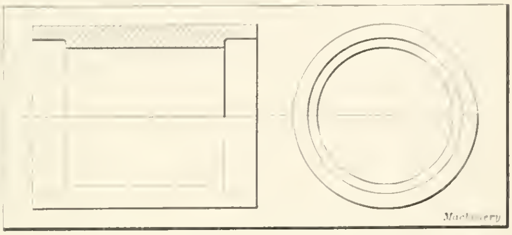


Fig. 1. Work that required Special Internal Chuck to hold it

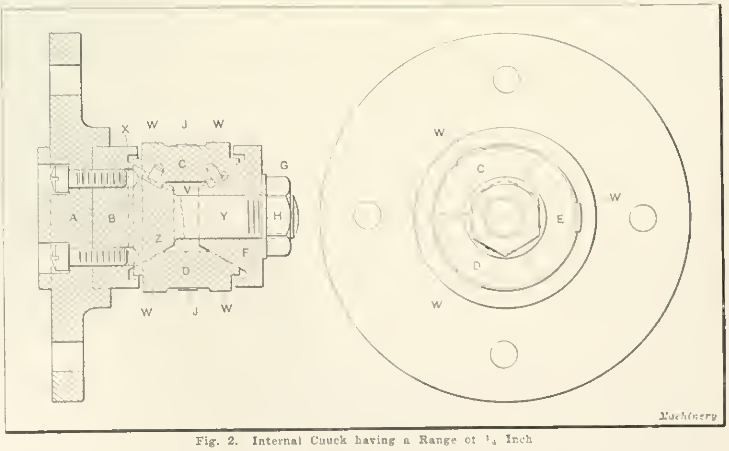


Fig. 2. Internal Chuck having a Range of 1/4 Inch

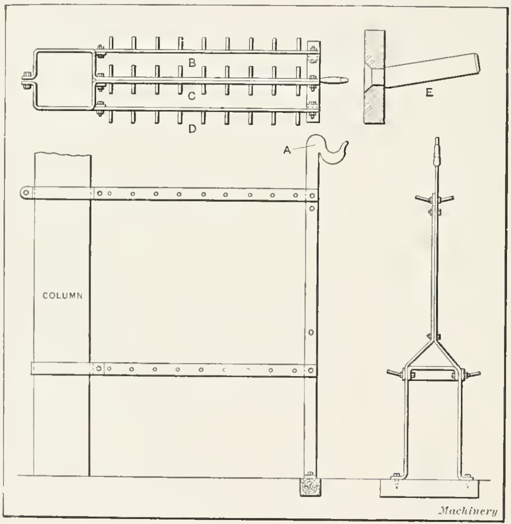
A chuck of this design has a range of nearly 1/4 inch and the question of the strength of its grip is a mere matter of leverage. It must be remembered that if two turns of the nut of a mandrel will expand the ring 1/32 inch, while the same number of turns will expand this chuck 3/16 inch, the difference will have to be compensated for by an increased leverage at the wrench. That is the reason that a hardened tool-steel stud and nut is absolutely necessary because a wrench 20 to 24 inches long must be used. A chuck constructed along these lines needs not even the aid of a driver to withstand the thrust of an extra heavy steel chip. It is compact, efficient, inexpensive, and last but not least, it will stand up.

R. Franz Elhop

RACK FOR HOLDING WRENCHES AND CHAINS

The illustration shows a convenient form of rack for holding wrenches and chains. The importance of keeping the different forms of wrenches and chains that are required in a shop in some handy place so that each workman knows where to locate them is obvious. If the tools are left scattered around the shop, a great deal of time is lost in looking for the particular size that is wanted. The use of this rack has done away with the loss of time resulting from this cause, and by so doing has been the means of effecting a material reduction in operating costs.

Referring to the illustration, it will be seen that this rack is attached at one end to a column, the other being held by the support *A* which has a hook at its upper end from which the chains are suspended. *B*, *C* and *D* are the three parts from which the wrenches are suspended. Holes are drilled in the handles of the wrenches about 1/16 inch larger in diameter than the pins in the rack. The size of rack will, of course, be made suitable for the purpose for which it is intended. A detail of one of the pins and the method of mounting it in the rack is shown at *E*. The design could easily be modified by having a support *A* at each end of the rack. In this case, the rack could be set in any convenient position on the floor of the shop and a hook for carrying chains could be provided at both ends.



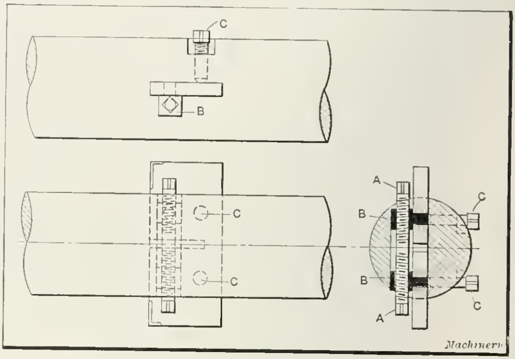
Rack for holding Wrenches and Chains and Detail of One of the Pegs

Lincoln, Neb. H. E. Gillette

ADJUSTABLE BORING BAR

The cutters of an ordinary boring bar soon become dull when the tool is working constantly on steel, hard brass or similar stock, and it is an expensive matter to replace them. The tool illustrated herewith is provided with an ingenious method of adjusting the cutters so that it is possible to compensate for wear. Referring to the illustration it will be seen that the cutter is split through the center and the two halves are adjusted by the screw *A* which is threaded right- and left-hand. The two threaded sections of this screw run in the tapped holes in the dogs *B* which fit into suitable holes in the cutters. After the required adjustment has been secured the cutters are clamped firmly in place by means of the screws *C*.

In using this tool it is an easy matter to compensate for any wear which develops in the cutters, as it is merely necessary to loosen the screws *C* and then turn the screw *A* sufficiently to obtain the required distance between the cutting edges. Consequently, there is no necessity for variations in the work to be produced through wear in the boring bar. It will be evident that a number of different cutters could be made for use in a single bar, and for this purpose it would only be necessary to make the various sized cutters, having the holes in them of a standard size so that the driving dogs *B* and screw *A* could be used for all sizes of cutters. When assembling a bar of this type, the dogs are screwed onto the adjusting screw to such a position that the two dogs can be entered into the corresponding holes in the cutters. The whole arrangement is then slipped into the bar and fastened by the two screws *C*. Experience has shown that the screw is most effective when placed quite close to the cutting edge of the cutter.

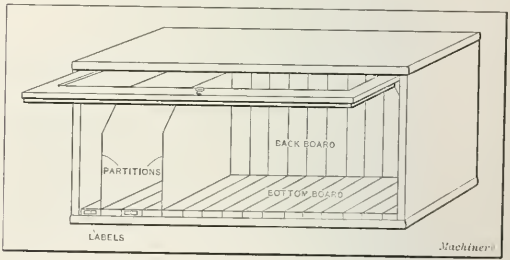


Boring Bar made with Adjustable Cutters

W. R. C

FILING CATALOGUES

The writer has seen several letters in Machinery regarding the use and abuse of catalogues and believes that many readers will be interested in the method of filing catalogues which is used in the factory where he is employed. The accompanying illustration shows one section of a sectional book-case, which has been fitted up to receive catalogues. As additional sections can be added as required, this method makes it easy to provide more space whenever it is necessary.



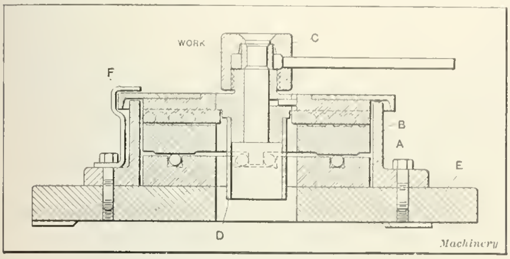
Sectional Book-case arranged for filing Manufacturers' Catalogues

Referring to the illustration it will be seen that saw cuts are made in the bottom and back boards of the book-case at intervals of 2 inches, and partitions are made of 24 gage galvanized iron to fit in these cuts. It will be obvious that the partitions can be fitted in any of the slots to provide spaces to suit the number of catalogues on different subjects. A card index is kept in connection with this cabinet, the catalogues being listed in this index under the manufacturers' names and also under the classes of equipment which are shown in them. It has been found that the ease with which any catalogue can be located by this means, has more than paid for the trouble that was taken in fitting up the cabinets and compiling the card index.

Lancaster, Pa. D. R. Long

SELF-ALIGNING REAMING FIXTURE

In describing the accompanying design for a self-aligning reaming fixture, the writer presents a very useful tool to the readers of MACHINERY. It is used for reaming small bushings or other parts which cannot be handled in a turret lathe. The bottom plate *A* has grooves cut in its upper surface which are filled with hardened steel balls. These balls bear on the sides and bottoms of the grooves with about 0.001 inch clearance on the sides. Plate *B* has a tongue which engages between two rows of balls in the center groove of plate *A*, this groove being provided to locate the fixture longitudinally. In the top of plate *B* there are grooves similar to those in plate *A* except that they are cut at right angles to those in plate *A*. These are also filled with balls which locate the fixture transversely.



Self-aligning Fixture for reaming Bushings

It will be evident from this description that as soon as the reamer touches the work, the fixture will adapt itself to the center of the reamer. The cap *C* has an internal thread which is relieved after the manner of a breech block for the purpose of rapid manipulation. Tube *D* is used as a spout to carry away the cutting fluid which is used on the work. Pads are provided on the under side of the plate *E* which raise the base enough to allow the cutting fluid to escape. The clamp *F* is simply used to hold the fixture so that the plates will not rise when removing the reamer from the work.

Bristol, Conn. F. A. HOTCHKISS

ANGLE AND TRANSFER GAGES FOR DIEMAKERS

The illustrations show two tools which the writer has found particularly useful during his experience as a diemaker. The tool shown in Fig. 1 is an angle gage which was especially designed to test the clearance on dies, but it will also be found useful on other classes of angular work. The tool is made from a Starrett adjustable square, the blade of the gage being the only part which has to be made especially for this tool. This blade is made of tool steel and is hardened, ground and lapped to an accurate finish; it has a knife edge *C* on the working side. The groove *D* is made to slip over the extension *E* on the hook-bolt of the adjustable square. In using the gage, the blade is set to the required angle by using a protractor on the edge *H* of the tool body and the edge *I* of the blade; the nut *F* is then tightened so that the hook-bolt draws the blade up against the end of the slot *G*, clamping it securely in position. As the knife edge *C* has been made exactly parallel with the edge *I*, this method of setting the gage is quite accurate. The blade can be set at any desired angle so that the gage is universal in its application.

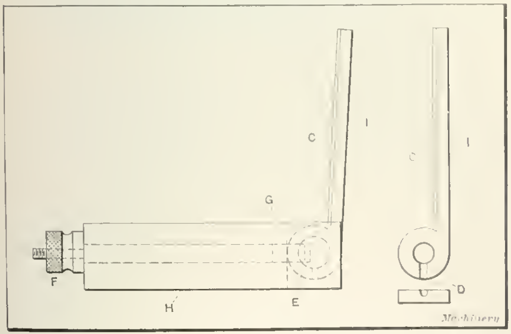


Fig. 1. Angle Gage for securing Required Clearance on a Die

The tool shown in Fig. 2 is a transfer gage for use in locating the holes in a punch-pad so that they will be in exact alignment with the corresponding holes in the die. The hole *A* in the gage is 0.250 inch in diameter and is exactly square with the base of the tool body, which is hardened, ground and lapped to an accurate finish. In using the tool, a temporary punch *B* is made to fit accurately in the hole *A*. After the hole for the first punch has been drilled in the punch-pad and the punch *D* set up in it, the punch *B* is inserted in the tool and placed in approximately the desired position on the punch-pad. The screw *C* fits into the hole which screws the punch-pad onto the extension holder. The die is then placed over the punch so that the punch *D* enters the corresponding hole in the die, after which punch *B* is moved around until it fits into its corresponding hole in the die. The screw *C* is next tightened up so that the transfer gage is held securely in position on the punch-pad. The die is then lifted off and the punch *B* removed from the transfer gage. The hole in the punch-pad to receive the punch is now drilled and reamed through the hole *A* in the gage, which serves as a guide for this purpose. The writer has found this to be the most rapid and accurate method for performing this operation which has ever come to his attention.

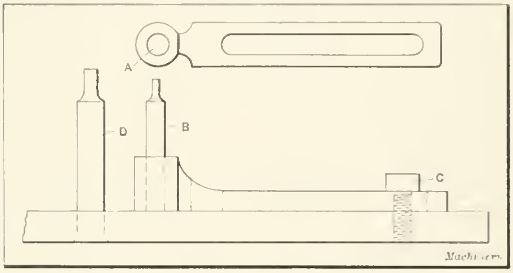


Fig. 2. Transfer Gage for locating Holes in a Punch-pad

Detroit, Mich. A. TIMMS

TOOL FOR FORMING HARD RUBBER

We unconsciously adhere to precedent or move in a rut, so to speak, and it often happens that a mistake or an accident rather than sound reasoning proves the means of throwing light on a perplexing subject. After the accident, with its accompanying enlightenment, we find that we have the means at hand for satisfactorily producing the quantity or quality for which we have been striving. But it makes us feel rather foolish to find that the solution was reached by a path directly opposite to the one we were following.

Of several instances that have come to my notice, I recall one in particular. I was employed as a toolmaker and it fell to my lot to make a circular forming tool for forming pieces from hard rubber rod. We used carbon steel almost exclusively in those days and as the forming tools would not "stand up" to cut many rubber pieces, the boss obtained a sample of special steel that would harden at a low temperature and in oil. He said, "When you come to harden that tool, heat it to a bright red and dip it in water; that ought to make it hard enough." I chucked the disk of steel he gave me, and when facing it off, I noticed that it did not "feel right" when the lathe tool was cutting. I went to the boss and told him that I did not like the way that new steel cut, as the chip rolled off as smooth as machine steel and it did not feel gritty enough for tool steel. He replied that it was a well annealed and especially fine grained tool steel. I completed the tool and decided that if that steel would harden at a dull red in oil, it would be very likely to fly into a thousand pieces if heated to a bright red and dipped in water; and concluded that the "old man" had better do the hardening himself. A wire was placed through the hole and just as the boss removed the tool from the bath, the foreman of the screw machine department happened to pass. The boss told him to take the new tool and see how it would "stand up" in one of the machines. After flashing the tool over the fire once or twice to remove strains, he handed it over to the foreman who tried out the tool.

Several hours later I visited the screw machine department and asked the foreman how the new tool was "standing up." "Fine," he answered, "we made over 300 pieces before we had to sharpen it." I strolled over to the machine to watch it work and noticed that the face of the tool had several small dents in it where the machine setter had probably tapped it with a wrench while setting the cutting edge on center. That piece of special steel was cut from the wrong bar and the forming tool that was giving such good results was made of machinery steel. We concluded that the reason why the soft steel tool stood up longer than a very hard tool was due to its ability to become charged with the gritty substance in the rubber that is so disastrous to the keen edge of a hardened tool. Had we not made this mistake, probably our next move would have been to use high-speed steel.

It rather upsets precedent to state that, for this class of work, cast brass will stand up longer than very hard steel. Several times in later years, when making tools for working compound, fiber or hard rubber, I have used machine steel, and after grinding them to a keen cutting edge, I have rolled fine emery into the face of the tools. Diamond dust is better. With the face of the tool charged with a substance harder than the grit in the work, it prevents the hard rubber acting as a very fine emery wheel and grinding away the edge.

Pittsfield, Mass. F. E. Shailor

SCREW SLOTTING FIXTURE

The illustrations show a fixture used for cutting the slot in cheese-head screws when large quantities are needed. Referring to Fig. 1 it will be seen that this fixture consists of a stand *A* which carries the circular disk *B* mounted on shaft *C*. This disk is equipped with four holders E_1, E_2, E_3 and E_4 which carry the screws that are to be slotted. When it is desired to use this fixture, the workman places a handle on the square end *F* of shaft *C*; he then places a screw to be slotted in the holder E_1 and turns the handle. This turns the disk and the screw reaches position E_2, where it is pressed down between the taper wedges of the holder by the adjustable dog *G* on the top part of the stand *A*. The saw *H* is set to cut a slot of the required depth as the screw passes over it at E_3; the workman keeps on turning the handle and the disk moves on until it reaches position E_4, where the edge of the screw head shown at *J* is gripped by the adjustable plate *K* and withdrawn from its holder. The illustration shows a screw just leaving the holder, from which it falls onto the inclined surface *L* and slides down into a tray. When a number of screws are wanted, the workman keeps on turning the handle with his right hand and places a screw in each holder as it comes around; the cutting of the slots in the screws is almost continuous, one slot being cut for every quarter of a revolution of the disk.

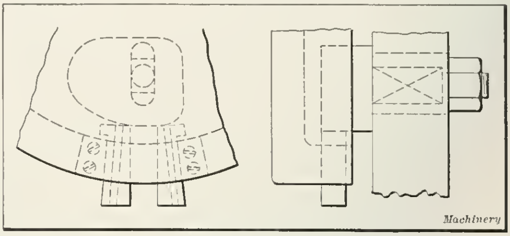


Fig. 4. Special Clamping Mechanism which ejects through Engagement of the Wedges with a Dog

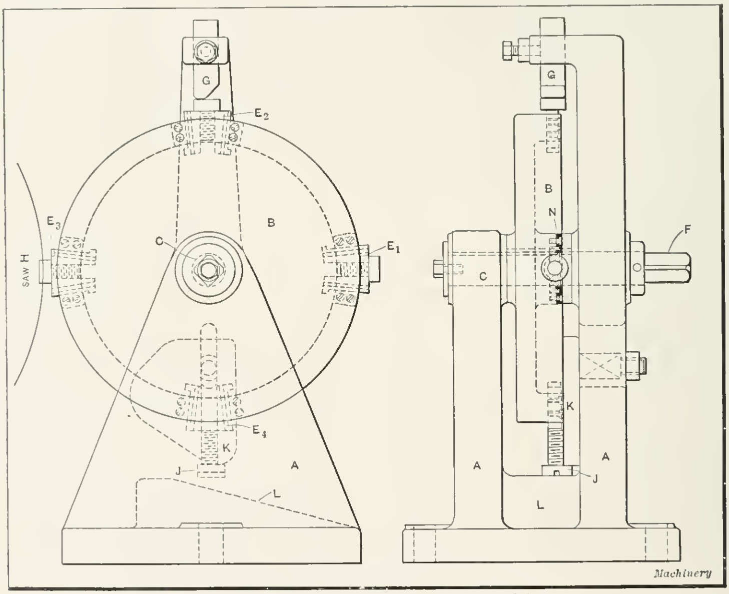


Fig. 1. Attachment for sawing Slots in Cheese-head Screws

Fig. 2 shows an enlarged view of one of the holders. When the workman presses a screw into the holder, the head *S* pushes the two wedges *M* down the tapered hole cut in the disk, forcing them together to secure a grip on the screw that is to be slotted. The plates *N* act as guides and supports for these gripping members, and the projections *O* on the ends of wedges *M* prevent them from coming out when the screw is forced from the holder after the slot has been cut. This tapered holder is adapted for different sizes of screws by moving the wedges in or out. When the screw is withdrawn, the wedges are opened up a little and this makes it easier for the workman to insert an unslotted screw in its place. If just placed in the holder, the screw will be forced in when it reaches the dog *G*. Screws can be slotted very rapidly by this method, as the pause which occurs when cutting the slot gives the workman time to insert another screw in the holder at E_1.

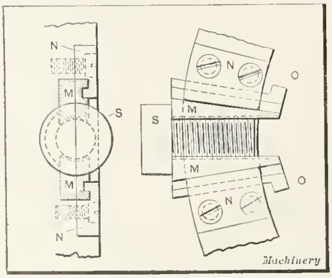


Fig. 2. Enlarged View of Jaws of the Clamping Mechanism shown in Fig. 1

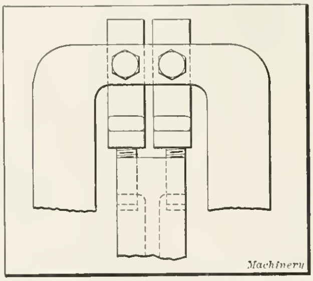


Fig. 3. Multiple Fixture arranged for using Two Saws

Fig. 4 shows another arrangement for withdrawing the screw. Instead of the plate forcing the screw itself out, the jaws of the holder are forced back along the tapered hole, thus opening them and allowing the screw to drop out. This method is especially suitable for use with headless screws. The first method is, perhaps, the best, as having the screw itself pulled out does away with any chance of its sticking. If required, more than four holders could be arranged around the disk, but it is doubtful whether this would be worth while, for it would only mean a shorter movement to bring the next screw to the saw and this can be done very quickly with four holders.

Fig. 3 shows a double fixture that can be used when two saws are available to cut the slots; these saws are placed side by side, the distance between them being the same as between the two sets of holders. There would, of course, be two sets of stops and withdrawing attachments used with such a fixture, and this idea might also be carried still further by having several rows of screws going at once. By this means, different diameters and different lengths of screws could be slotted at the same time. The holders could, if necessary, be set at unequal distances around the disk, so that the different operations of cutting the slot, withdrawing, or putting the screw in place, would be done at different times, thus requiring the workmen to apply less force to turn the handle.

Manchester, England W. R. Oakes

A SIMPLE TOOLPOST GRINDER

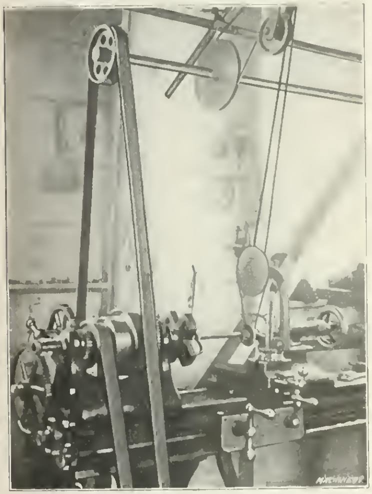


Fig. 1. A Simple Form of Toolpost Grinder

The design for a toolpost grinder presented in this article is not advanced as an example of the highest class of tool making, but simply as a useful grinding attachment for the lathe. It was made to meet the requirements of a special class of work and gave entirely satisfactory results. The construction is extremely simple and will be readily understood by referring to the accompanying illustrations.

The wheel is carried on a stud, as shown, mounted in the shank that fits in the toolpost, and is driven by a small pulley belted to the speed pulleys which provide for a surface speed of 5000 feet per minute on a 2-inch wheel. The stud on which the wheel runs is made of $\frac{1}{4}$-inch drill rod and the sleeve which carries the wheel is of gun-metal. These two parts were ground together after the stud was hardened, in the same way that the plug and barrel of a water tap are ground, oilstone powder being used as an abrasive. It will be seen that a small steel wedge holds the stud in position in the shank, and adjustment is made by tapping the stud backward or forward and then clamping it in the required position. The speed pulleys are made of wood bushed with gun-metal.

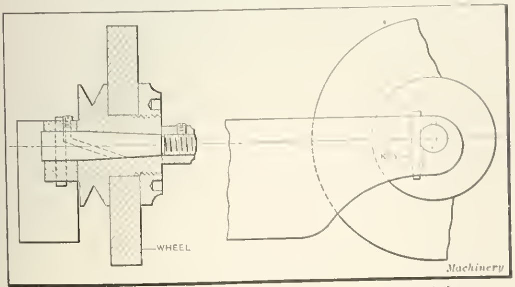
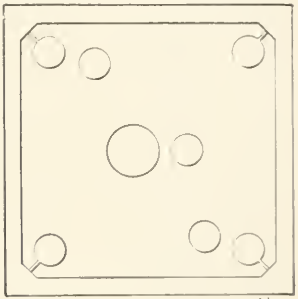


Fig. 2. Design of the Wheel Support for the Toolpost Grinder

Christchurch, New Zealand. John Peddie

METHOD OF PREVENTING DIES FROM CRACKING THROUGH SCREW-HOLES

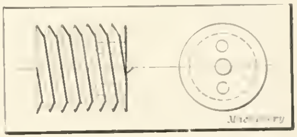
The writer has found that many dies are lost by cracking through screw or dowel pin holes. This is particularly true if these holes are located at the corners of square or rectangular die-blocks. The following gives a simple method of eliminating this difficulty which has given very satisfactory results. The corners of the die-block are cut away in a shaper or milling machine, as shown in the accompanying illustration. After this operation has been performed, a slot is cut into the screw hole with a very fine saw. This gives the block a little play, and relieves the strains set up in the metal in hardening, thus preventing the die from cracking.


Method of preventing Dies from cracking at Screw or Pin Holes

New York City Thomas Williams

CENTERING PLUG FOR LAYING OUT DRILLED HOLES

The following is a simple and effective method of laying out holes in bronze wearing-plates for locomotive driving wheels where the holes have not been uniformly spaced. It was formerly the practice to use the old plate for locating the holes when it was necessary to replace the wearing-plate in a wheel. This method was unsatisfactory because the holes in the old plate were more or less worn, so that inaccuracy in the location of the holes resulted. These bronze wearing-plates are located on the inside face of the wheel-hub, the hub being counterbored to a depth of $\frac{3}{8}$ inch to receive the wearing-plate, and eight $\frac{7}{8}$-inch holes are drilled and tapped in the hub to a depth of $1\frac{1}{2}$ inch to secure the wearing-plate in place.



Plug for laying out Holes in Bronzo Wearing-plates

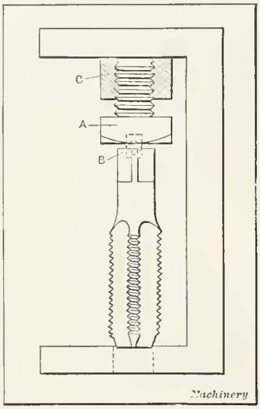
To provide for doing this work rapidly and accurately, the writer devised the following method of procedure: Eight plugs of the design shown in the accompanying illustration, $\frac{7}{8}$ inch in diameter by $\frac{7}{8}$ inch long were turned, threaded and drilled with two $\frac{1}{8}$-inch holes $\frac{3}{8}$ inch deep. These holes are for the purpose of enabling the plugs to be screwed in with a spanner. The plugs are screwed into the wheel hub so that they are flush with the surface, leaving the small points projecting. A manilla paper washer is next cut to the size of the counterbored hole and slit on one side to enable it to be slipped over the axle. This paper washer is then inserted in the counterbore and a light pressure of the thumb on the plugs causes the projecting points to pierce the paper. In this way, a templet is produced which accurately locates the centers for drilling the holes in a new wearing-plate. Seven-eighth inch screws are used for attaching all sizes of wearing-plates to the driving wheels so that the same set of plugs can be used for laying out the plates for different sized wheels. This method affords a rapid and accurate means of doing this work, and after drilling and countersinking the wearing-plates, they can be fastened to the wheels without any trouble.

Catasauqua, Pa. Edwin Chapman

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

STEEL BALL FOR HOLDING TAPS AND REAMERS

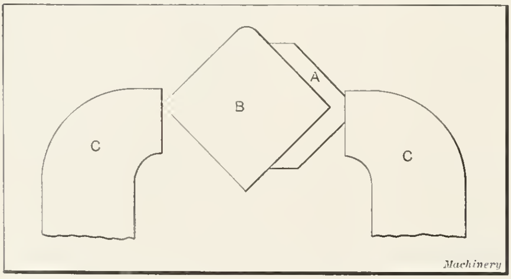


The accompanying illustration shows a convenient method of holding taps, reamers, etc., in close quarters. Referring to the illustration, it will be seen that a hole is drilled in the end of the tap shank and a corresponding hole drilled in the head of the bolt *A*. The depth of the holes is a little less than half the diameter of the ball *B*. In tapping a hole with this apparatus, the bolt is screwed all the way into the block *C*. The tap is next placed in position and the ball *B* placed in the hole in the end of its shank. The bolt *A* is then screwed out, so that it comes into contact with the ball *B*. It will be seen that under these conditions the ball prevents the tap from dropping out of place. The tap can then be driven in the usual way, the bolt *A* being unscrewed at about the same rate that the tap is screwed into the work.

Corbin, Ky. J. A. Jesson

HOLDING SQUARE PIECES CORNER-WISE IN A VISE

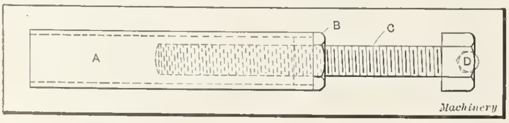
When it is required to hold square pieces corner-wise in a vise in order to round off the corners, or for any similar operation, the attachment *A* shown in the accompanying illustration will be found convenient. This attachment is made from a piece of ½ by 1 inch flat bar, machined to the shape shown in the illustration. It will be seen that the work *B* fits into the angle in the attachment while a sufficient flat is provided on the opposite side to give the vise jaw *C* a good bearing surface.



Dubuque, Iowa. E. J. Buchet

SPREADER FOR SHOES AND WEDGES

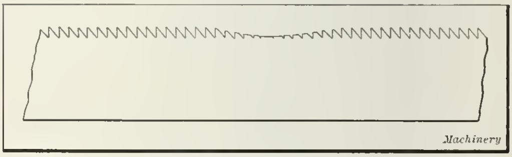
The illustration presented in connection with this article shows a convenient form of spreader for use in holding the shoes and wedges of locomotive driving boxes in position while adjusting their alignment. It is constructed of a piece of 1¼-inch wrought iron pipe *A* which has part of a ⅞-inch hexagonal nut *B* forced into it. The top part of this nut is left in its original shape so that it forms a shoulder, which prevents the nut from slipping into the pipe when the pressure is applied. The screw *C* is an ordinary machine bolt ⅞ inch by 8 inches in size, in which a steel ball *D* ½ inch in diameter has been inserted. The edges of the head of the bolt are peened over around the ball to prevent it from dropping out. This ball constitutes the bearing point for one end of the spreader and prevents the bolt head from coming in contact with the shoe while it is being turned in tightening up the shoe and wedge.



Olean, N. Y. Leroy Smith

TO INCREASE THE LIFE OF A HACKSAW

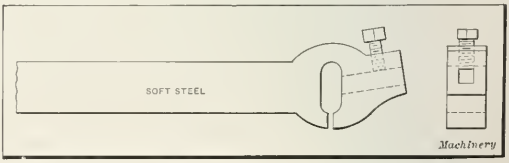
Many mechanics have doubtless noticed that when one tooth of a hacksaw blade is broken out, the teeth next to it will soon break, and that the blade will not last long after one tooth has failed. This condition is particularly noticeable when sawing rather thin sheet metal or starting on the corner of a heavier piece of work; the latter cause of breaking blades might easily be avoided by setting the work up so that the saw will not start to work on the corner. When one or two teeth on a saw blade are broken, the writer has found it to be a good plan to grind down the adjacent teeth on each side of the gap, graduating them in the manner shown in the illustration. This does away with the sudden jerk which occurs when the gap caused by a broken tooth allows the saw to drop down over a sharp corner or the edge of a thin piece of work; hence, the tendency to "dig in" or "bite" is eliminated, together with the tendency for the uneven action to break the blade.



Meriden, Conn. James Gallimore

LATHE SPRING TOOL

The accompanying illustration shows an improved form of lathe spring tool intended to take the place of the type of goose-neck spring tools which are in common use. The advantage of the present design lies in the fact that it is adapted for holding cutters of ordinary square tool steel, instead of requiring the entire tool to be made of high-priced stock. This tool gives excellent results in cutting worms in a lathe and can also be used in a variety of other classes of service. Little explanation is necessary to make the advantages of this tool evident to any mechanic, and dimensions have been omitted because it will, of course, be necessary to make the tool of a suitable size for the class of work on which it is to be used.



Denver, Colo. Stanley Edwards

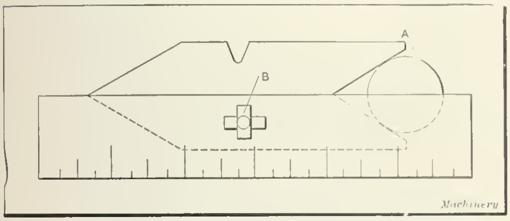
MAKING MALE AND FEMALE TEMPLETS

The writer has noticed toolmakers and diemakers holding small male and female templets up to the light in fitting them together. Where this method is used, it is difficult to hold the faces of the two templets exactly square, and unless this is done errors are likely to be introduced. An easy method of avoiding this difficulty is to place the two templets against a piece of glass. In this way, they are held square with each other and can be fitted together by the method previously referred to.

Newark, N. J. Eugene Leach

CENTER GAGE AND INCH SCALE USED AS CENTER SQUARE

A center gage and a 4-inch scale may be combined for use as a center square. This is done by placing the scale on the center gage so that one edge of the scale coincides with the center line of the center gage and projects beyond the end *A*, as shown in the illustration. The use of this combination as a center square may be briefly described as follows: To center the end of a piece of round stock, place the end of the stock in the end *A* of the center gage under the scale, and draw a line across the stock, using the edge of the scale as a straightedge. Then turn the stock through one-fourth revolution and draw another line as before. The intersection of these two lines determines the center of the end of the stock.

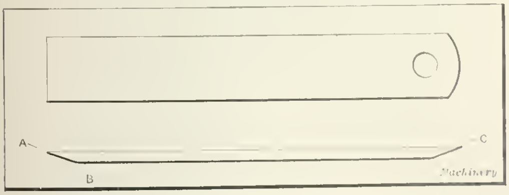


A T-head bolt *B* can be securely fastened to the center gage in a crosswise manner, as shown, and the scale slotted lengthwise to correspond. This enables the mechanic to use the scale and center gage either separately or in combination.

Boston, Mass. Adelbert Peon

ERASING INK MARKS FROM TRACINGS

The tool illustrated herewith is intended for erasing ink marks from tracings. It is made from a piece of a hacksaw blade on which the edge *A* is ground down as shown in the illustration. This is a much more satisfactory tool than a knife for taking the preliminary steps in removing ink marks. The flexibility of the hacksaw blade enables it to be bent down so that it lies almost flat on the paper, and in this way the ink can be removed without cutting the cloth. The sharp corners of the blade can also be used for removing dots, fine lines, or lines close together. After the bulk of the ink has been removed, an ink eraser is used to remove most of what is still left. The tracing is then cleaned with a pencil eraser, after which it is burnished with the rounded section of the blade shown at *B*. The end *C* may be conveniently used as a tack-puller. This may seem a complicated way of making an erasure, but the writer has found it to be an extremely convenient method and one which gives very satisfactory results.

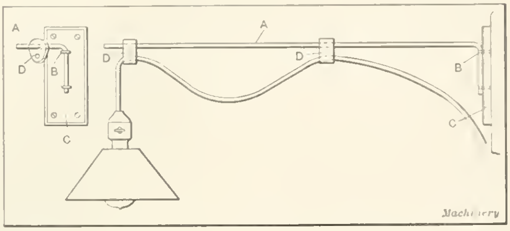


Brazil, Ind. Leroy M. Curry

ELECTRIC LIGHT BRACKET

In some sections of the country the need for artificial lighting in shops and factories is confined to the two or three winter months, and then only for a few hours at each end of the day. Where such is the case it is hardly worth while to install expensive equipment for lighting purposes, when a simple homemade apparatus can be designed to meet all the requirements.

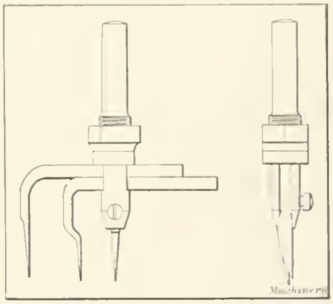
The accompanying illustration shows the equipment used in a plant engaged in the manufacture of a mechanical device, and can be explained as follows: The swinging arm *A* is held to the window casing by the holders *B* attached to the block *C*. The position of the lamp is controlled by the cord passing through the holes in the maple blocks *D*, whereby the height of the lamp is arranged to suit the convenience of the operator. In use, this method has been found economical and efficient. The bracket is quickly adjusted and is giving very satisfactory results.



Hartford, Conn. Charles F. Scribner

CUTTING RUBBER DISKS

It often happens that a shop has more or less call for rubber, fiber or leather disks and washers. The quantity needed is usually small and would be rather expensive to purchase. The illustration shows a handy device for cutting such disks and washers cheaply and, what is quite important, exactly, to any required diameter. This tool is provided with a shank adapted to fit into the ordinary drill-press chuck, and the cutting arms are adjustable to different diameters by the use of the hexagon lock-nut and washer shown in the illustration. The piece of sheet rubber, fiber or leather is laid upon the drill-press table, and the rapidly revolving tool is forced down into the material exactly as in ordinary drilling operations. If the center hole left by the guide-pin is objectionable, or if only a disk is wanted, the pin and inner cutting arm may both be removed, but the piece of material which is being worked on must be held firmly upon the drill-table. In all cases, a piece of soft wood should be put under the material; this will prevent dulling the points of the cutting knives against the iron table. In cutting rubber, a little water should be used as a lubricant. A Connecticut Manufacturer



* * *

In a report made under the direction of the Associated Factory Mutual Fire Insurance Companies, the value of sawdust for extinguishing fires in japanning tanks and similar classes of factory equipment is described. Sawdust would hardly be regarded as a suitable medium for this purpose but experiments conducted by Mr. E. A. Barrier of Boston, have shown that it is more efficient in dealing with small outbreaks of fire in liquid combustibles such as lacquer and oil, than sand—the material which is most generally used. For this purpose it appears to make little difference whether the sawdust is wet or dry, but the mixture of bicarbonate of soda with the sawdust adds materially to its efficiency. This is due to the decomposition of the bicarbonate of soda with the consequent liberation of carbon dioxide. The greater efficiency of sawdust than sand for extinguishing this kind of fire seems to be due to the fact that the sawdust remains on top of the burning material for a greater length of time than sand, owing to its being less dense.

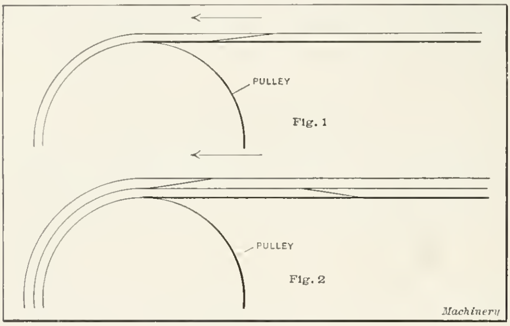
HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

INCLINATION OF BELT LAP-JOINT

H. B.—In what direction should the lap-joint of a belt incline, relative to the direction of the belt's motion? Should the leading end or point of the lap be next to the pulley or on the outside?

A.—There is a difference of opinion among mechanics and belt makers regarding this point. The Chicago Belting Co. recommends the method shown by the accompanying illustrations, which we believe is also advocated by most belt manufacturers. Fig. 1 shows a single-ply belt and, as will be seen, the leading end of the lap is on the pulley side. The lap is inclined in this way to prevent the end from opening. When the leading end is on the outside, it tends to open up slightly, especially if the belt is operated at high speed, owing to the resistance of the air. As soon as there is a very slight opening, the atmospheric resistance tends to increase it, but when the leading end of the lap is next to the pulley, any tendency of the point to rise, is overcome by frequent contact with the pulleys. Fig. 2 shows how the lap joints of a double or two-ply belt should be inclined. In this case, the lap of the outer ply is in the same relation to the direction of motion, as for a single belt, whereas, the lap of the inner ply inclines in the opposite direction. With this arrangement, the leading ends of the laps in both plys, will be inside and protected, and the outer ends are to the rear and not subjected to the atmospheric resistance.



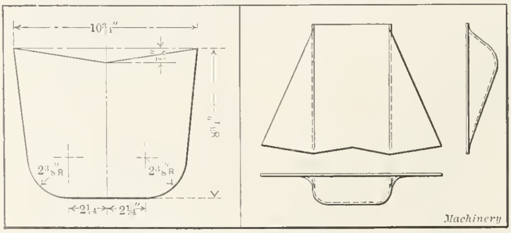
Figs. 1 and 2. Inclination of Lap-joint relative to Direction of Motion for Single and Double Belts

A PROBLEM IN PRESS WORK

Answered by J. Stanitz, Buffalo, N. Y.

The following will answer the question asked by "P. B." in the May issue of MACHINERY in regard to a method of producing dies for drawing a steel shell of the form illustrated.

Fig. 1 shows an approximation of the blank to be used, the exact shape being found by repeated trials. Successive blanks are cut out by hand, being slightly modified until a shape is finally produced that will have the form shown in Fig. 2 after the first drawing operation. The curved notch in the front of the shell is not cut in the blank, but trimmed out after the shell has been completely drawn up. Fig. 3 shows the punch and die used for the first drawing operation, which are made of cast steel. This punch and die are used in a double-action drawing press. If difficulty is experienced through the shell breaking at the deep corner, the blanks should be annealed before drawing. The "hold-down" which keeps the blank in firm contact with the die should be adjusted so that the metal will be able to flow easily; at the same time the blank should be held tight enough to prevent wrinkles forming in the shell. The die is provided with a "kicker" which is operated by the positive knockout of the press. After the first trial has been made with this punch and die, the stamping will show where there is too much or too little metal and the shape of the blank must be modified until it gives satisfactory results.



Figs. 1 and 2. Approximation of the Blank and the Work after the First Drawing Operation

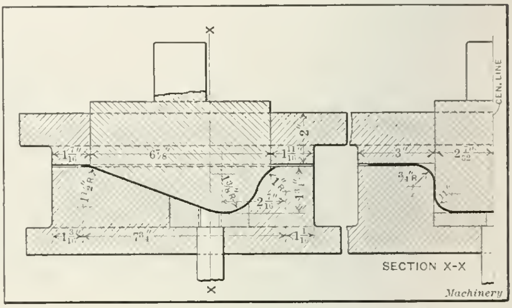


Fig. 3. Punch and Die used for the First Drawing Operation

The punch and die which are used for the three succeeding operations are shown in Fig. 4. Three punches are provided, all of which operate in the same die. The radii *A* on these punches are ½ inch, ¼ inch, and 1/16 inch, respectively. If a very sharp corner is required, another punch for use in a fifth drawing operation will probably be necessary. This punch and die is operated as follows: The shell, as it comes from the first drawing operation, is placed on top of the die; the punch then descends and reduces the radius of the corners from 11/16 inch to ½ inch and bends up the two "ears" which form the sides of the shell. After the corners have been reduced to the proper shape by the successive drawing operations, the curved notch in the front of the shell is trimmed to shape in a punch and die which needs no description to make its construction clear to any mechanic. In order to obtain satisfactory results, it is absolutely necessary to bring the shell to the shape shown in Fig. 2 in the first drawing.

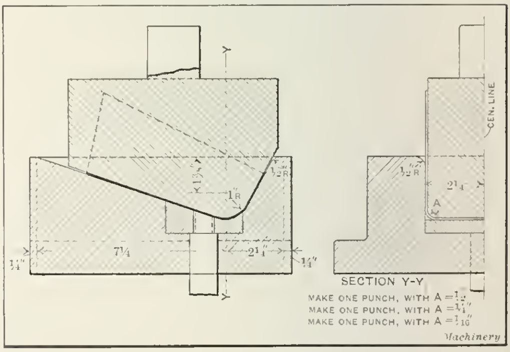

Y
CEN. LINE
½"R
1¾"
1"R
½"R
2¼"
A
¼"
7¼
2¼"
¼"
SECTION Y-Y
MAKE ONE PUNCH, WITH A = ½"
MAKE ONE PUNCH, WITH A = ¼"
MAKE ONE PUNCH, WITH A = 1/16"
Y
Machinery

Fig. 4. Punches and Die used for the Second, Third and Fourth Drawing Operations

* * *

During the International Exhibition at Ghent, Belgium, this summer, the Zeppelin firm will maintain a regular airship passenger service between Düsseldorf, Germany, and the exhibition grounds. The distance is about 130 miles. The service will be maintained throughout the months of August, September and October, and the fare for the flight will be $70.

SECTIONAL PUNCH AND DIE CONSTRUCTION

BY A. L. MONRAD*

The punch and die that are to be described in this article differ considerably from the usual type of sectional punch and die construction. It is always the desire of a tool designer to produce a tool that is accurate and also inexpensive to make and to maintain in operating condition, and very few companies will now take the risk of making solid dies on account of the danger of their cracking during the hardening and tempering process. The die shown in Fig. 1 is made in sections, so that all the cutting edges and the inside of the die can be machined and ground to the required dimensions without requiring any hand work. This construction makes the punch and die inexpensive to produce, and in event of its being damaged during the hardening process or when placed in operation, the damaged parts can be renewed at a relatively small cost. The punch and die are used in manufacturing laminated copper washers for which there is a demand of several thousand a day. These washers are square with a square hole in the center and are produced from sheet copper 0.020 inch in thickness. An inclined power press with automatic roll feed is used, and the finished work slides into a receptacle at the rear of the press.

Fig. 1 shows plan and sectional views of the die, from which it will be seen that there are three piercing and three blanking dies carried on one bolster. The die is made up of fifteen sections which are held together by double dovetail plugs fitting into corresponding holes. When ribbon stock is fed through the die, the holes in three washers are pierced at the first stroke of the ram, and at the next stroke the blanking punch cuts away three washers with the holes in their centers which were produced by the preceding stroke; at the same stroke, the holes are pierced for the next three washers. None of the sections of the die have been drawn in detail as they will be readily understood from the assembly drawing. All of the die sections are machined approximately to the required dimensions with the exception of the inside or cutting edges, which are left a few thousandths over size to permit grinding them after hardening. The face is recessed on the outer edge to within 1/4 inch of the cutting edge and 5/8 inch from the bottom, thus leaving a narrow strip all around the cutting edge in order to reduce the surface to be ground as far as possible. Each section of the die is held securely to the cast-iron bolster *D* with one or two fillister screws, and the sections are then wedged together with double dovetail blocks *C*. The cutting edge of each section is only hardened down about 3/8 inch and is drawn to a light straw color. When all the sections are assembled on the bolster *D*, the double dovetail holes are laid out with a templet and each of the sections is then milled with a dovetail cutter to receive the clamping blocks *C*. The blocks are made of tool steel, in strips 12 inches long; these strips are then sawed up into pieces 5/8 inch in length and the ends are filed to a slight taper so that they will just enter the holes between the die sections. These blocks are hardened in oil and drawn to a blue color. The die sections are next screwed to the bolster and the dovetail wedges are driven in; this method of fastening holds the die as securely as if it were a single piece.

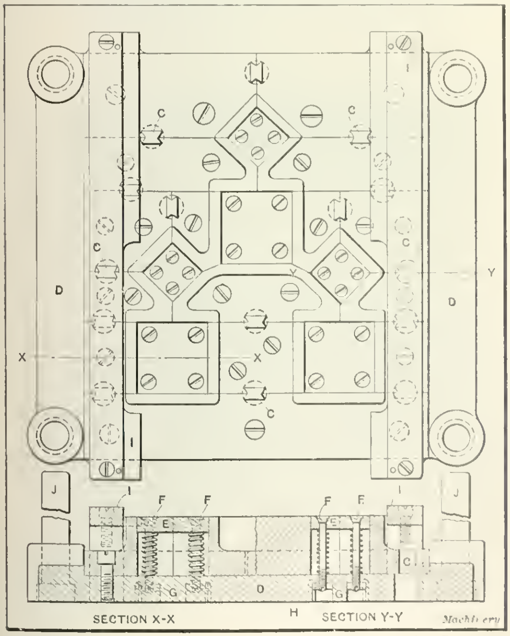


Fig. 1. Plan and Sectional Views of Blanking and Piercing Dies

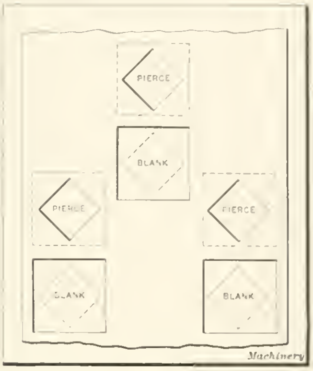


Fig. 2. Diagram showing Piercing and Blanking Operations on Ribbon Stock

Each of the piercing and punching dies is equipped with an ejector plate *E* which is a sliding fit in the holes and held in position with four flat head screws *F*. Spiral springs are placed around these screws to hold the ejector plates in position. The screws *F* extend through the bolster and carry adjusting nuts *G* which fit in counterbored holes on the under side of the bolster. Small holes are drilled in the under side of the bolster before the counterbored holes for the adjusting nuts are bored. These small holes are then plugged up to keep the drill from running out while counterboring the larger holes for the nuts *G*. When the plugs are removed from the small holes, the portion of the hole which was not removed during the counterboring operation serves as a guide in drilling a hole to receive the small pin *H* which is tapped into the nut *G* and keeps it from turning. The ejectors are adjusted by means of the screws *F* so that they are about 1/32 inch above the cutting edge of the dies. A long guide plate *I* is placed at each side of the die and fastened in position with fillister screws and a dowel pin on each end.

The cast-iron bolster plate *D* is planed on the bottom and top and also across the bosses. The four holes in each corner are next drilled, reamed and counterbored to receive the sub-press pins *J*, similar holes being made in the punch holder after the punch and die have been assembled. The sub-press pins *J* are made of tool steel hardened up to the head; the heads are ground to a driving fit in the die bolster and the pins are ground to a sliding fit in the punch holder. To locate the holes for these pins in line with each other, and also to have them square with the punch and die, the following method was used: After the punch and die were hardened and assembled, two parallels were placed between the bolsters. The punch was placed inside the die and the punch and die clamped together with four C-clamps. After the work had been clamped in this way the holes were bored in the punch holder through the holes in the die bolster, and were consequently in perfect alignment.

Fig. 3 shows plan and sectional views of the blanking and piercing punches *A* and *B*, which are made of tool steel and left soft. These punches are secured to the cast-iron holder *C* by means of two fillister screws and two dowel pins. In order to locate the punches in proper alignment with the die, the punches are first marked so that they can be replaced in the same positions. The ejectors are then taken out of the die and blocks made of 3/4-inch cold-rolled steel are placed in the die holes in their places. These parallel blocks are faced off to the proper height to bring them 1/16 inch below the cutting edge, all six of the blocks being of the same height. The punches are next placed in their respective die holes and the punch holder *C* is then slipped over the four sub-press pins in the die bolster and lowered onto the punches. With a right angle scratch-awl, lines are marked on the punch holder to locate the four sides of each punch, the scriber being worked through the screw holes in the die bolster. The punch holder is next withdrawn, and from the outlines of the punches on the holder the four holes for each punch are located, drilled and counterbored to receive the two set-screws and the two dowel pins. When all of these holes are drilled in the holder, the latter is once more replaced on the punches and secured with four C-clamps. Care must be taken not to twist the punches and also to see that the two bolsters are parallel with each other. All of the screw and dowel pin holes are now drilled into the punches to a depth of about 1/32 inch, the holes in the punch holder serving as a guide. The C-clamps are now loosened and the punch holder removed; all of the punches are then taken out of the die and the holes are drilled to the required depth, after which the screw holes are tapped. When this work has been finished, the punches are replaced in their respective positions on top of the blocks in the die. Care must be taken to have all the chips removed and the work perfectly clean. The punches are secured with screws and the two bolsters again strapped together with four C-clamps; straight dowel pin holes are then reamed through the bolster into the punches. In that way all of the punches and sub-press pins are in perfect alignment.

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* Address: Rockfall, Conn.

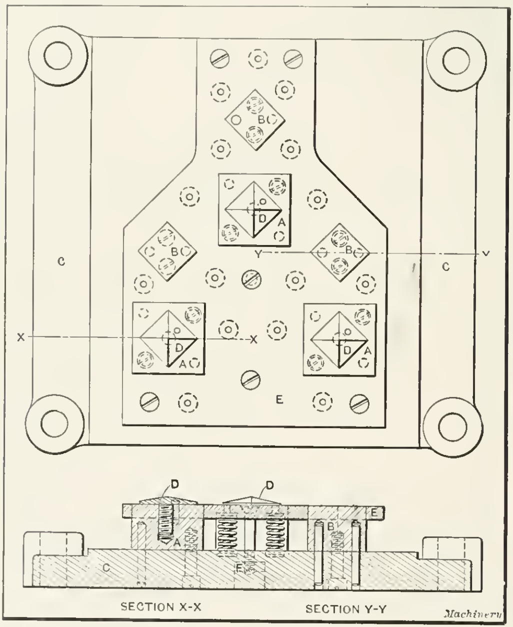

Fig. 3. Plan and Sectional Views of Blanking and Piercing Punches

Pilots *D* are screwed on top of the three blanking punches to guide the metal during the blanking operation. These pilots enter the holes in the washers which were pierced by the preceding stroke of the ram, and prevent the work from twisting. These pilots are held in place by a screw and a dowel pin. A stripper plate *E* made of 5/16-inch cold-rolled steel surrounds the punches and is held in position by the tension of fifteen springs. This stripper plate is made to fit between the guides *I* on the die and is a free fit on the outside of the punches. The stripper plate is adjusted by the flat-headed screws and nuts *F*. It will be noticed that there is a small hole in the center of each spiral spring seat. These holes are made in the following manner: All of the holes in the stripper plate are laid out in the usual way and drilled through with a 1/8-inch drill; the stripper is then placed on the bolster with all of the punches in position and the holes are transferred through onto the bolster. The spring seats can now be counterbored on the stripper and bolster and by this means all of the spring seats will be in perfect alignment with each other.

* * *

BLANKING AND DRAWING A LARGE STEEL CUP IN ONE OPERATION

A good example of deep drawing is shown by the accompanying illustrations, the work being an outside jacket for the Stuart & Clark automobile speedometer. This jacket, which is 3 3/16 inches outside diameter by 2 7/16 inches deep, is made from 0.042 inch deep drawing sheet steel, and is formed from a blank 6¾ inches diameter in one operation in the double-action press shown in Fig. 2. The dies, punch and work are illustrated in Fig. 1, where the construction of these tools is clearly shown. At *A* is shown the blanking die which is held, when in use, to the base of the ram of the press, as indicated in Fig. 2. This consists of an iron casting *a*, to which the cutting die *b* is fastened by screws and dowels.

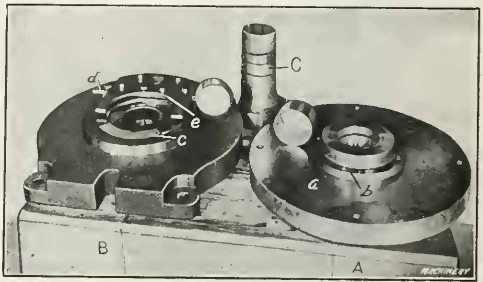

Fig. 1. Tools used in blanking and drawing a Large Steel Cup in One Operation

The combination blanking and drawing die is shown at *B* and consists of the regular cast-iron bolster in which is inserted the cutting die ring *c*, having an irregular top cutting face. The stock is located by the guide *d* and the blank is stripped from the punch by the stripper *e*. The punch used, which is shown at *C*, is held in the double-action part of the press. The drawing die is rounded well on the top, giving a slight mouth taper and is then made straight so that the work is forced completely through it, dropping into the box placed under the press. This job is being handled successfully in the Chicago plant of the Stewart-Warner Corporation.

D. T. H.

Fig. 2. Double-action Punch Press in which the Tools shown in Fig. 1 are used

BROACHING A VACUUM CLEANER PART

BY RALPH R. LAPOINTE[*]

During recent years, a considerable amount of information has been published on broaching machines and their application on different classes of work. The following description of the method of broaching a vacuum cleaner part illustrates the facility with which the Lapointe Machine Tool Co., Hudson, Mass., handles operations of this nature. Fig. 1 shows one of the blanks from which these parts are made, a finished part and the broach which is used for this operation. A better idea of the nature of the work will be gathered from Fig. 2, where a piece is shown in course of development from the rough forging at *X* to the finished part at *Z*.

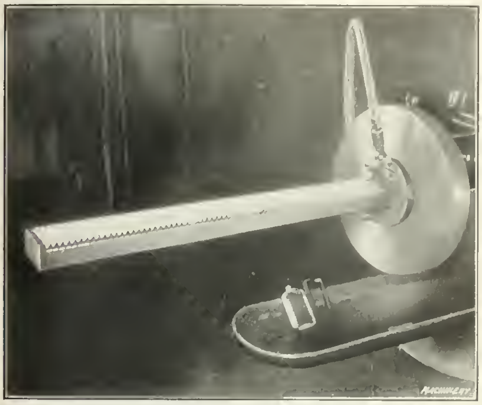

Fig. 1. The Broach and Vacuum Cleaner Part it is used to finish

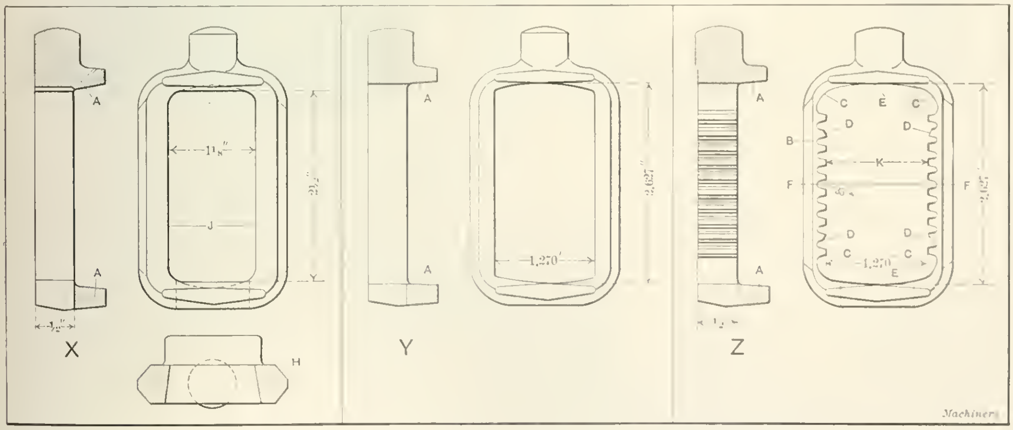

Fig. 2. Diagram showing Vacuum Cleaner Part in course of Production from Rough Forging X to Finished Piece Z

These pieces consist of light drop-forgings that have edges shown at *A* which make them rather difficult to hold. The thinness of the metal at *B* also provides very little abutment to withstand the strain of heavy broaching. Referring to the illustration of the finished piece shown at *Z* in Fig. 2, it should be remembered that not only are the rack teeth cut, but also the clearance at *C*, the angular teeth *D* and the end surface *E*, all of these surfaces being finished at one passage of the broach. In finishing these pieces, it is necessary to have the center line *F-F* concentric with relation to the end surfaces *E* and this feature was easily provided for through finishing the pieces on the broaching machine. If the surfaces *E* had been machined by separate operations on any other machine than a broaching machine, there would be a possibility for the introduction of an error at this point.

It will be seen that the pieces are approximately 1/2 inch thick and that they have a draft *H* on the inside of the forging. The amount of material removed at the dimension *J* was 0.198 inch on each side. The broaching operation would have been easier to handle if this draft had not been necessary. Attention is also called to the fact that the rack teeth were machined with a degree of accuracy which held the dimension *K* within a limit of 0.002 inch, which is exceptionally close when the lightness of the work is considered. After the first two thousand pieces had been broached, the first and last pieces of the series were checked in order to determine if any wear had developed in broaching. There was not any error between the dimensions of these two pieces which could be measured. It is stated that in broaching this first series of 2000 pieces, a saving of 80 per cent was made over the time that would have been required to manufacture them by any other method; this saving is net, the cost of the broaches being included in the cost of production.

The broach is made so that the rough forging shown at *X* is first machined to the outline shown at *Y* in Fig. 2. After this section was obtained, the clearance at each end, the teeth and the angular cut on the teeth *D* were machined. The gear tooth section was given very little clearance, so that the broach could be sharpened at the front of the teeth. This greatly increased its life. This broach would machine at least 6000 pieces at a rate of production of about 30 pieces per hour.

* * *

In a report from Consul Douglas Jenkins, the results of the use of ball bearings on railway cars in Sweden, are referred to. About two years ago, one of the smaller private railroads in Sweden began testing ball bearings in railway traffic, one passenger car being fitted with them for experimental purposes. This car has since been used in regular traffic and the management of the road finds that the ball bearings have given entire satisfaction. It is estimated that the operating cost is reduced at least seven per cent by the use of ball bearings, and there is also a considerable saving in lubricants and cost for attention to the bearings. This railway company has sent in a further order for ball bearing equipment, and another railway company has also decided to adopt ball bearings on passenger equipment. The Swedish State railroads recently applied ball bearings to a coach running in the express train traffic between Stockholm and Gothenburg. The first experiment having proved satisfactory, the State railways have given orders for more ball bearing equipment for railroad cars and intend to make a thorough and systematic test.

* * *

The New York Central and Hudson River Railroad Co. has recently placed an order with the General Electric Co., Schenectady, N. Y., for nine electric locomotives. The weight of these locomotives is to be 100 tons each and they will exert sufficient tractive effort to haul a train weighing over 1000 tons at a speed of 60 miles an hour. In regular service they will have a capacity for developing 1400 horsepower continuously or as high as 500 horsepower for short periods.

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[*] Address: Lapointe Machine Tool Co., Hudson, Mass.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE LODGE & SHIPLEY "SELECTIVE HEAD" LATHE

To combine strength, simplicity and durability, the selective type of automobile transmission has been adopted by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, for the gear box drive of its new "selective head" lathe. This permits any one of the spindle speeds to be selected instantly—hence the name "selective head." A constant-speed single driving pulley running at a high belt velocity delivers ample power to the cutting tool under all conditions. As the diameter of the work increases, the gear ratios and the torque are proportionately increased. Thus lathe work requiring a maximum amount of power can be handled most advantageously by this machine. Power is transmitted through hardened steel gears mounted on shafts running in ball bearings. As the result of this and other refinements the selective head attains an exceptionally high mechanical efficiency.

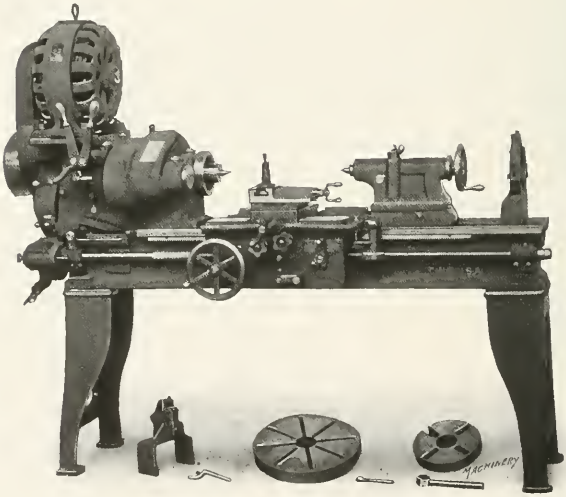


Fig. 1. Lodge & Shipley 14-inch Selective Head Lathe

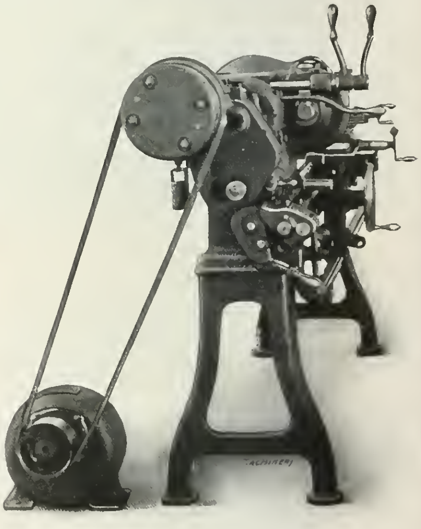


Fig. 2. 16-inch Selective Head Lathe with "Simplicity" Motor Drive

The headstock is made of box section, with the sides extended up to the center line of the spindle, which makes an unusually rigid casting. Further stiffness is added by internal bracing with both longitudinal and cross ribs. The back of the headstock is planed to receive the gear box which is made as a separate unit. There are six speed changes in the gear box. From the gear box the drive is either direct to the spindle or through shifting back gears in the headstock proper, giving twelve spindle speeds in all back geared lathes from 14- to 27-inch. The 30- and 36-inch lathes can be provided with triple gearing and this gives eighteen speeds. These two sizes are also built without triple gearing, and they then have twelve changes of spindle speed. In the triple geared lathe there are six speed changes by direct drive from the gear box, another six changes through the back gears, and the third set of the six slowest speeds is obtained through the triple gearing driving into the internal gear of the faceplate. On the 42- and 48- inch machines the triple gearing is always supplied in order to provide speeds sufficiently low to accommodate large diameters.

An extended flanged hub attached to the gear box carries the driving pulley and thus relieves the driving shaft of all belt pull. Inside the pulley are two frictions, one of which drives the initial shaft direct, while the other drives it at a back geared speed. The friction is at the initial point only, to insure a powerful drive, and the friction will easily slip the belt. The ratio of the direct speed to the back geared speed is about 2.6 to 1. This is approximately the ratio between the finishing and roughing speeds on a given diameter of work; therefore, in order to increase the speed from a roughing to a finishing cut, the gear shift does not have to be made, it being only necessary to shift the friction lever from one side to the other. The friction pulley is entirely enclosed at its outer end to retain the oil. A combination oil and belt guard is provided at the inner edge to prevent throwing oil on the belt.

All gears within the gear box are of the stub-tooth 20-degree pressure angle type. They are made from chrome-nickel steel, heat-treated and hardened. After hardening, the bores of the gears are ground concentric with the pitch circles, and the gears are finally mounted on an arbor in a special machine where the teeth are lapped, so that any distortion produced in the hardening is removed. This insures perfectly true gears, easy rolling action and noiseless operation. All of the transmission gears in the gear box are made from chrome-nickel steel, heat-treated and hardened. This gives a tensile strength of about 260,000 pounds per square inch, an elastic limit of about 240,000 pounds per square inch and a scleroscope test of "seventy degree" hardness. This produces a gear of fibrous structure and exceptional strength and resiliency. It not only results in practically indestructible gearing, but also reduces the frictional loss in transmission because of the great hardness of the gear teeth and the excellent wearing surfaces which they present to each other.

The entire speed changing mechanism, except the back gears of the headstock, is contained in the gear box which is an independent unit tongued and bolted to the back of the headstock. It may be removed at any time without affecting the other parts of the head, or without removing the motor, if a motor drive is used. The gear box is oil-tight and dust-proof, and the gears run at all times partly submerged in oil. The initial shaft of the gear box, which has either direct or back geared speed, transmits power to the driven shaft through sliding gears. The initial shaft in the gear box which receives the sliding gears has four keys formed upon it. There are no screws or cotter pins inside the gear box, nor any other small parts which might work loose and get into the running gears. Both shafts in the gear box in all sizes of lathes are mounted in anti-friction ball bearings. Threaded dust plates retain the ball bearings in their respective seats and exclude dirt or grit from both the ball bearings and the gear box. No shaft runs at a higher rate of speed, even in the small lathes, than 375 R. P. M. This comparatively low rate of speed and the anti-friction properties of the ball bearings help maintain an exceptionally high efficiency of transmission.

The six speeds provided by the gear box are obtained through two vertical levers, conveniently located on the front of the headstock. The lever nearest the operator controls the two frictions in the driving pulley and stops, starts and gives fast and slow speeds by moving the lever to the right or left. The other vertical lever shifts the gears and must be moved to the right or left and also in or out to select the required gear. The horizontal lever operates both a positive stepped clutch on the spindle and the sliding back gear pinion which is interlocked with the clutch so that both cannot be engaged at the same time. A plate on the front of the headstock gives a complete list of all speeds and the position of levers for obtaining them.

The back gearing is located at the front of the headstock. The back gear shaft and pinion in lathes from 14- to 36-inch sizes are cut from a single steel forging. The teeth of the pinion are hardened and the shaft is journaled in continuously lubricated bronze bushings. The triple gear is operated by a handwheel which slides the triple gear pinion into or out of mesh with the internal face gear. All headstock driving gears are of steel, and as previously explained, gears subjected to the most wear are of chrome-nickel steel heat-treated and hardened. On all lathes, the gearing is designed to give a practically uniform speed progression throughout the entire speed range.

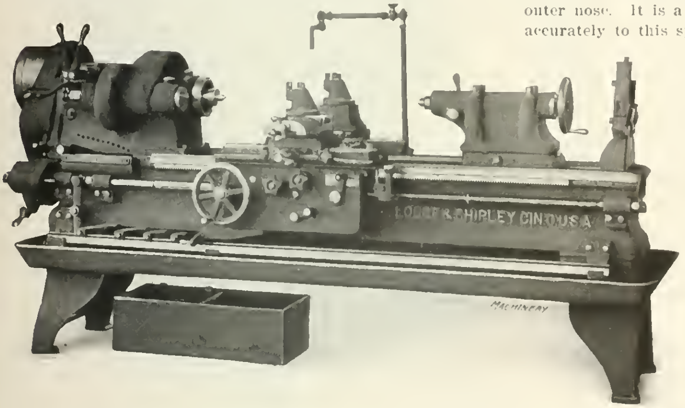


Fig. 3. Belt-driven 18-inch Lodge & Shipley Selective Head Lathe

The spindle is of large diameter and made from chrome-nickel steel. The end thrust is taken against the rear housing by alternate bronze and hardened steel thrust washers, and the spindle bearings are of special composition white metal, renewable, interchangeable, and continuously lubricated by wick oilers from large oil wells. These white metal bearings are faced and turned in halves to exact gage size; the headstock casting is reamed to the same size, and the screw holes are drilled in a jig. The spindle has a double nose, consisting of an inner cylindrical portion and an outer cup. The cup is threaded internally to hold the chuck plate in position and the end is faced to provide a very large diameter shoulder against which the faceplate is tightened. The inner cylindrical portion of the nose is left blank and extends beyond the outer nose to form a pilot to receive the faceplate or chuck plate. This pilot at all times accurately centers the chuck plate, and by centering the bore of the chuck plate before the threaded portion is reached insures having the threads engage easily and the chuck plate drawn squarely against the face of the outer nose. It is a comparatively easy matter to fit a chuck accurately to this spindle, as the bore may be reamed to the standard size to fit the pilot and the thread is only used to hold the plate in position against the face of the cup. The threading of the chuck plate is easily done, as it is a job of external chasing. The large diameter of the shoulder afforded by the cup prevents the faceplate from becoming stuck to the spindle nose and makes it always an easy matter to remove the faceplate or chuck. Spindle noses of selective head lathes from 14- to 20-inch are made to the same standard, so that chucks will interchange from one lathe to another between these sizes. Similarly, another standard is used for all lathes from 22- to 36-inch. As the larger lathes are triple geared, there are but the two sizes of spindle noses for the entire range of lathes.

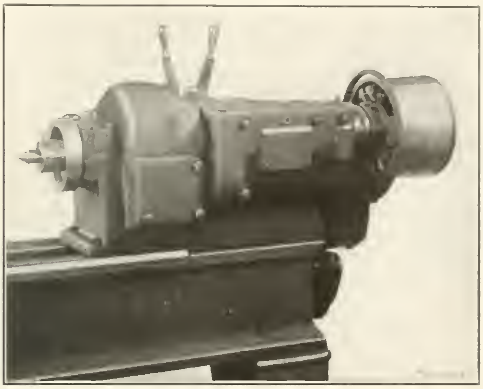


Fig. 5. Rear View of Lodge & Shipley Selective Head Lathe

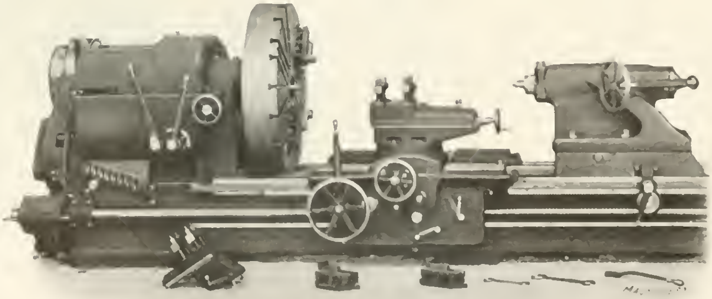


Fig. 4. Lodge & Shipley 48-inch Selective Head Lathe

No countershaft is necessary with this lathe if the machine can be placed near the lineshaft, and the drive may be secured from either a straight or quarter turn belt. If a countershaft is required, either a single speed plain tight and loose pulley countershaft or a double friction countershaft may be used. Any standard make of motor, either direct or alternating current, constant or variable speed, within reasonable limits of size and speed can be mounted on the top of the headstock and direct connected through gearing. A gear which contains the same friction mechanism as the pulley is substituted for the pulley at the end of the gear box, and a suitable casting is mounted at the end of the headstock cover and carries an intermediate fiber gear running in positively lubricated journals. This casting serves as a gear guard and cover for all of the motor drive gears. A pinion on the armature shaft meshes with the intermediate fiber gear, thus giving a direct drive to the gear box of the headstock. At any time, a regular belt-driven selective head lathe may be driven from an individual motor placed on the ceiling or on the floor and connected to the headstock pulley by a belt. This constitutes the "simplicity" motor drive illustrated in Fig. 2. A constant-speed motor is generally used for this style of drive.

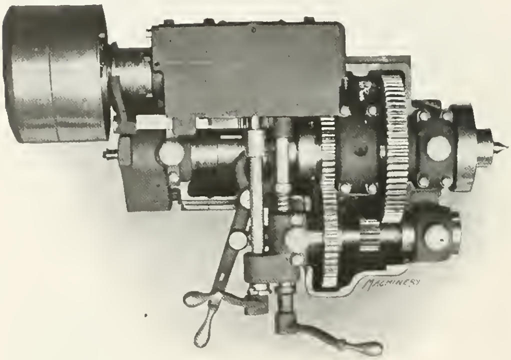


Fig. 6. Interior of the Lodge & Shipley Selective Head

The bed is made from close grain iron of high tensile strength, and the top is cast against a chill which makes the top of the bed hard and dense, greatly lengthens the period of accurate alignment, and so closes the pores that dirt and grit cannot become imbedded in the ways to wear the carriage by a lapping action. The tailstock has floating binders to insure correct alignment of the tailstock spindle, an exceptionally long spindle of tool steel, and the barrel extended beyond the face of the tailstock to afford a firm support to the spindle at all times. The clamping bolts for holding the tailstock to the bed are operated from the top of the barrel. In 22-inch lathes and larger, a pawl on the base of the tailstock engages the rack in the center rib of the bed to afford a positive brace.

The quick change gears for feeds and threads are of drop-forged steel, located beneath the headstock and firmly supported in the walls of the bed. Changes of feed or thread can be quickly made while the lathe is under cut. The carriage is gibbed inside and out; it has an oil trough around the front and rear wings and the extra wide bridge takes a supplementary scraped bearing against the inside horizontal and vertical flat surfaces of the bed, thus providing a positive support directly in line with the tool thrust. The compound rest has a special square base so designed that the top slide cannot be overhung, which provides a solid metal-to-metal anvil support under the tool to prevent any vibration. The apron is self-contained and double walled, with studs supported front and rear. All gearing except the frictions is of steel, and a stub tooth rack pinion insures adequate strength. Manufacturing equipment consisting of multiple stops for length and cross feeds, connected compound and plain rests, pan pump and tubing and a four-way tool block can be furnished with any of these lathes. These are valuable additional appliances for turning repetition work.

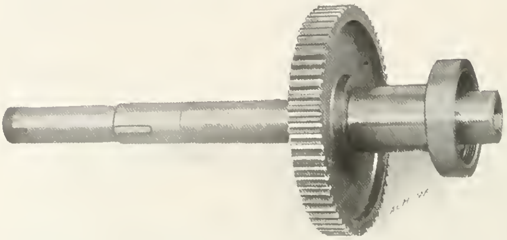
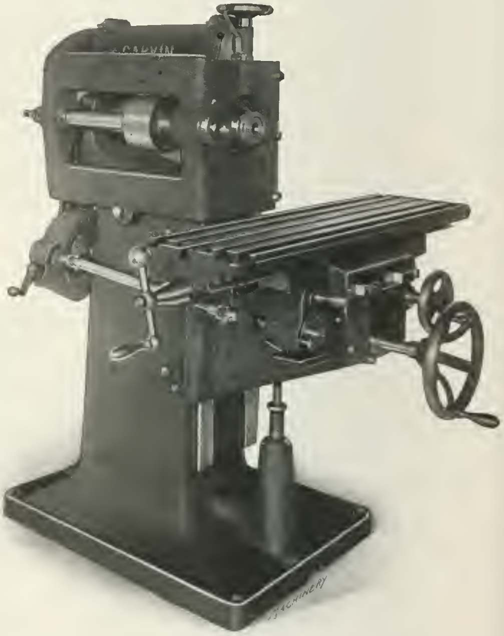


Fig. 7. Spindle and Face Gear of Lodge & Shipley Selective Head Lathe

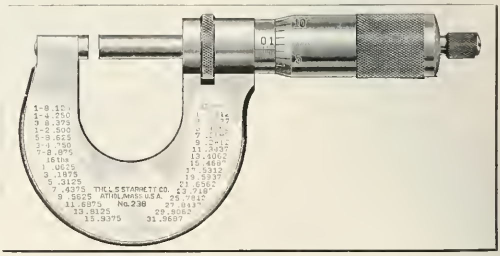
GARVIN MILLING MACHINE WITH ROUGHING SPINDLE

The illustration shows the No. 13 size of plain milling machine manufactured by the Garvin Machine Co., Spring and Varick Sts., New York City, equipped with an auxiliary spindle for taking a roughing cut. This roughing spindle works ahead of the regular spindle and its use has been found a valuable time saver, as both the roughing and finishing cuts are taken without requiring more than one setting of the work. The roughing spindle has a 1-inch vertical adjustment and is driven from a separate countershaft. The automatic table feed is 24 inches, the in and out adjustment 7 inches, the vertical adjustment 19 inches and the weight of the machine 1900 pounds.


Garvin No. 13 Plain Milling Machine with Roughing Spindle

HEAVY STARRETT MICROMETER

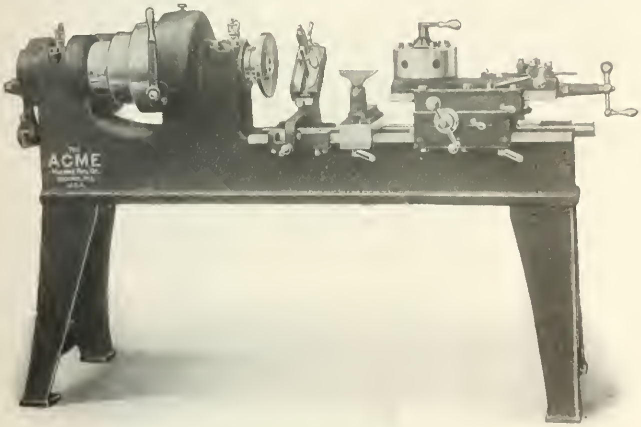
A micrometer which has been specially designed to stand hard use and even abuse, is just being put on the market by the L. S. Starrett Co., Athol, Mass. This micrometer does not embody any new mechanical features but is simply made



Starrett Micrometer adapted for Hard Usage much heavier than other micrometers, the idea being to furnish an instrument which machinists may use for general purposes. The large bearing surface for the screw threads and the heavy construction of the frame give a micrometer which will outlast anything which is now made. It is provided with a Starrett ratchet stop and lock-nut and has hardened contacts to minimize the wear. Decimal equivalents are stamped on the front.

ACME 16- AND 18-INCH UNIVERSAL TURRET LATHE

The illustration shows a universal turret lathe which has been brought out by the Acme Machine Tool Co., Cincinnati, Ohio. This machine is made in 16- and 18-inch sizes and equipped with a geared friction head, chasing attachment and hand rest. All bearings in the machine are accurately ground and hand scraped and all operating levers are placed within easy reach of the operator.



Acme Universal Turret Lathe provided with Geared Friction Head

The head is cast solid with the bed and is provided with friction back gears giving two speeds for each cone step. By having the head cast integral with the bed it will be obvious that the maximum rigidity is secured. The spindle is made of high carbon hammered crucible steel and runs in babbitt bearings which may be readily renewed when necessary.

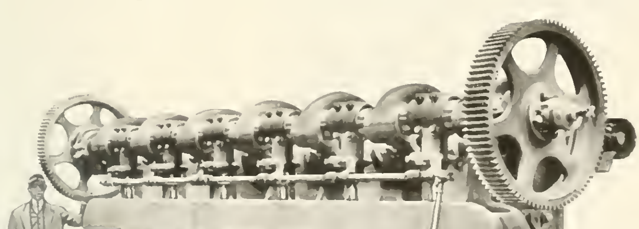
The turret is round in form and provided with six tool holes fitted with set-screws. It is arranged so that stock up to the full diameter of the hole can pass through the turret, thus allowing short stiff tools to be used for turning long work. The turret is indexed automatically by the backward movement of the turret slide, and the locking bolt is placed at the front end of the slide where it works in hardened and ground taper bushings located near the outer edge of the turret. The turret slide is provided with swivel and set-over adjustments. Both lever and screw feed are furnished for the longitudinal movement of the slide which is graduated for swiveling and provided with an adjustable stop. The set-over movement of the turret is obtained by means of a bell crank handle and a screw with a large micrometer dial to insure obtaining exact diameters. The stop for determining the central position of the turret can be shifted to allow the turret to pass beyond the center in either direction. Taper gibs on both sides of the slide provide means for taking up side wear. The saddle rests on an adjustable taper base insuring perfect alignment between the holes in the turret and the spindle. A binder handle on the front of the saddle provides for clamping it to the bed.

The chasing attachment is arranged for chasing straight or taper threads either right or left hand, the same leader and follower being used in all cases. Three leaders and one three-prong follower are provided with the lathe for cutting 11½, 14 and 18 threads per inch. The hand rest saddle with two hand rests of different lengths is also included as a part of the regular equipment. The machine shown in the illustration is arranged to be driven from a double friction countershaft with ring oiling bearings, but when desired the lathe can be arranged for electric motor drive.

FERRACUTE PRESS

The Ferracute Machine Co., Bridgeton, N. J., has recently built several presses similar to the machine illustrated herewith. The frame of this machine is composed of seven columns or housings—all exactly alike—and the ram is connected to the crankshaft by six pitmans each having its own pitman strap and ram adjustments which practically makes six presses in one. The important advantage secured from this form of construction lies in the fact that it is possible to construct a press of any length within reasonable limits by merely adding or subtracting the required number of units. The shaft, bed, ram and tie-rods are the only parts of the press which are affected by the length.

Presses of this type are suitable for bending or forming long lengths of structural material and are also adopted for punching long strips or sheets. They may also be used to advantage in connection with sub-presses. Treadles may be arranged anywhere that they are needed along the treadle shaft (the illustration shows a machine provided with four treadles) which enables the operator to start the press from any desired position. Torsional stresses in the long crankshaft are reduced to a minimum by having a gear at each end; these gears have cut teeth. All of the pitmans are adjusted at the same time by means of a horizontal worm shaft acting simultaneously on a worm-wheel on the pitman stems, the shaft being actuated by a ratchet lever which will be seen in the illustration.



Ferracute Press with Frame built in Sections

The slots in both bed and ram are carefully planed to insure accurate alignment of the dies which may be clamped at any point along the bed. There is a clutch at each end of the press, the action of these clutches being simultaneous. Holes are provided in the bed between each pair of columns to allow the punchings to drop through. The ram is gibbed to each column and has a stroke of 2 inches but a longer stroke may be provided if necessary. The adjustment of the ram is up to 3 inches. The shaft is made of high carbon steel and is 5 inches in diameter at the cranks and 4 inches at the journals. The press is driven by two 30-inch flywheels on the backshaft, each flywheel having a weight of 475 pounds. The total weight of the machine shown in the illustration is about 29,300 pounds.

QUINT TURRET DRILL

The illustrations show a six-spindle vertical turret machine with rotating spindles which has recently been placed on the market by A. E. Quint, Hartford, Conn. This machine has been designed to facilitate the performance of successive operations on work which must be drilled, reamed, counterbored and tapped, and as all of the operations can be performed at one setting of the work, a considerable saving of time is effected.

A projecting knee is cast on the lower part of the column of the machine. A two-jaw universal chuck is fastened to this knee, the chuck being provided with a capstan wheel on the screw to provide for opening and closing the jaws. The capacity of the chuck is for work up to 12 inches in diameter, and it is so arranged that it may be operated on or off the center. Adjustable buffer plates are provided on the top of the chuck and also on top of the baseplate of the machine which serve to guide the work while it is being clamped in the chuck. It will be seen that the baseplate is made with a slot 14 inches in width extending right through to the front of the base. This allows long pieces to be operated on, the length being limited only by the depth of the pit which is provided under the machine.

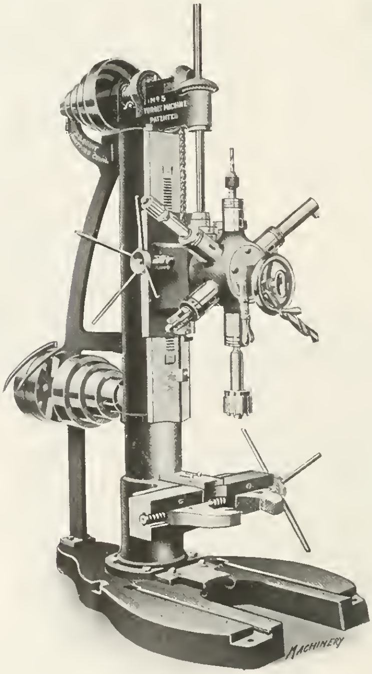


Fig. 1. Left-hand Side of Quint Turret Drill

The machine which is the subject of this description is known as the No. 5 pattern. The sliding head is balanced by a weight inside the column. This head carries the feeding mechanism, the locking index and the steel spur gearing for transmitting motion from the vertical driving shaft to the rotating spindles in the turret head. It will be seen that the six-spindle turret is mounted on the sliding head, the turret being free to rotate on the head. Any spindle which is required may be swung into the working position without stopping the machine by means of the lever shown on the front of the turret. When this lever is swung to the right, it releases the index bolt; the turret is then rotated to bring the required spindle into the operating position; the lever will then automatically lock the turret in place. The spindle in the operating position is the only one which revolves.

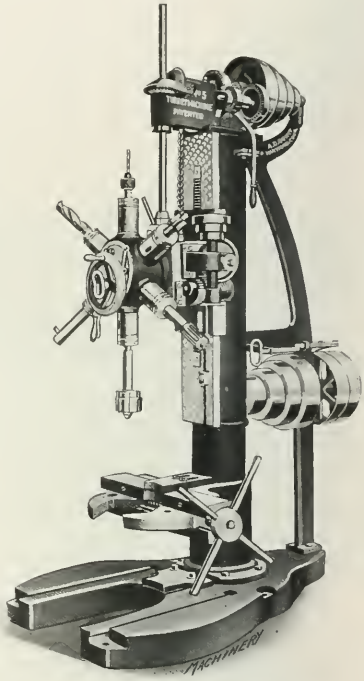


Fig. 2. Right-hand Side of Quint Turret Drill

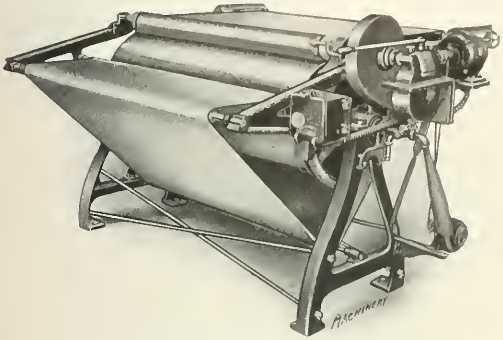
The hand feed is operated by means of the handwheel at the front of the turret, and the power feed is operated by a belt and cone pulleys on the sliding head, the power feed being started and stopped by means of the handle at the front of the handwheel which controls the hand feed. The power feed can also be tripped by means of the stop shown in the slot in the face of the column of the machine. This stop may be adjusted for any depth of hole up to 28 inches. The quick return of the head is effected by means of the pilot wheel on the left-hand side of the machine which operates a pinion in mesh with the rack in the face of the column. The lever for connecting the back-gears may be operated while the machine is running.

The machine is 8 feet high and occupies a floor space of 3 feet 4 inches by 6 feet. The distance from the face of the column to the spindle is 16¼ inches. The turret head is made with either four or six spindles, the spindles being reamed to No. 4 Morse taper. The total weight of the machine is 4000 pounds.

AMERICAN BLUEPRINT IRONER

The blueprint ironer illustrated herewith is a product of the American Laundry Machinery Co., Rochester, N. Y. This machine does away with the necessity of hanging blueprints up to dry after they have been washed, and blueprints dried in this way are not only available in less than one minute after they have been washed, but they also come out of the ironing machine perfectly smooth. The latter consideration is of particular value in filing, as the space required by flat prints is far less than that which is taken up by prints dried in the ordinary way. In addition, the tendency of the prints to become distorted in drying is eliminated, and this means that the danger of errors in scaling from the print will be reduced.

The machine consists of a 20-inch cast-iron roll which is supported by substantial end frames held together by tie-rods. The cast-iron roll is heated by either gas or steam, and a multiple fabric apron runs over it. A blueprint which is to be ironed is placed on this fabric belt and carried with it underneath the heated roll which moves at the same speed as the apron. After the print has been carried under the roll, it is separated from the roll by means of the curved metal guard which is shown in the illustration. The blueprint then falls back onto the apron and is carried on to the opposite side of the machine. As the speeds of the roll and apron are the same, there is no frictional resistance to mar the surface of the blueprint paper. The print comes out thoroughly dried and ironed quite smooth. A simple hand lever is provided which allows the apron to fall away from the heated roll when the machine is not in operation. The adjustment of the apron is provided for by a set of hand screws so that there is no trouble in having it run true at all times. These machines are built in two widths, having heated rolls of 46 and 60 inches in length. The illustration shows the blueprint ironer equipped for electric motor drive, but belt drive may be employed if the user so desires.



American Blueprint Ironer which dries Blueprints quickly and without Distortion

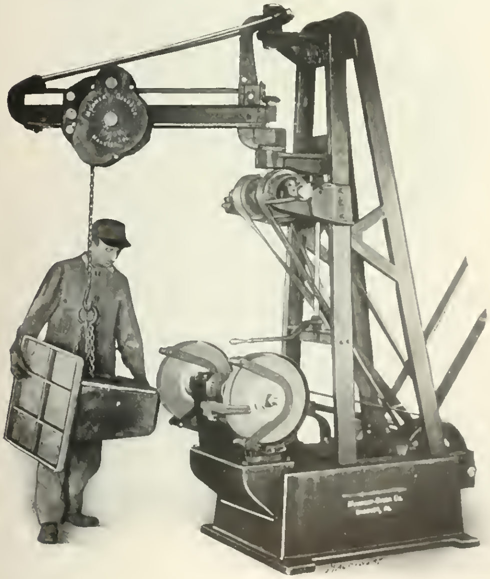


Fig. 1. Right-hand Side of Crane Grinder, showing Method of Operation

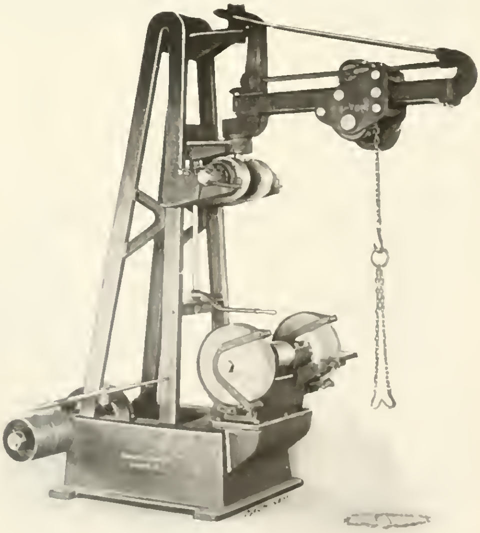


Fig. 2. Left-hand Side of Machine

MUMMERT-DIXON CRANE GRINDER

The machine illustrated herewith is a product of the Mummert-Dixon Co., Hanover, Pa., and has been designed to facilitate grinding those classes of work which are too large and heavy to be handled in the ordinary way. It will be seen that the machine is virtually a grinding stand combined with a power jib crane, and the advantageous features of this combination will be readily apparent to those who have heavy castings to grind.

In handling castings which are too heavy to be lifted by hand, the crane is used to support them at the proper height from the floor and at the proper distance from the wheel. It is then only necessary for the operator to swing the work against and along the wheel. As he is not required to do the heavy work that is necessary in lifting the castings into position, he is able to turn out a great deal more work in the course of a day.

The hoist is operated by power controlled by a lever which is conveniently located in relation to the operating position. Provision is also made for operating the hoist by hand, a crank handle which fits on the end of the shaft being provided for this purpose. The hoist trolley is mounted on the jib and driven by a square shaft which receives power from the clutch pulleys through bevel gears. Two clutch pulleys are provided—one for hoisting and the other for lowering—which are driven by belts from the countershaft at the back of the machine. The hand lever previously referred to controls both clutches. Moving this lever in one direction engages the lifting clutch and moving it in the opposite direction engages the lowering clutch. When the work has been brought to the desired position, the lever is thrown to the central or neutral position; in this position neither clutch is engaged and the work is held stationary.

The trolley follows in or out on the jib as the workman moves the casting. The swinging jib also follows the movement of the casting. By this means it is an easy matter for the operator to swing any surface of the casting into contact with the wheel. The emery wheel stand is mounted at the front of the base and gives plenty of clearance in front and under the wheels. The arbor is made of steel and runs in long self-oiling bearings. A detachable rest is provided which is convenient for use with the lighter classes of work which are handled on this machine. The wheels are protected by steel guards. Two steel frames, constructed of channels, are mounted on the back part of the base and the brackets which support the swinging arm of the jib crane are fastened to these frames. The countershaft which runs in self-oiling bearings is placed at the back of the machine so that the belts are out of the operator's way.

SCRIVEN SPEED REGULATOR

The variable speed jackshaft shown in Figs. 1, 2 and 3, is manufactured by the S. & S. Variable Speed Gear Co., 50 Church St., New York City. This device consists of a pair of pulleys which may be expanded or contracted to give the required speed regulation. It is operated by a chain or handwheel, and when one pulley is expanded the other is contracted a corresponding amount or *vice versa.*

The construction of this regulator will be readily understood by referring to Fig. 3 which shows a view of one of the pulleys with the end plate removed. The two pulleys are bolted together and mounted on tubular shafts shrunk into end plates which form the outside of the built-up hub. The pinion shown in Fig. 3 is operated by the chain or handwheel previously referred to. This pinion meshes with gear teeth cut in the spokes of the pulleys which support the members of the expanding rims. These spokes are staggered so that they do not interfere with one another. One pulley is assembled right- and the other left-hand so that turning the pinion expands one pulley and contracts the other. The spokes fit into slots milled in the plates which compose the hub of each pulley, and the arrangement is such that when the pulley is expanded to its largest diameter there is still two-thirds of the spoke supported by the hub.

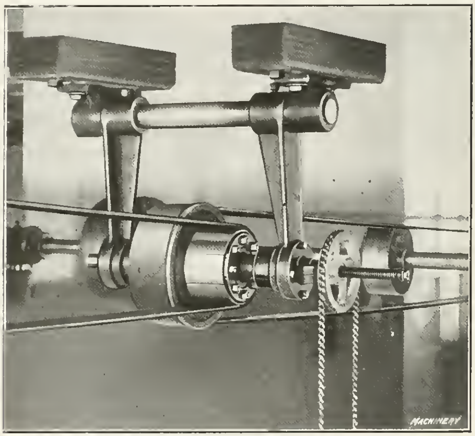


Fig. 1. View of the Scriven Speed Regulator in Operation

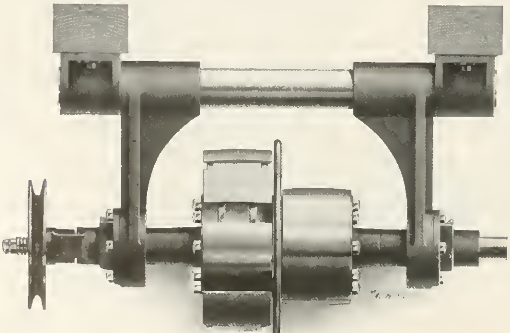


Fig. 2. The Scriven Variable Speed Jackshaft

When the operating wheel or chain is moved, a threaded sleeve communicates a longitudinal movement to an inner shaft which turns the tubular shaft. This shaft has spiral grooves of long pitch cut in a portion of its length which transmit a rotary movement to the pinion; this construction makes it impossible for the speed to alter through vibration. The load is carried by the two expansion pulleys and is balanced by the action of the pinion in expanding and contracting the pulleys. The running shaft is free to move back and forth to adjust itself to the load. In this way the tension is always kept equal, as any change made in the adjustment of the speed regulator causes one pulley to take up the length of belt that is given out by the other pulley. The running shaft swings to automatically adjust itself to the new condition.

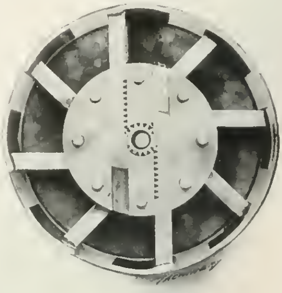
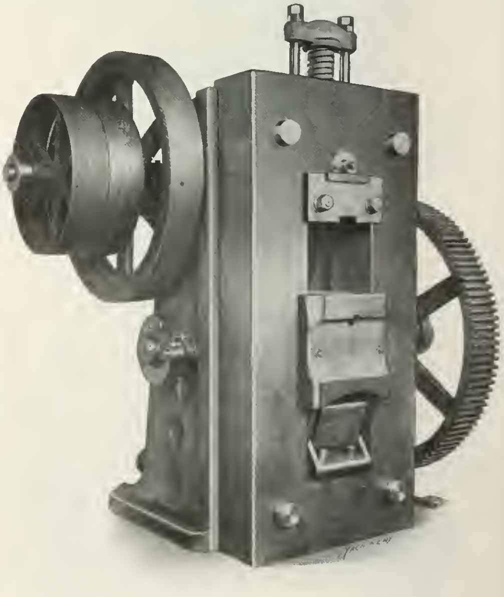


Fig. 3. View of Pulley with End Plate removed to show Mechanism

MAX AMS KNUCKLE JOINT PRESS

The illustration shows a heavy knuckle joint press which has recently been brought out by the Max Ams Machine Co., Mt. Vernon, N. Y. The application of the knuckle joint principle on this machine gives a slow powerful movement at the end of the stroke which makes presses of this type especially suitable for coining and swaging operations, where it is necessary for the metal to flow under pressure. The design of this press has been worked out with the view of making it as compact as possible so that the minimum amount of floor space will be required. The frame which receives the pressure is a steel forging securely bolted to a cast-iron frame that carries the driving mechanism. The toggle links are steel castings and the pins and seats are of tool steel hardened and ground. They are placed below the table so that all lost motion is taken up by the weight of the mechanism. This arrangement also has the advantage of preventing oil from running on the dies and work. The table is guided by adjustable bearings.



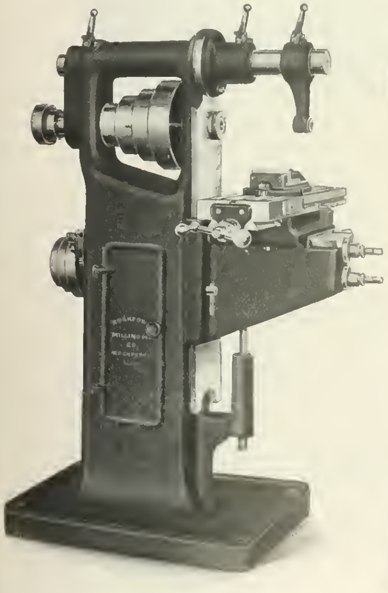
Max Ams Knuckle Joint Press for Coining and Swaging Operations

The adjustment for the dies to regulate the pressure is obtained by a steel wedge which is adjusted by a screw. This screw is provided with a collar graduated to 0.001 inch which enables the operator to keep an accurate record of the setting of the dies. The clutch is of the sliding key type and is constructed in such a way that no backlash can occur.

This press will exert a pressure up to 600 tons. The width between the uprights is 14 inches, the largest die space 12 inches, the stroke 1¼ inch and the adjustment ⅜ inch. The flywheel is 45 inches in diameter by 6 inches face and weighs 1100 pounds. The tight and loose pulleys are 28 inches in diameter by 6 inches face and the ratio of the gearing is 1 to 8 1/3. The total height of the machine is 93 inches and the total weight 19,000 pounds.

ROCKFORD NO. 0 PLAIN MILLING MACHINE

The illustration shows a plain milling machine known as the No. 0 type which has been brought out by the Rockford Milling Machine Co., Rockford, Ill. This machine is provided with six belt-driven feed changes and the feed can be operated and reversed while the machine is in motion. The table has a working surface of 30 by 7½ inches and is fitted to the saddle with taper gibs for taking up wear. It has oil grooves on the sides and oil pockets at each end. The knee is extended at the top and has an exceptionally long bearing on the column of the machine. The spindle runs in bearings fitted with felt oil retainers. The bearings are adjusted from the rear end of the spindle by means of a nut. It will be seen that an overhanging arm is provided for heavy work. This arm is fitted with the Rockford Milling Machine Co.'s patented flanged support bolted to the column. This construction gives great stiffness, materially reducing vibration and effecting a corresponding increase in cutting capacity.



Rockford No. 0 Plain Milling Machine

KEEN IMPACT HARDNESS TESTER

The importance of determining the proper degrees of hardness in various metals for different uses is being generally recognized in almost every manufacturing establishment. Not so very long ago the hardness of metals was not considered of special importance except in the extreme conditions of hardness or softness. It is understood now, as it always has been, that hardness is simply relative, being the term applicable to all conditions varying from the softest talc to the hardest diamond. Copper and lead, as well as the best tool steel, each possess their peculiar degrees of hardness.

In manufacturing bearing metals, such as babbitt or bronze, it is necessary to produce compositions of suitable hardness for many different conditions of service. Copper, though a soft metal, presents considerable variation in hardness, depending on the impurities present or the physical condition produced by rolling and heat-treatment. The importance of recognizing and measuring variations in hardness must appeal to everyone who has had experience in the working of metals.

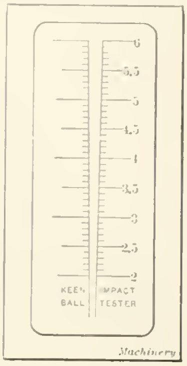


Fig. 4. Scale used to interpret Results

The steel industry offers a particularly appropriate field for a study of hardness and it is in this field that instruments were first devised for study. Many types of devices have been used, most important of which are the old file test, the Turner scratch sclerometer, Keep's drilling test, the Brinell ball method and Marten's cone modification, the Shore scleroscope and the Kryoff method of electro-magnetic balance. Of these instruments and methods the Brinell ball test and the Shore scleroscope seem to have met with the most favor.

A low priced and efficient instrument for studying metal hardness has recently been placed on the market by McKenna Bros. Brass Co., Pittsburg, Pa. This instrument, which embodies some of the features of the Brinell system and Shore system, enables anyone to make a scientific investigation of hardness of the metal which he is using in order to determine its suitability for the purpose. The instrument is called the impact ball tester and is shown in position for operation in Fig. 1. It makes practically the same test as the Brinell machine, but is much more convenient to use and more rapid in manipulation. It is portable, weighing only 6½ pounds, and may be carried anywhere and used intelligently by the "man on the job." The instrument is operated by raising the weight *C* until it touches *A*, the instrument being plumbed by means of the level in the top. When the weight *C* is released, it drops on *D*, giving a blow which is transmitted to the hardened ball *F*, causing a small circular dent to be made in the metal to be tested. The diameter of this indentation is determined by means of a celluloid scale which accompanies the instrument. The scale shows the hardness numeral directly opposite the point of tangency when laid over the dent and adjusted so that both lines are tangent to the circle. The degree of hardness, of course, varies inversely as the diameter of the indentation.

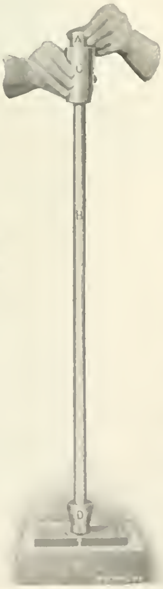


Fig. 1. Keen Hardness Tester

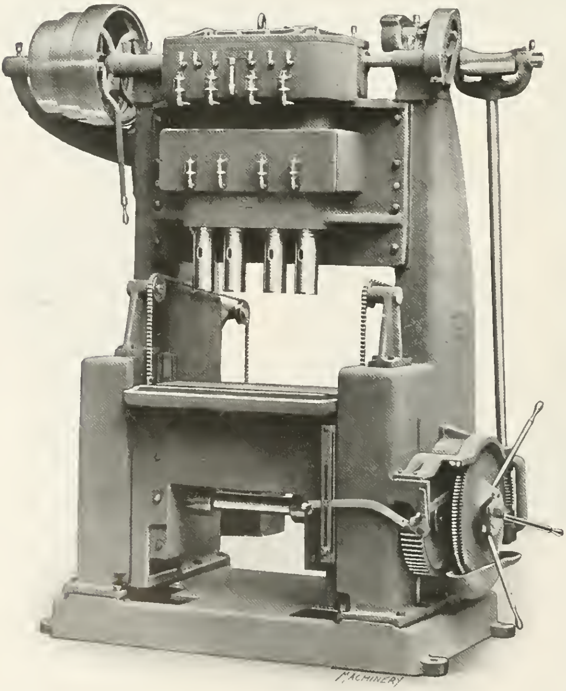
Fig. 2. Detail of Level A

Fig. 3. Detail of the Ball Socket

FOOTE-BURT CYLINDER BORING MACHINE

The four-spindle boring machine illustrated herewith is a product of the Foote-Burt Co., Cleveland, Ohio. This machine was especially designed for boring and reaming cylinders and can be used with equal success on cylinders cast singly, in pairs or *en bloc*. In operating machines of this type the work is held in a suitable box jig provided with removable jig plates equipped with the usual form of hardened and ground steel bushings. Bronze bushings on the spindles of the boring machine fit into these jig plate bushings after the boring tool has left them and provide support for the spindles while engaged in the boring operation. It will be evident that with a jig of this type bolted to the table of the machine and guiding the spindles, the entire machine is braced in such a way that there is practically no chance for deflection under cut. The use of worm and worm-gear drive with a final reduction through double pitch nickel steel spur gears, insures a steady drive under all conditions. The spindles are made of special high-carbon steel forgings and run in taper bearings provided with means of adjusting for wear. It will be seen from the illustration that the driving mechanism is entirely enclosed, and all of the gears run in oil.

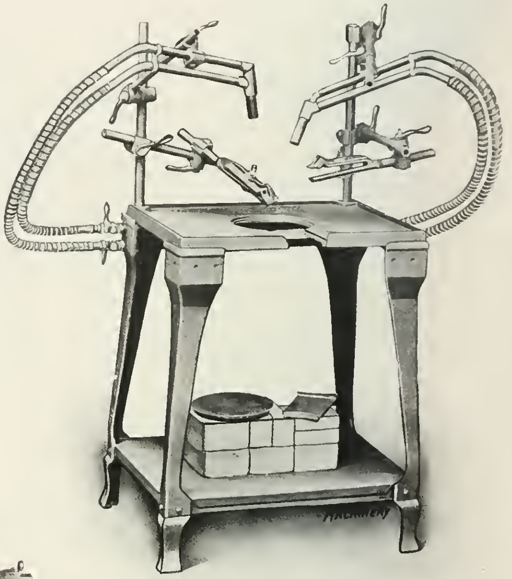
The feed is also through worm and worm-gears with the final drive through spur gears. An extremely accurate knockout is provided to disengage the power feed. Counterweights are attached to the table directly in line with the spindles and the table slides are so proportioned that the table does not feed out of the ways even at the highest point of its travel. A brake is provided to stop the spindles quickly at the end of a cut and prevent scoring the cylinders when the table is returned. The entire operating mechanism is simple and compact and arranged to insure the maximum output without requiring excessive effort on the part of the operator. These boring machines are built in several different styles to meet various requirements. The machine shown in the illustration is a four-spindle fixed-center boring machine. Machines of this type are built with two, three, four or six spindles to meet the requirements of different classes of work. In addition to the fixed-center type, machines are also built with the center distance adjustable with two, three and four spindles. The capacity of the machines is such that they can drive high-speed steel boring tools to the limit of their capacity.



Four-spindle Fixed-center Type of Foote-Burt Cylinder Boring Machine

IMPROVED BRAZING TABLE

The distinctive feature of the brazing table shown in the accompanying illustration is the method by which the work and the burners are supported. Referring to the illustration, it will be seen that two vertical supports are provided at the rear of the table and the burners and work holders are secured to these supports by universal clamps. The position of both the work and burner clamps may be adjusted vertically on the supports; any desired position along the horizontal bars may be obtained in a similar manner, and the clamps may be set at any desired angle by adjusting the clamp brackets. These clamp brackets are made in two parts which are held together by an adjusting screw, the joint being provided with teeth to afford a secure grip. The adjustments which are provided by these universal clamps make it possible to hold the work in any position over the table, and the burners can then be adjusted to apply the heat in this position. The work holders are so efficient that it is unnecessary to rivet many classes of work before brazing.



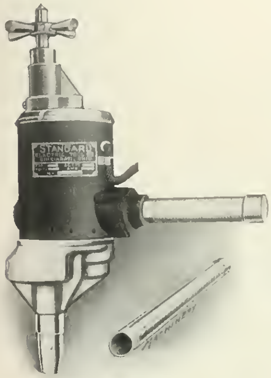
Improved Brazing Table with Universal Work and Burner Clamps

The brazing table is made of cast iron and is 18 by 24 inches in size. A removable center 7½ inches in diameter is provided and also a removable front section 3½ inches in width. The burners are made of wrought iron, which makes them particularly serviceable, and they are provided with ¼-inch brass nozzles. Two horizontal pipes run along the back of the table. These pipes are connected with the air and gas mains, respectively, and it will be seen that connection is made with the burners from each end of these pipes by means ot armored rubber hose. The gas consumption is 200 cubic feet per hour per burner, when the burners are working at their full capacity, and the air pressure required is ½ pound or more.

A useful shop forge or furnace of any desired shape may be made by building up a firebrick structure on the table, spaces being provided to admit the burners. Such a gas heated furnace may be successfully used for forging, tool dressing, straightening bent axles and other classes of service. In addition, bearing metals may be melted off bearings, babbitt and solder pots quickly heated, and other classes of service of this kind handled in a convenient manner. This brazing table is a product of the Improved Appliance Co., 455 Kent Ave., Brooklyn, N. Y.

STANDARD 1 1-4 INCH PORTABLE ELECTRIC DRILLS

The Standard Electric Tool Co., Cincinnati, Ohio, has added two types of 1¼ inch portable electric drills to its line which have a capacity up to 1¼ inch in steel. One of these tools is of the universal type and may be operated on either alternating or direct current circuits; the other is intended for use on direct current only.

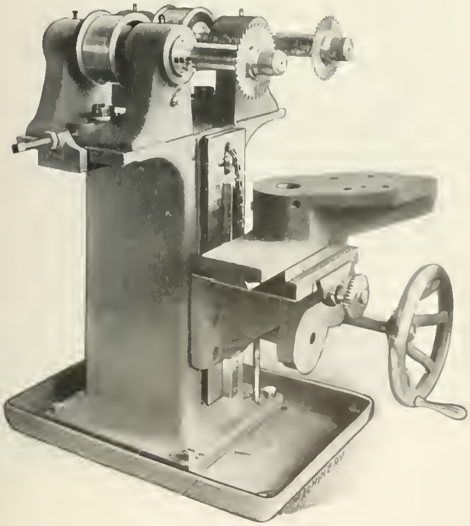


Standard Portable Electric Drill for either Alternating or Direct Current

The special features of these tools may be briefly outlined as follows: Ball bearings are used throughout; the motors are constructed to withstand the hard use to which tools of this kind are frequently subjected and still maintain their highest electrical efficiency; the motors are of the series type; all gears are of steel and generated in the Fellows gear shaper; the gears are casehardened, mounted on ball bearings and packed in grease; the tools are of very simple construction, being made up of five units that can be taken apart without disturbing any of the electrical connections. This is particularly convenient when it is necessary to dismantle a tool for cleaning or inspection.

BURKE BUSHING SPLITTING MACHINE

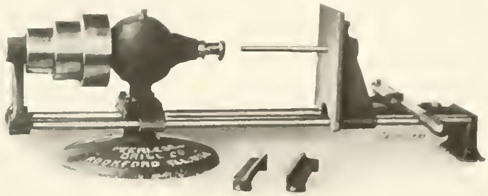
The two-spindle milling machine shown in the accompanying illustration is manufactured by the Burke Machine Tool Co., Conneaut, Ohio. The illustration shows the adaptation of this machine for splitting bushings up to six inches in length. For this purpose the machine has been equipped with the special table shown on which an air chuck is mounted. The work is held in this chuck and both sides of the bushing are split at the same time.



Burke Two-spindle Milling Machine adapted for splitting Bushings

PEERLESS TAPPING AND THREADING MACHINE

The tapping machine shown in the accompanying illustration is a recent product of the Peerless Drill Co., Rockford, Ill. The design of this machine adapts it for practically all classes of tapping operations and also for threading long rods, pipes and tubing. The illustration shows the machine set up for a threading operation, the method of setting up the work and operating the machine being apparent. For tapping operations, the tap is mounted in the spindle of the machine in place of the die shown in the illustration.

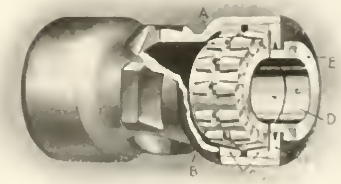


Peerless Tapping and Threading Machine

This is a convenient machine for use in the manufacture of gas and electric fixtures. The nose of the spindle is 1¼ inch in diameter and the hole through the spindle ¾ inch in diameter. The chuck can be placed either on the spindle or on the vertical table of the machine as desired, to meet the requirements of different classes of work.

MAKUTCHAN ROLLER BEARING

The illustration shows a roller bearing which has been developed by the Makutchan Roller Bearing Co., 332 S. Michigan Ave., Chicago, Ill., for use on line shafting hangers. A casual glance at the design of this bearing might lead one to believe that it violated the principles governing the design of equipment of this kind. Such, however, is not the case for the lines of contact between the rollers and the inner and outer races of the bearing correspond with the theoretical line of contact which a ball of large diameter would have in engagement with races of this width. The manufacturers claim that the efficiency with which the rollers of this bearing run in their races is equal to the efficiency with which the large balls referred to would run, and tests which they have conducted tend to show that the friction loss in the bearing is not greater than 0.25.



Makutchan Roller Bearing

Referring to the illustration, the rollers are shown at *A*. *B* is a bronze separator which maintains the proper alignment of the rollers in the bearing. A pair of tapered cups which constitute the outer race are shown at *C* while the inner race is illustrated at *D*. The part *E* is known as the "shaft collar." This collar is a close fit on the shaft and is secured against the end of the bearing by means of a set-screw. It will be seen that an adjusting nut *F* is carried in the threaded end of the hanger. This nut regulates the adjustment of the bearing. It will readily be seen that moving the nut in or out tightens or loosens the tapered cups *C*. By this means, any wear which develops in the bearing can be compensated for without the necessity of renewal. In use, the rollers are packed with a light grease and do not require attention more than once or twice a year. Bearings of this type have a capacity for carrying an amount of lateral thrust load equal to the radial load for which they are adapted.

STANDARD DOUBLE-ACTION SINGLE CAM PRESS

The Standard Machinery Co., 7 Beverly Pl., Providence, R. I., has brought out a double-action single cam press designed for working celluloid, rubber, and other pliable materials. Such materials work better under a heat up to about 600 degrees F., and the purpose of this press is to provide means of heating as well as working the celluloid or rubber that is being operated upon.

The construction and principle of operation may be briefly outlined as follows: The blanking ram is actuated by two connecting-rods which straddle the crankshaft and operate the machine on a one-inch stroke. The drawing and forming plunger passes up and down through a bronze lining inside the blanking ram and is provided with a special separate adjustment. The top of this ram is made in the form of a yoke and is supported by a spring adjustment connected to the upper part of the frame of the press. It is actuated by a single split cam which is made of hardened and ground tool steel; the design of this cam will be readily understood by referring to Fig. 3. This cam is made in halves and keyed and screwed on the center of the crankshaft midway between the upper boxes of the press. The cutting stroke of the blanking ram is 1 inch, but the total drawing stroke afforded to the inner ram by the cam is 1¾ inch and is made as follows: When the press is started, both the blanking ram and drawing ram start on the downward stroke. The drawing ram travels down 1¼ inch and it then dwells during one-fourth revolution, after which it draws the remaining part of the stroke, which is ½ inch.

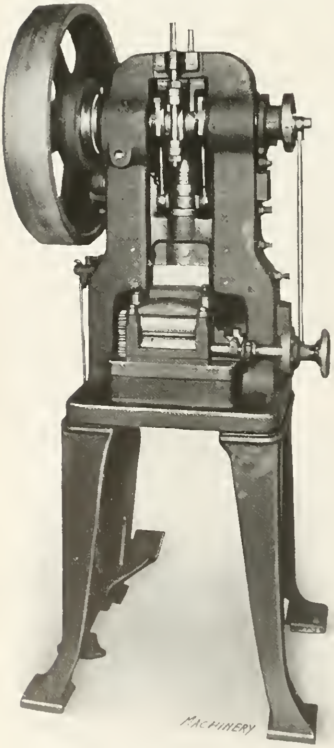


Fig. 1. Rear View of Press showing Roll Feed Mechanism

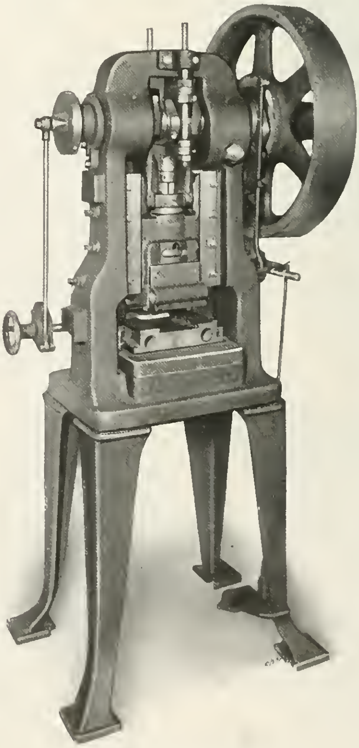


Fig. 2. Front View of Standard Press showing Electrically Heated Die Holder

A special die-holder is set on the bolster plate of the press, and by referring to Fig. 2, two holes can be seen in this die-holder which are provided for the purpose of inserting electric terminals. In the punch holder of the press, a recess for two more electric terminals is provided. These terminals are set at right angles to those in the die-holder, one being at the front and the other at the rear. These electric terminals provide for heating the punch and die up to a temperature of 500 degrees F.

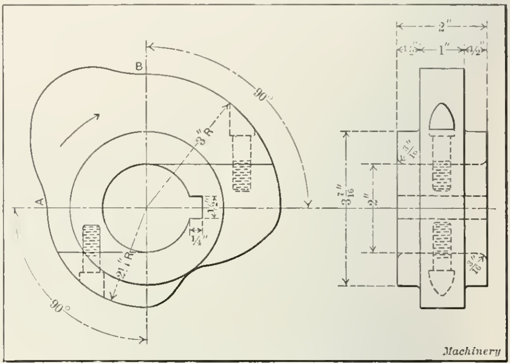


Fig. 3. Design of Cam used for operating the Forming Ram

The celluloid or hard rubber stock is fed through the roll feed shown in Fig. 1, the stock coming in from the rear of the press. The center of the roll feed frame is at a distance of 8 inches from the center of the ram and is entirely separate from the die holder or punch holder, thus enabling the temperature to be kept practically normal at all times. When the stock has passed through the feed rolls it is still cold, and when the press is tripped, the blanking dies cut the disk or disks from the sheet. The drawing ram then comes down and draws or forms these disks into the required shape. The object of allowing a dwell after the forming punch has traveled 1¼ inch of its stroke is due to the fact that the material is very thick. This allows the impression to be made gradually, which has the effect of making the design more distinct.

In addition to building the machine with a roll feed, a design is being developed to use a dial feed for secondary operations. The principal dimensions of the machine are as follows: Over-all height, 6 feet; floor space occupied, 24 by 30 inches; distance between uprights, 14 inches; size of flywheel, 27 inches diameter by 4½ inches face; weight of flywheel, 300 pounds; total weight of machine, 1600 pounds.

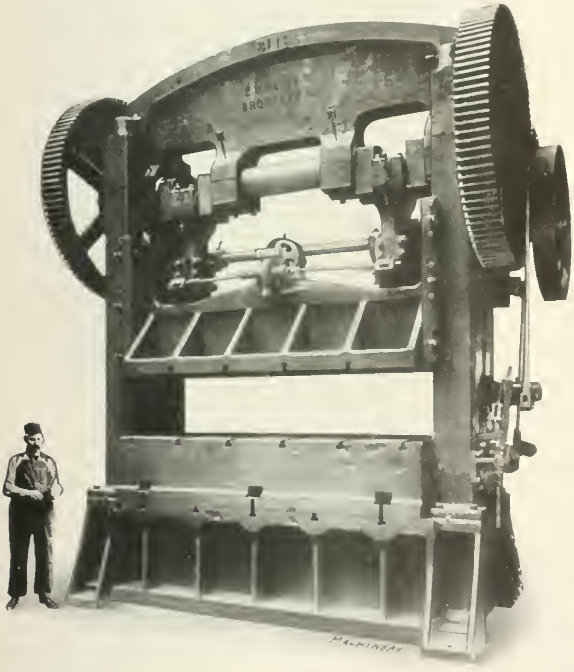
LUFKIN TAPE WITH INSTANTANEOUS READING

For the benefit of those readers not familiar with the meaning of the term "metallic" as applied to measuring tapes, it should be stated that this name is used to designate that class of woven tapes which has metallic strands interwoven with the linen threads. It does not mean that the tape is made of metal of any kind, as might be inferred, and metallic tapes must not be confounded with steel tapes.

The Lufkin Rule Co., Saginaw, Mich., has just placed a metallic tape upon the market which has what is known as the "instantaneous readings" method of graduation. This consists of placing small figures beside each inch mark on the tape which indicate the whole number of feet in the measurement. This makes it unnecessary to refer back to the last foot mark when taking readings and reduces the possibility of making an error. This method of graduation has been used by the Lufkin Rule Co. on the steel tapes of its manufacture, but has only recently been used on metallic tapes.

BLISS DOUBLE CRANK PRESS

Large power presses are now finding wide application in the production of sheet metal articles which were formerly made from castings and machine finished. The illustration shows a double crank press equipped with a special automatic stop feature which has recently been brought out by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This machine is 19 feet high, weighs 190,000 pounds, exerts a working pressure up to 750 tons and is one of the largest presses which has been brought out by this company. Owing to the extreme strain to which the gearing is subjected, the entire train of gears are made of steel castings machine cut from solid metal. The ratio of the gearing is 38 to 1. The crankshaft which operates the slide has a stroke of 16 inches and is made from 50 point carbon open-hearth steel. The crankshaft is twin driven to avoid torsional strain during the operation of the press. The driving pinion on the intermediate shaft which imparts motion to the main gears is placed centrally on the intermediate shaft to eliminate the tendency toward torsional strains in this shaft.



Bliss Double Crank Press capable of exerting Pressure up to 750 Tons

The slide is adjusted by an independent electric motor fitted with a jaw clutch for starting and stopping. The motor is placed on the top of the slide and operates through universal joint connections to the multiple thread worms on the main connections. Both connections are adjusted simultaneously, alignment with each other. The counterbalance of the slide is effected by counterweights placed in the main driving gears. The distance from the bed to the lower face of the slide, stroke and adjustment up, is 64 inches, adapting the press for dies of considerable height; when shallow dies are to be operated, bridge bolsters are used. The machine is controlled by a hand-actuated powerful friction clutch of the double grip type. The clutch is arranged with a device by means of which the press is automatically stopped on the top center and which also permits of starting and stopping the moving parts at any point of the stroke independent of the automatic stop, giving the combined advantages of a positive automatic stop on the top center, and absolute control over the moving parts at any point of the stroke. Control of the device which, in turn, controls the friction clutch is by means of a spring handle which is attached to the shifter handle, the spring handle operating on a pin clutch. The pin clutch being operated direct from the shifter handle allows the operator to start the moving parts at any part of the stroke independent of the automatic feature for stopping the press on the top center. The pin clutch can, by a small lock attached to the shifter handle, be locked so that the press may be run continuously.

The automatic stop device is located on the lower part of the right-hand upright and is actuated from the crankshaft by means of the connecting rod, crank disk, rack and pinion. The automatic stop feature operates on the up-stroke of the crankshaft, when the pinion engages with the pin clutch which is connected to the rocker shaft to which are keyed the levers for operating the friction clutch. Another advantage in connection with this special feature of the press is that the press cannot be set in motion by any accidental pressure against the shifter arm, as it is first necessary to operate the spring handle before the press can be set in motion. The bearings of the back shafts, friction clutch and loose pulley are bronze bushed and the bushings have babbitt with graphite cast in them to aid lubrication. To avoid possible damage to the press by excessive pressure, the flywheel is arranged with a safety coupling.

LENNOX THROATLESS SHEAR

The accompanying illustrations show a new type of rotary metal shear designed along entirely new lines, which is a product of the Lennox Throatless Shear Co., Marshalltown, Iowa. The construction of this machine has been worked out to meet the demand for a shear that would cut sheets of metal of large size and irregular shapes. The main head of the machine is built with a helical throat which makes it possible for a sheet to be split and in or out curves cut to a very small radii.

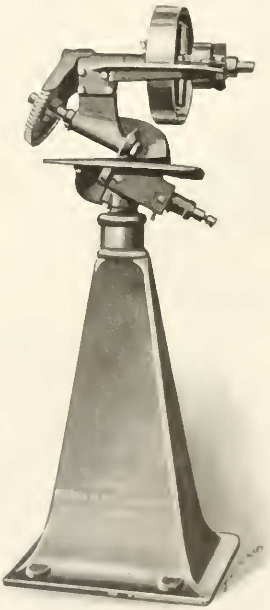


Fig. 1. Smallest Size of Lennox Throatless Shear

The knives are designed to allow the cuts to be made without binding on the knives, causing chipping. The mechanical operation of this shear is such that it eliminates all unnecessary friction. As it is impossible to keep two knives of exactly the same diameter, it would be necessary to have a compensating drive to prevent one shaft from traveling faster than the other and causing a continuous slipping of the shears which would reduce their efficiency. To avoid this difficulty, only one shaft of the Lennox throatless shear is driven, and the manufacturers state that a saving of at least 50 per cent of the power requirements of the machine is effected in this way.

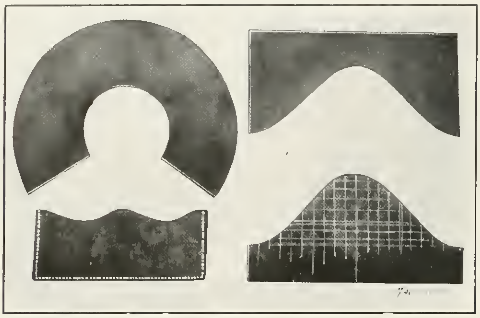


Fig. 2. Examples of Work done on the Lennox Shear

The main head of the machine is a steel casting and all other parts are of ample strength to withstand severe service. The machines are equipped with either belt or motor drive. When motor drive is used, a friction clutch gear is furnished which will allow the motor to run continuously and the shear to be started and stopped instantly at the will of the operator. The design is of unusual simplicity and the machines occupy a very small amount of space.

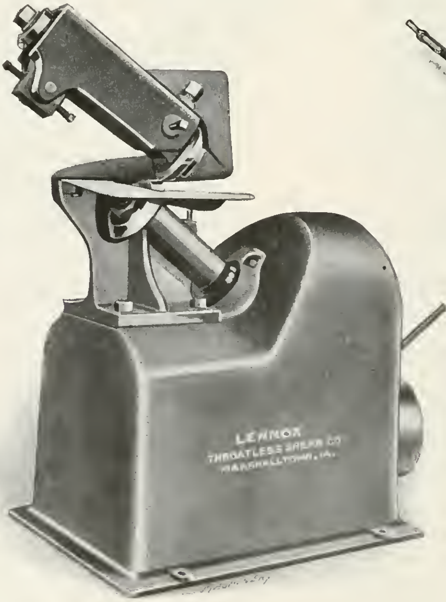


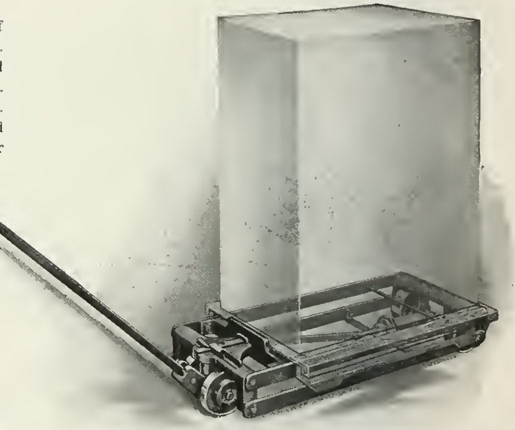
Fig. 3. Largest Size of Lennox Throatless Shear

The different sized shears of this line will cut to radii from 2½ inches to 10 inches, according to the size of the shear, and they will handle work from No. 30 gage up to ½ inch in thickness. Fig. 2 gives a good idea of the irregular cutting that can be done on the Lennox throatless shear. This illustration shows a dome sheet shearing, a square elbow pattern, and the two parts of a plate which have been sheared along the contour of a conic section.

NATIONAL ELEVATING TRUCK

To any manufacturer who has given the subject brief consideration, the increased efficiency attained through the use of elevating trucks and wooden skids for moving work through the factory—as compared with the ordinary form of truck—will be readily apparent. In using trucks of this kind, the work is placed upon a skid which is raised from the floor by side pieces. In order to put the skid and its load on the truck, it is merely necessary to back the latter underneath the skid; the truck is then elevated to enable the skid and its load to be carried to the position in the factory where it is required. The use of such a method effects a saving in several directions. In the first place, the number of expensive trucks which are required is greatly reduced, as it is not necessary to leave trucks idle in the factory with material stored upon them or to have the trucks standing beside a machine while a given operation is being performed upon the material with which they are loaded. For such conditions, the cheap wooden skid is quite as useful as an expensive truck and it is only necessary for a factory to buy a sufficient number of elevating trucks to look after moving the skids about the factory.

The accompanying illustration shows the Chapman elevating truck which has recently been brought out by the National Scale Co., Chicopee Falls, Mass. This truck is lifted by means of the handle which is used to pull it. When the handle is raised to a vertical position, the truck is dropped to its lowest position and can then be easily backed under the skid. In order to pull the truck, the handle is naturally drawn forward into an inclined position and in so doing the truck is raised. The most important feature in the design of the elevating mechanism of this truck lies in the provision of a plunger check which prevents the load from being suddenly dropped onto the floor when the handle is released. The benefit of this design is particularly apparent where heavy loads are being handled. It is quite possible to handle loads as great as 1½ ton on trucks of this type, and when such loads are allowed to drop suddenly upon the floor from a height of 1½ inch, it will be found that considerable damage can be done to the building. In addition, the provision of this check acts as a safeguard to the operator of the truck. As it is impossible for the load to drop suddenly and jerk the handle forward with considerable violence, the danger of the operator being struck by the handle is eliminated.



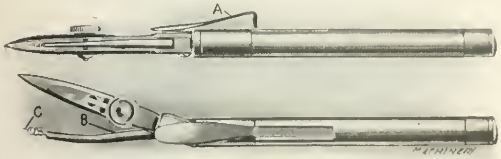
National Elevating Truck with Check to prevent Load from dropping suddenly

K. & E. FOUNTAIN DRAWING PEN

It is generally recognized that a large amount of the time required to ink in a drawing or make a tracing of a pencil drawing is spent in filling the drafting pen. Furthermore, difficulty is experienced in keeping the T-square and triangle in place while the draftsman is refilling his pen. Several efforts have been made to overcome these difficulties by means of a fountain pen, but trouble has been experienced in getting India ink to flow properly in pens of this type. This trouble has been overcome by the Smith fountain drawing pen which has recently been placed upon the market by the Keuffel & Esser Co., Hoboken, N. J.

This new draftsman's pen is made of steel and German silver and the ink is held in a rubber reservoir inside the handle. The ink is delivered to the pen from this reservoir through a delivery tube which extends down between the blades of the pen as shown in the accompanying illustration. When the supply of ink becomes exhausted, the draftsman merely presses the lever *A*; this compresses the reservoir and forces ink down to the pen through the delivery tube *B*. It is not necessary to stop work to refill the pen and after a little practice the draftsman will be able to replenish the supply of ink while he is ruling a line.

In order to fill the reservoir, the pen is swung to one side as shown in the lower illustration and the wire *C* is then withdrawn from the delivery tube. The lever *A* is next pushed down to expel the air from the reservoir and the delivery tube is then dipped into the ink bottle. The lever *A* is now slowly released and this allows the ink to be drawn up into the reservoir. It is then merely necessary to replace the wire in the delivery tube—taking care not to entirely close up the end—and then swing the pen back into position. The end of this wire which passes into the tube is enlarged, and if any difficulty is experienced through the ink becoming clogged in the tube, the trouble is easily remedied by withdrawing the wire. The pen itself is provided with a quick-opening device to facilitate cleaning.



K. & E. Drawing Pen in Working Position and with Pen swung to One Side

VEEDER COUNTERS

The illustrations show a new line of counters which has recently been brought out by the Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. There are two styles, termed, respectively, "setback" and "locked wheel" counters.

Fig. 1 shows the four-wheel "setback" counter suitable for use in counting separate lots of work on punch presses, printing presses, looms, stamping machines, etc. When the lot is finished the counter can be turned forward until all of the figures are at zero, by one turn of the knob provided for this purpose at the left-hand end of the counter. The resetting shaft picks up the number wheels from any position and carries them forward to zero, without the possibility of interference.

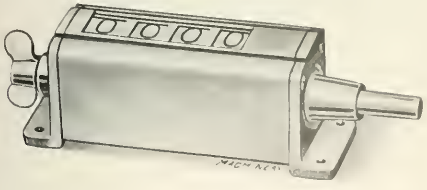


Fig. 1. Veeder Four-wheel Setback Counter

In the design of these new Veeder counters, special attention has been given to making instruments which will operate with the greatest ease; each wheel turns upon a comparatively small shaft and the pinions which transfer the motion from one wheel to the other, also turn upon small shafts. The wheels and pinions are so arranged that there is no frictional contact at their peripheries, except where the pinions engage the wheels, so that they turn with the utmost freedom. The counter is built up of units, each unit consisting of a short section or shell, which carries a pinion and entirely encloses the number wheel, with the exception of an opening through which the figures are read. This enables counters to be assembled with as many number wheels as may be desired within certain limits. The usual number of wheels supplied is four, but the counter may be made up with only two, or in special cases, with six or even eight sections. The greater the number of wheels, the greater is the wear and strain on the first transmitting pinion, so that a large number of wheels should not be employed where the counter is operated at a comparatively high speed. The unit shells which carry the wheels are held together between two end plates by means of four screws, and are usually covered by a drawn brass case which holds the glass window through which the figures may be read. In this complete form the counters are dust-proof and may be made waterproof by the application of suitable cement around the glass.

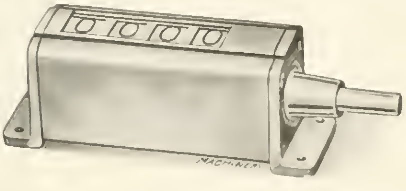


Fig. 2. Veeder Locked Wheel Counter

The "locked wheel" counter shown in Fig. 2 is similar to the "setback" counter except that its transfer pinions are solid and the number wheels are not provided with cams and pawls for setting them to zero. The number wheels are locked in all positions and cannot be moved, except through the mechanism provided for driving the right-hand ring. This type of counter is specially useful where work is paid for by the piece, as it may be connected to the machine in such a way that the figures cannot be moved except by running the machine.

NEW MACHINERY AND TOOLS NOTES

Precision Level: G. S. Crosby, 46 Lexington Ave., Brooklyn, N. Y. This level is made in two sizes, 5 and 8 inches. It is a one-minute level and is only intended for precision work.

Shop Goggles: Julius King Optical Co., 10 Maiden Lane, New York City. Shop goggles to protect the eyes of workmen engaged in operating grinding machines and similar classes of work.

Steel Shelving: Standard Steel Shelving Co., 149 Fremont St., Boston, Mass. Steel shelving constructed on the multiple-unit sectional system and adapted for stock racks, storeroom shelves, and similar purposes in manufacturing plants.

Metal-cutting Saws: E. C. Atkins & Co., Indianapolis, Ind. Two types of metal-cutting saws. The first is a hand saw made with either an adjustable or stationary handle, and a blade 18 inches in length. The second is an extension-frame hacksaw.

Direct-current Ammeters and Voltmeters: Weston Electrical Instrument Co., Newark, N. J. Four types of electrical indicating instruments which comprise a portable voltmeter, two forms of switchboard ammeters, and a battery testing voltmeter.

Boiler Plate Punching Machine: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A 48-inch open gap machine designed for punching out $6\frac{3}{4}$- by $12\frac{1}{2}$-inch manholes in $1\frac{1}{2}$-inch boiler plate. The machine was built for the Dillon Steam Boiler Works, Fitchburg, Mass.

Motor-driven Grinding Machine: Ransom Mfg. Co., Oshkosh, Wis. A grinder especially adapted for use on heavy steel castings in the foundry. The motor is mounted at the center of the machine and the armature shaft is extended at either end to carry the grinding wheels.

Autogenous Welding Outfit: George C. Schemmel, Wapakoneta, Ohio. A self-contained oxy-acetylene outfit for welding and cutting. The arrangement of the gas generators and other parts of the equipment has been worked out with the view of making the outfit as compact as possible.

Centering Device: Carroll-Jamieson Machine Tool Co., Batavia, Ohio. This device fits the lathe-spindle taper. The driving chuck is self-centering and the tailstock fixture may be readily adapted for different diameters of shafting. The tool is made in two sizes for maximum diameters of 1¾ and 3 inches.

Punch Press Safe Guard: Hardware Supply Co., Grand Rapids, Mich. A punch press safeguard fastened to the machine by means of a bolster bolt at the right-hand side. The guard is operated by a chain connected to the treadle and throws the operator's hands out of the "danger zone" before the ram can descend.

Die-sinking Machine: Melling-Northrup Co., Jackson, Mich. This tool combines the cherrying and profiling mechanisms in a single machine, and oscillating cutters are used in place of the usual revolving cutters in the cherrying device. The chief claim made for the machine is the economy which it effects in die-sinking operations.

Peening Machine: William Gibbs, Brantford, Canada. Machine for peening the steel disks used on seeding drills. Its essential parts consist of two plates provided with a series of rings filled with hardened balls. These plates are driven in opposite directions, and form the disk mounted between them to the required shape.

Rivet Heater: Improved Appliance Co., 455 Kent Ave., Brooklyn, N. Y. A rivet heater made in two sizes having a capacity for heating rivets ¾ by 3 inches at the rate of 100 per hour and 180 per hour, respectively. The smaller size will take rivets up to 4 inches in length; and the larger size takes rivets up to 6 inches in length.

Disk Grinder: Diamond Machine Co., Providence, R. I. A grinding machine designed for the use of either disk wheels or ring-wheel chucks. The spindle has cast-iron split bearings tongued and grooved for adjustment, and the thrust is taken on the right-hand side of the column where hardened and ground tool-steel collars are provided.

Knurling Tool: C. A. Herman, Woonsocket, R. I. A tool designed to knurl work up to the last 1/32 inch in a speed lathe, bench lathe or drilling machine. The handles are slotted to admit the knurls, and a slotted tongue into which a pin at the end of one handle fits provides for adjusting the tool for different diameters of work.

Keyseat Milling Machine: Premier Machinery Co., Milwaukee, Wis. A small keyseat miller, the spindle of which is driven by an internal expanding friction clutch. The machine has power vertical and longitudinal feed. The table has a longitudinal movement of 6 inches. The machine may be removed from the base and clamped on a shaft for cutting a keyway by hand.

Universal Grinder: Cincinnati Grinder Co., Cincinnati, Ohio. A 16 by 72 inch universal grinding machine built for manufacturing work. The machine swings 16 inches over the table and takes work up to 72 inches between centers. The wheel spindle carries a wheel 14 inches in diameter by 1½ inch face, and runs in phosphor-bronze boxes provided with means of compensating for wear.

Constant-speed Milling Machine: Kearney & Trecker Co., Milwaukee, Wis. A milling machine with constant-speed motor-drive, especially designed for heavy duty. The machine is equipped with means for automatic lubrication of the gears, bearings and milling cutters. It is driven by a five-horsepower Westinghouse electric motor mounted on an adjustable bracket, power being transmitted through reduction gears mounted inside the machine.

Armor-plate Planing Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This is a double-action machine with a toolpost that carries two steel relief tool aprons on which the tools are mounted to cut on both the forward and return strokes. Each apron is mounted on a swivel saddle to relieve the side tool pressure on either return stroke. The main saddle carrying the tool-post is counterweighted and provided with power feed and fast-reversing traverse.

Chip Separator: W. M. McKenzie, Dorchester Center, Mass. A machine designed for separating screw machine product from chips, after the oil has been extracted. It will separate parts as small as 0.07 inch in diameter by 3/16 inch in length. In operation, the workman simply dumps the oil-extractor pan into a receiving hopper, from which the product and chips pass down a chute. The chips are blown into a receiving box while the finished parts are delivered into a receiver.

Offset Boring Head and Drill Chuck: J. T. Flynn Mfg. Co., 1181 Porter St., Detroit, Mich. A change in the No. 10 chuck of this company's manufacture which consists of an improvement in the design of the adjusting screw. The screw is now made in two pieces, one having a square head which fits into a corresponding socket in the other part. Each part of the screw has a groove cut in it into which is fitted a collar. These collars fit into grooves in the cross block and insure having the jaws properly located.

Spring Winding Machine: Sleeper & Hartley, 98 Beacon St., Worcester, Mass. A manufacturing machine which combines a wide wire range with a capacity for a large variety of spring forms. In operation, the wire is taken from a coil and fed into the machine where the spring is wound and cut off automatically. The wire range is from No. 20 to No. 8. Wire from No. 20 to No. 14 may be wound into springs of from 1 to 22 coils, while from No. 14 to No. 8 wire can be wound into springs having from 1 to 13 coils per inch.

Instrument for Testing the Ways of Machines: C. H. Norton, Worcester, Mass. This device was developed by Mr. Norton to enable the operation of testing the straightness and parallelism of the ways of machines to be performed with greater rapidity and accuracy than was possible with former methods. The device consists of an aluminum base resting on three points of support. A vertical mast about 10 feet in height is supported by this base and carries two indicators, which move in planes at right angles to each other. The design of the instrument is such that any error is magnified from 400 to 500 times.

Boring and Turning Mill: Niles Tool Works, Hamilton, Ohio. This machine is said to be one of the largest boring and turning mills which has ever been constructed. It was built for the Philadelphia plant of the William Cramp Ship & Engine Building Co. Aside from its unusual size, the most distinctive feature of the machine is the reach arm which is 31 feet in length. This long arm is necessary for reaching the center of the table when the housings are set back. A boring head traverses the entire length of the arm and any piece of work from 10 inches to 29 feet in diameter can be handled by the machine.

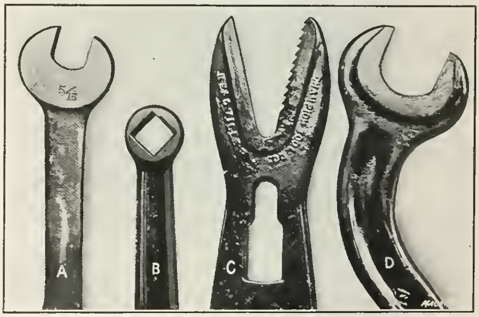
* * *

BROACHING WRENCHES

The illustration shows four types of wrenches on which the J. N. Lapointe Co., New London, Conn., has accumulated some interesting data regarding possible speeds of production when broached on its broaching machine.

The first example *A* shows one end of a double open wrench for a 5/16-inch U. S. standard nut, the opening for which is 19/32-inch wide. Special jigs were made for holding all the wrenches shown, taking three or four, or even six at a time. Thus 200 to 300 wrenches per hour could be broached. It was found that a broaching tool holds its size on this work much longer than any other form of tool suitable for doing the same work.

The box wrench shown at *B* cannot be done at as high a rate per hour as the open-end wrenches, of course, because of the smallness of the broach. The production rate on this piece, in which the opening is ½ inch square, was 100 per hour.



Samples of Wrenches with Jaws formed by Broaching

The alligator wrench shown at *C* has a vee-shaped opening, one side of which is smooth, the other side having serrations or teeth standing at an angle of about 80 degrees with the side. Both sides of the vee were broached at one operation. The saving of time effected by broaching as compared with the time required with ordinary means used for finishing alligator wrench jaws is so great as to make a comparison of the figures almost ridiculous.

The wrench shown at *D* is an open-end S-wrench, the end shown for a ½-inch nut, having an opening ⅞ inch wide. As stated previously, the production rate for the open-end type of wrenches was found to be from 200 to 300 an hour, depending on the number of wrenches operated on at once. The number operated on at once was as high as six at a time with the smaller sizes.

* * *

The seven most important exporting ports of the United States in the order of the value of the exports shipped from each, are New York, Galveston, New Orleans, Baltimore, Philadelphia, Boston and San Francisco.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-sixth annual convention of the American Railway Master Mechanics' Association and the forty-seventh annual convention of the Master Car Builders' Association were held at Atlantic City, June 11 to 18, inclusive. The Master Mechanics' convention was held June 11, 12 and 13 and the Master Car Builders' convention, June 16, 17 and 18 on Young's New Pier. The technical program of the American Railway Master Mechanics' Association included the following papers and discussions:

June 11—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Specifications for Cast-steel Locomotive Frames". Individual Papers: "Maintenance of Electrical Equipment," by C. H. Quereau; "Engine Testing Plant," by Prof. E. C. Schmidt.

June 12—Discussion of reports on: "Main and Side Rods"; "Safety Appliances"; "Design, Construction and Maintenance of Locomotive Boilers"; "Steel Tires"; "Minimum Requirements for Headlights"; "Standardization of Tinware"; "Superheater Locomotives"; "Specifications for Materials Used in Locomotive Construction." Individual Paper: "Three-cylinder Locomotives," by J. Snowden Bell.

June 13—Discussion of reports on: "Use of Special Alloys and Heat-treated Steel in Locomotive Construction"; "Smoke Prevention"; "Engine Tender Wheels." Individual Paper: "Tests of Superheater Locomotives," by Dean C. H. Benjamin.

The following officers were elected for the American Railway Master Mechanics' Association:

President, D. R. MacBain, L. S. & M. S. Ry.
First vice-president, F. F. Gaines, Central of Georgia Ry.
Second vice-president, E. W. Pratt, C. & N. W. Ry.
Third vice-president, Wm. Schaifge, Erie R. R.
Treasurer, Angus Sinclair, *Railway and Locomotive Engineering*, New York City.
Executive Committee: W. J. Tollerton, Rock Island Lines; J. F. DeVoy, C. M. & St. P. Ry.; J. R. Wallis, P. R. R.; F. H. Clark, B. & O. R. R.

The program of the Master Car Builders' convention was as follows:

June 16—Discussion of reports on: "Revision of Standards and Recommended Practice"; "Train Brake and Signal Equipment"; "Brake Shoe and Brake Beam Equipment"; "Coupler and Draft Equipment"; "Car Wheels."

June 17—Discussion of reports on: "Safety Appliances"; "Rules for Loading Materials"; "Overhead Inspection"; "Car Trucks"; "Train Lighting and Equipment"; "Train Pipe and Connection for Steam Heat"; "Tank Cars"; "Specifications for Tests of Steel Truck Sides and Bolsters for Cars of 80,000, 100,000 and 150,000 Pounds Capacity." Topical Discussion: "Retirement from Interchange Service of Cars of 40,000 and 50,000 Pounds Capacity"; Discussion of reports on: "Capacity Marking of Cars"; "Lettering Cars."

June 18—Discussion of reports on: "Damage to Freight by Unloading Machines"; "Air-brake Hose Specifications"; "Revision of Present Specifications Car Construction."

The following officers were elected for the Master Car Builders' Association:

President, M. K. Barnum, I. C. R. R.
First vice-president, D. F. Crawford, P. L. W. of P.
Second vice-president, D. R. MacBain, L. S. & M. S. Ry.
Third vice-president, R. W. Burnett, C. P. Ry.
Treasurer, John S. Lentz, L. V. R. R.
Executive Committee: C. E. Fuller, U. P. Ry.; T. M. Ramsdell, C. & A. R. R.; C. F. Giles, L. & N. R. R.

The annual exhibition of railway car and locomotive parts supplies, etc., held on the pier simultaneously with the conventions under the auspices of the Railway Manufacturers' Supply Association, was larger than ever before. The exhibit space had been increased by nearly 5000 square feet, making a total of over 88,000 square feet. The exhibit included a number of new and interesting machine tools, under demonstration. Among the manufacturers exhibiting were the following concerns:

American Pulley Co., Philadelphia, Pa. Pressed steel pulleys for lineshafting, etc.

American Tool Works Co., Cincinnati, Ohio. Motor-driven machine tools, comprising 30-inch lathe, 16-inch toolroom lathe, 6-foot radial drill, 3-foot radial drill and 24-inch back geared crank shaper.

Baker Bros., Toledo, Ohio. Heavy-duty high-speed drilling machine equipped with ball bearing gear box and alloy heat-treated steel gears.

Baush Machine Tool Co., Springfield, Mass. 6-foot radial drill and automatic staybolt drilling machine.

Besly & Co., Charles H., Chicago, Ill. Besly motor-driven disk grinder and Besly patternmaker's disk grinder and shaper.

Best, W. N., New York City. Burners using oil and tar for locomotive, marine and stationary boilers, and other liquid fuels for furnaces, etc.

Boker & Co., Hermann, New York City. Tool steels.

Brubaker & Bros., W. L., Millersburg, Pa. Taps, reamers, dies, end mills, etc.

Bullard Machine Tool Co., Bridgeport, Conn. 36-inch vertical turret lathe, motor driven.

Cincinnati Bickford Tool Co., Cincinnati, Ohio. 6-foot radial drill, 28-inch upright drill with tapping attachment.

Cincinnati Planer Co., Cincinnati, Ohio. 36-inch by 36-inch by 8-foot planer with Triumph-Monitor reversible motor drive.

Davis Boring Tool Co., St. Louis, Mo. Expansion boring tools for car wheels, turret lathes and turret boring mills.

Detroit Hoist & Machine Co., Detroit, Mich. Pneumatic and electric hoists and motors.

Eveland Engineering & Mfg. Co., Philadelphia, Pa. Electric riveters.

Goldschmidt Thermit Co., New York City. Materials and appliances used for welding by the thermit process.

Gould & Eberhardt, Newark, N. J. 28-inch shaper, and 12-inch hobbing machine, motor-driven.

Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa. Overhead trolley tracks, screw hoists, etc.

Independent Pneumatic Tool Co., Chicago, Ill. Piston air drills, pneumatic grinders, pneumatic hammers, etc.

International Oxygen Co., New York City. Oxygen and hydrogen producing equipment for autogenous welding and cutting.

Jessop & Son, Inc., Wm., New York City. Tool steels.

Landis Machine Co., Waynesboro, Pa. Bolt cutters; die heads, etc.

Landis Tool Co., Waynesboro, Pa. 16-inch by 6-foot plain grinding machine; No. 3 universal grinding machine.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. 24-inch by 10-foot engine lathe, motor-driven; 18-inch by 10-foot engine lathe, motor-driven.

Lucas Machine Tool Co., Cleveland, Ohio. No. 31 horizontal boring, drilling and milling machine with vertical milling attachment; No. 33 horizontal boring, drilling and milling machine.

Manning, Maxwell & Moore, Inc., New York City. Representing the Hendey Machine Co., Torrington, Conn. (lathes, centering machine and milling machine); J. N. Lapointe Co., New London, Conn. (broaching machines); Cincinnati Shaper Co., Cincinnati, Ohio (shaper and planer); National Machinery Co., Tiffin, Ohio (bolt cutters, nut tapping machines, etc.); Reed-Prentice Co., Worcester, Mass. (lathes).

Norton Co., Worcester, Mass. Grinding wheels.

Nuttall Co., R. D., Pittsburg, Pa. Cut gears.

Oxweld Railroad Service Co., Chicago, Ill. Oxy-acetylene cutting and welding apparatus.

Reed Mfg. Co., Erie, Pa. Machinists' vises.

Rich Tool Co., Chicago, Ill. High-speed drills and drilling machine.

Richmond Stay-Bolt Drilling Machine Mfg. Co., Richmond, Va. Stay-bolt drilling machines.

Ryerson & Son, Joseph T., Chicago, Ill. Samples of iron and steel.

Standard Roller Bearing Co., Philadelphia, Pa. Ball and roller bearings.

Vixen Tool Co., Philadelphia, Pa. "Vixen" files, and machine for resharpening "Vixen" files.

Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathes.

Watson-Stillman Co., New York City. Hydraulic power plant demonstrating vertical broaching, shearing rivets, etc.

Wiley & Russell Mfg. Co., Greenfield, Mass. Taps, dies, reamers, etc.

Wilmarth & Morman Co., Grand Rapids, Mich. Surface grinder and drill grinder.

Yale & Towne Mfg. Co., New York City. Electric and hand chain hoists, blocks, trolleys, etc.

* * *

A "Safety First" rally was held under the auspices of the New York Central Lines in Indianapolis, Ind., June 11 and Cincinnati, Ohio, June 12. About seven hundred employes were present at Indianapolis and over five hundred at Cincinnati. Addresses were delivered by Messrs. M. A. Neville, superintendent; Hadley Baldwin, superintendent; C. R. Meyers, chief claim agent; J. T. Luscombe, master mechanic; D. F. Schaff, superintendent; C. D. Miles, supervisor air brakes; and Marcus A. Dow, general safety agent New York Central Lines. Fifteen similar meetings have been held along the New York Central Lines since April, 1913, all of which have been well attended, and from the interest thus far displayed by the employes it appears that meetings of this character are a phase of the "Safety First" movement to which much attention and energy can be profitably devoted. The growth of sentiment for greater safety of railway operation is in remarkable contrast to the indifference with which accidents to railway employes were regarded a few years ago.

SAFEGUARDING THE INDUCTION MOTOR

It is an inherent characteristic of the squirrel cage type of induction motors to take a heavy starting current, ranging from three to seven times the full load current. This, in the case of large motors, may cause a serious drop of potential in the supply circuit, and to avoid trouble from this source, a starting compensator should be used. This device consists of an auto-transformer with taps for obtaining a reduced potential. A suitable mechanism is provided for momentarily connecting the motor to these taps for starting and then, when the motor has attained full speed, disconnecting it from the taps and throwing it directly on the supply circuit. The contacts are immersed to take advantage of making the break under oil to prevent burning the contacts and disturbances in the circuit. Starting compensators are not usually required for motors smaller than 7½ horsepower. The design and construction of the compensator is worked out in a way to insure the highest degree of dependability. The windings of the coils are thoroughly insulated to give a high factor of safety and to render a breakdown of the insulation practically impossible. The taps are brought out to provide a number of derived voltages sufficient for all conditions of service.

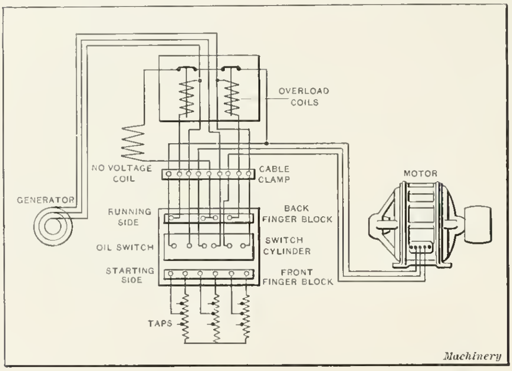


Diagram illustrating Construction of the Floor Type Compensator

The compensators for motors smaller than 18 horsepower have three taps giving 50, 65 and 80 per cent of the line voltage, with line currents, respectively, 25, 42 and 65 per cent of the current that would be taken by the motor if no compensator were used. For motors larger than 18 horsepower, the compensators are provided with four taps giving potentials equal to 40, 58, 70 and 85 per cent of the line voltage, and respective currents equal to 16, 34, 50 and 72 per cent of the current that would be taken by the motor if it were started direct from the line. After the motor has come up to the required speed, the handle must be thrown quickly to the "running position," the running contacts at the same time being taken care of automatically by the tension of springs which return the former to the "off" position. Lugs on the back of the lever arms prevent the contacts from moving further away than the "off" position.

To guard the motor from injurious overloads, all standard compensators listed for 110 to 550 volt induction motors are provided with fuses of the cartridge type mounted on a slate base and separated by barriers for from 1040 to 3000 volt motors. The compensators are provided with series, time limit, oil dashpot relay panels, enclosed by a dust-proof sheet iron cover, which shut down the motor if the overload stays on for an interval of time greater than that for which the dashpot is set.

Compensators of this type are made for all potentials up to and including 3000 volts, with a line current up to 400 amperes at 550 volts, and 200 amperes at 3000 volts. They are designed to bring the motors up to approximately full speed within one minute after the switch is thrown into the starting position. These compensators are made in two types, the suspension and the floor type. Suitable push buttons may be wired into the circuit of the no-voltage release coil to shut down the motor from a remote point if desired. The push button would normally be in the closed position. The overload relay has five calibration points, the lowest being the normal current of the motor and the highest 300 per cent of full load current. The compensators described in the preceding are manufactured by the General Electric Co., Schenectady, N. Y.

* * *

EARLY DEVELOPMENT OF BALL AND ROLLER BEARINGS

Endeavors to develop ball and roller bearings were made much earlier than is generally supposed. For instance, in building the old Trinity Church, Lancaster, Pa., a roller bearing was used to carry the heavy weather vane, weighing 150 pounds. This bearing was discovered in the year 1909, at which time repairs were made. Although it would not be considered a good example of machine and bearing construction today, it had held out under heavy service for a period of 115 years. The bronze spherical rollers, which in the beginning had a diameter of 1 3/16 inch, had worn down to 19/32 inch, while the races showed but little wear. Robert Fulton is supposed to have been the maker of this bearing; others ascribe it to Getz, the engraver of the Washington penny and the large seal of the United States. Trucks with axles mounted on rollers were submitted to the French Artillery Commission in 1795 or 1796. The political disturbances then rife in all probability caused this construction, which was not put to any practical use, to be forgotten. The Sayner Hütte (Foundry) in Sayne-Neuwied a. Rh., in 1845 had cranes equipped with ball bearings, and in 1847 the Bavarian Government Railroad made experiments with a roller bearing produced by Baron v. Rudoffer. In 1853 an American applied for a patent on a ball bearing of a peculiar construction, the outer race being made of hard rubber; it was not put into practical use, however. The German Patent Office in 1878 granted a patent on a ball bearing for a truck, to George Weckamp of Budapest. Krupp used ball bearings as early as 1871 in cranes and other machines, and, since 1885, in rotating naval gun carriages, but no far-reaching importance can be attributed to any of these forms of application. The use of ball bearings of commercial importance began with the development of the bicycle. Adjustable ball bearings for bicycles were patented by William Brown of England, in 1880, and ball bearings were first used on the Columbia high-wheel bicycle in that year.

* * *

THE "IMPERATOR"

The *Imperator*, the world's greatest steamer—for the time being—sailed from Hamburg June 11 and reached New York June 18. The length of this latest marvel of marine architecture is 919 feet, breadth 98 feet, depth 62 feet. Her displacement is 70,000 tons and registered tonnage 50,000 tons. The vessel is propelled by four screws driven by steam turbines having an aggregate power of 62,000 H. P. The rotor of one turbine weighs 135 tons, contains 50,000 blades and its casing is 25 feet long and 18 feet diameter. The shafts are 18 inches diameter and the propellers 16 feet diameter. The weight of the rudder alone is 90 tons and its stem is 30 inches diameter. The vessel was built for comfort and safety, no attempt being made to achieve excessive speed, the average speed for which she was designed being 22½ knots. The hull is divided into numerous water-tight compartments, there being twelve transverse bulkheads and one longitudinal bulkhead. A series of coal bunkers arranged along the sides of the ship and a double bottom give the *Imperator* a double skin, making her virtually "a ship within a ship." The life-saving equipment includes 83 life boats which will accommodate the maximum passenger list and the crew of 1100. Steadiness in a seaway is insured by the Frahm compensating tanks which dampen the roll of the vessel and reduce it to a minimum even in a heavy sea.

* * *

Recent tests of locomotive springs made from chrome-vanadium steel indicated that the elastic limit was reached at a stress of 256,000 pounds per square inch. Oil-tempered carbon steel springs showed an elastic limit of 101,000 pounds per square inch: chrome-nickel steel spring-tempered springs, an elastic limit of 134,500 pounds.

METHOD OF HOLDING PIECES TO BE FORGED

BY WILLIAM ROBERTS*

In holding a piece to be forged under a power hammer, there is a considerable shock at each stroke which is very hard on the man who is doing the work. The accompanying illustrations show two arrangements for holding work which relieve the workman of this strain. Referring to the illustrations, it will be seen that spring jaws are provided in which the work is held. The shock of the blow is absorbed by the springs instead of being passed on to the workman's arms.

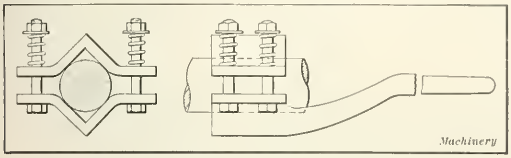


Fig. 1. Tool with Spring Jaws for holding Work while being forged

It will be seen that the tool shown in Fig. 1 is provided with a single handle, and this device is intended for holding work that does not require to be frequently turned while forging. The tool in Fig. 2 is provided with four handles which are at an equal distance from each other. This tool is particularly adapted for classes of forging operations that require the piece to be continually turned. It will be evident that the operator can change his grip from handle to handle and thus bring any surface of the work into position to receive the blow of the hammer. The dimensions of the tools have been omitted as the size will naturally depend upon the class of work for which they are to be used.

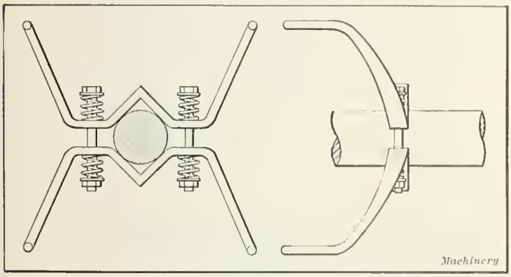


Fig. 2. Tool with Four Handles to facilitate turning the Work while forging

* * *

"BEVEL GEAR DRIVE FOR SHAFTS RUNNING IN THE SAME DIRECTION"—EXPLANATION

The statement was made in the letter "Bevel Gear Drive for Shafts Running in the Same Direction" by Francis W. Clough published in the June number that it possesses a valuable feature because of the possibility of locating one horizontal shaft above or below another and thus the advantage of a skew bevel gear could be obtained. The meaning was erroneously expressed. The author meant to suggest that shafts could be operated at other than 90 degrees with the combination; that one shaft might be horizontal and the other inclined to it in the vertical plane either at 90 degrees or any other angle required. The use of the term "skewed" was unfortunate as it conveyed the wrong impression.

* * *

The United States Civil Service Commission, Washington, D. C., will hold competitive examinations July 21 in certain principal cities throughout the United States for senior architect, senior inspector of car equipment, senior inspector of motive power, senior civil engineer, senior electrical engineer, senior structural engineer, senior railway signal engineer, and senior mechanical engineer. As a result of these examinations two grades of eligibles will be established, the salaries in the first grade ranging from $3000 to $4800 per annum, with necessary expenses when absent from headquarters in the discharge of official duties, and in the second grade from $1800 to $2700 and such expenses. Information as to where the examinations will be held can be obtained from the United States Civil Service Commission, Washington, D. C.

* * *

A. S. M. E. EXCURSION TO GERMANY

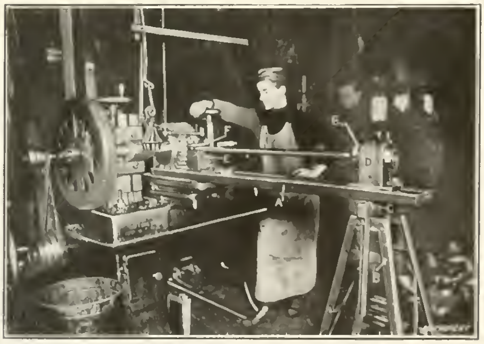
About two hundred and fifty members of the American Society of Mechanical Engineers, including ladies, sailed June 10 on the *Victoria Luise* for Hamburg, Germany, to take part in a joint meeting with the Verein Deutscher Ingenieure in Leipzig. Among those sailing were: W. N. Best, New York City; George M. Bond, Hartford, Conn.; Jacob S. Detrick, Baltimore, Md.; E. R. Fellows, Springfield, Vt.; Lester G. French, New York City; Arthur A. Fuller, Providence, R. I.; H. L. Gantt, New York City; Miss Kate Gleason, Rochester, N. Y.; James Hartness, Springfield, Vt.; Henry Hess, Philadelphia, Pa.; R. K. LeBlond, Cincinnati, Ohio; William Lodge, Cincinnati, Ohio; Henry M. Lucas, Cleveland, Ohio; J. W. Nelson, New York City; W. R. Warner, Cleveland, Ohio.

* * *

FIXTURE FOR MILLING PROPELLER SHAFTS

The accompanying illustration shows a fixture which is applied to a No. 7 Becker "Lincoln type" milling machine, for milling the square on the end of propeller shafts. The fixture consists of an auxiliary table *A* which is fastened by bolts to the regular table of the machine and is supported at its outer end by a stand *B* which is supplied with a roller *C*. This stand is held stationary, and the auxiliary table, of course, is free to slide back and forth when operated by the mechanism of the machine.

The propeller shaft which is 50¾ inches long is held in the special indexing fixture *D*, and is supported in a V-block *E* on the front end of the table in which it is clamped by the cross strip *F*. The nuts holding this strip, of course, have to be released before the work can be rotated for milling the remaining two sides of the square on the end of the shaft. The milling is accomplished by two 12-inch straddle milling cutters having thirty teeth made from high-speed steel. The square end on the shaft is 1¼ by 4¼ inches long and is cut down from the round bar 1½ inch in diameter in two cuts—that is one pass of the cutter completes two sides of the square. The indexing head, after the lock has been released, is rotated by the handle *G* shown projecting from the chuck, and is locked by a catch located in the opposite side of the fixture. This unique type of milling fixture is used in the plant of the Lewis Spring & Axle Co., Jackson, Mich.



Milling Fixture used for milling the Square End on Propeller Shafts

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"HEAT-TREATMENT OF GEARS AT THE BOSTON GEAR WORKS"—CORRECTION

The latter part of the second paragraph under "Kinds of Heat-treatment" in the article "Heat-treatment of Gears at the Boston Gear Works" published in the June number, should be

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* Address: 218 Beach St., Revere, Mass.

A Commercial Grinding Mach

FOR SUCCESSFUL GRINDING

in a manufacturing plant the grinding machine must be capable of fast speeds and heavy cuts or it lacks economy; it must be able to finish duplicate pieces to close limits or it lacks reliability.

These vital factors are the strong points of

The No. 14 Plain Grinding Machine

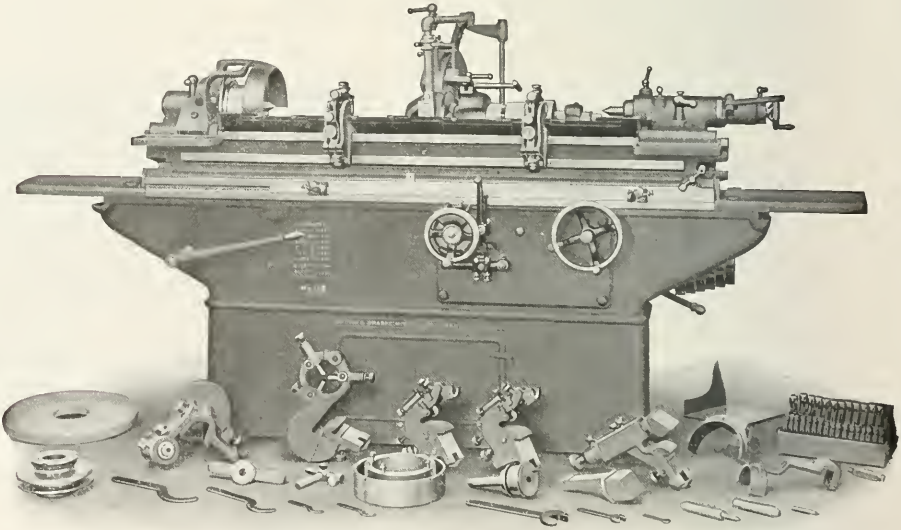
Capacity: 10" in diameter, 48" in length

Correct Wheel Speeds are possible owing to the rigid design and correct alignments.

Heavy Cuts are safe as the Universal Back Rests prevent springing and chattering.

Close Limits can be readily maintained by means of the Automatic Cross Feed.

Easy Control is assured by the convenient position of levers and hand wheels.



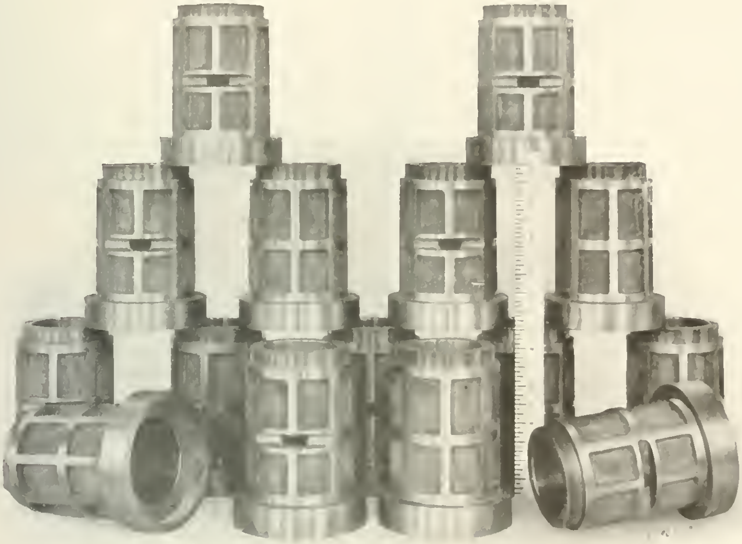
No. 14 Plain Grinding Machine

BROWN & SHARPE MFG. CO.

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co. Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

ine and the Work it is Doing



A RAPID PRODUCTION JOB

Phosphor bronze boxes for milling machine spindles. Ground externally on No. 14 Plain Grinding Machine. Larger diameter is straight, smaller diameter is taper and is ground to fit accurately in a hole in machine frame.

The ribs on these castings make *finish turning* difficult. The grinding machine finishes the rough turned castings not only to *closer limits* but *much quicker* than is possible on other machine tools.

This is but one example of what the No. 14 Plain Grinding Machine will do. It is capable of accuracy and speed on both light shafting and heavy reduction work.

Send for Further Information.

PROVIDENCE, R. I., U. S. A.

Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfort, a M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 75

corrected to read as follows: "These treatments cover steels with 0.10 to 0.60 per cent carbon; 3½ per cent, 5 per cent and 7 per cent nickel steels; nickel steel and chrome-vanadium steel of various carbon contents; and silico-manganese steels." Also under "Treatment Z" the third line should read "Reheat to 1450 to 1500 degrees F," and a fourth step should be added: "4. Quench in oil."

* * *

PERSONALS

John F. Winchester has taken a position with the Standard Oil Co., of New Jersey, as an automobile expert and oil salesman.

O. W. Gregg, formerly in charge of the power transmission department of Jones & Laughlin, Pittsburg, Pa., is now with the Chicago branch of the Saginaw Mfg. Co., and Gilbert Pulley Co.

W. S. Rogers, president of the Bantam Anti-Friction Co., Bantam, Conn., who recently underwent an operation for appendicitis at the Presbyterian Hospital, New York City, has fully recovered.

C. R. Chisholm, assistant to the master mechanic, Cristobal Marine Works, Canal Zone, has resigned from the service of the Isthmian Canal Commission to engage in the automobile business in Chicago.

Frank E. Shailor, a well-known contributor to MACHINERY, has resigned his position with the General Electric Co. at Pittsfield, Mass., to become works engineer of the American Electrical Heater Co., Detroit, Mich.

Albert H. Mitchel, formerly of the Chicago office of the Taft-Peirce Mfg. Co., Pawtucket, R. I., has succeeded Marcus M. Whipple as the New York sales representative of the company. The New York offices of the company are in the Woolworth Building.

J. F. Weeks has resigned from the engineering department of the American Mfg. Co., in order to become associated with C. S. Weeks, mechanical and consulting engineer, New York. This business will henceforth be conducted under the name of Weeks & Weeks.

John J. Grant, of the Grant Engineering Co., Detroit, Mich., will sail for a European business and pleasure trip July 8. Mr. Grant has been appointed consulting engineer by correspondence for the large automobile works of Clement & Co., of Paris, and also for the Austin Motor Works of Birmingham, England.

K. B. MacDonald, who for the past two years has been factory manager of the Russell Motor Car Co., Ltd., West Toronto, Canada, maker of Russell-Knight cars, has resigned. Mr. MacDonald was formerly associated with the E. R. Thomas Motor Car Co., of Buffalo, as factory manager. He has not yet announced his plans for the future.

John Calder, a well-known member of the American Society of Mechanical Engineers and an engineer of wide experience, has been elected president of the International Motor Co., with general offices in New York City. Mr. Calder was at one time executive engineer of the C. W. Hunt Co., and later manager of works and developer of the Remington typewriter industry at Ilion, N. Y., for nine years. He was later associate manager of the Cadillac Motor Car Co., at Detroit.

OBITUARIES

Bernhard Schuchardt, of Schuchardt & Schutte, died June 3 in Berlin, Germany.

Marcus M. Whipple, New York sales representative of the Taft-Peirce Mfg. Co., Pawtucket, R. I., died at his home in Newark, N. J., June 20, aged forty-nine years. Mr. Whipple was well and favorably known in the machinery trade.

Charles H. Cramp, former head of Wm. Cramp & Sons Ship & Engine Bldg. Co., Philadelphia, Pa., died at the home of his son in Philadelphia June 6, aged eighty-five years. Mr. Cramp was the son of William Cramp, the founder of the Cramp plant which was started on the Delaware River in 1830.

Dr. John T. Nicolson, professor of mechanical engineering, University of Manchester, England, and well-known investigator and writer on machine tool design, died March 27 at Macclesfield, England. Dr. Nicolson's book on lathe design, written in collaboration with Mr. Dempster Smith, is one of the most noteworthy contributions to the subject.

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COMING EVENTS

August 16-23.—Second Annual Gas Engine Show of the National Gas Engine Association at Kansas City, Mo. H. R. Brate, secretary, Lakemont, N. Y.

September 1-4.—A meeting of the Iron and Steel Institute at Brussels, Belgium. G. C. Lloyd, secretary, 28 Victoria St., London, S. W., England.

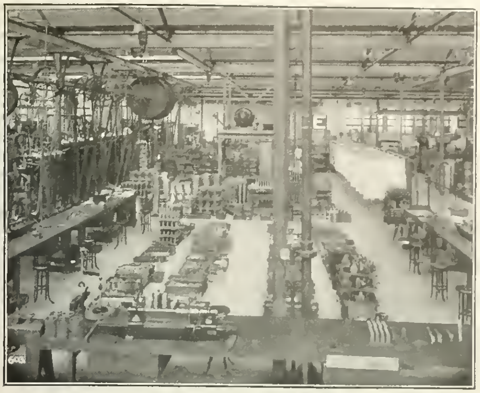
September 17-23.—Third International Congress of Refrigeration to be held in Chicago, Ill. For further information address the secretary-general, J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

October 10-17.—Eighth Annual Foundry & Machine Exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

EVERY DETAIL OF CINCINNATI MILLERS



Inspection and Routing Department.

Department for Assembling and Testing Feed and Drive Boxes.

Department for Testing the Completed Machines.

is inspected after every operation. Some of them pass through this department as many as twenty times before they are finished. Hardened gears, clutches, and similar parts are also tested with the scleroscope and must meet definite standards of hardness set for each piece.

The drive box, feed box, etc., each forms a complete unit of mechanism. They are assembled by skilled men who are expert on this work because they do nothing else.

Every unit when assembled is given a running test under working conditions before passing into stock.

The completed machine must pass an exacting inspection for alignment; must run continuously for a given period; and must also do a variety of milling successfully.

These running and working tests are a final check on each unit of mechanism, and are a guarantee that every detail is fully up to our high standard of excellence.

These are some of our Manufacturing Methods. Visit us and see them for yourself.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris, Barcelona, St. Petersburg. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerloffs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Aires.

October 19-25.—Seventh Annual Convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Illinois, Urbana, Ill., dedicated the new transportation building and locomotive and mining laboratories May 8 and 9. The transportation building is a fireproof structure 143 feet long and 65 feet wide. The locomotive laboratory is a brick and steel structure 117 feet long by 43 feet wide. The mounting mechanism for receiving the locomotives to be tested is of original design and of such capacity as to give accommodation to the largest locomotive yet built, not excepting those of the Mallet type.

American Society of Agricultural Engineers, I. W. Dickerson, secretary, Urbana, Ill., announces that the society is now ready to furnish technical assistance in the management of a competition of general purpose tractors. The president of the society, Mr. L. W. Chase, has appointed a special committee to advise and assist in the technical management of the competition. Rules and regulations governing the contest and supervising the testing and judging of the tractors will be furnished. The rapidly growing importance of tractors for agricultural purposes, etc., should make the work of the society of exceptional engineering value and interest.

International Engineering Congress will be held in San Francisco, Cal., in 1915, in connection with the Panama-Pacific International Exposition. The congress is to be conducted under the auspices of the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers. These societies, acting in cooperation, have appointed a permanent committee of management, consisting of the presidents and secretaries of each of these societies and eighteen members resident in San Francisco. W. F. Durand is chairman of the committee of management, with offices in the Foxcroft Building, San Francisco.

NEW BOOKS AND PAMPHLETS

Government Coal Purchases Under Specifications. By George S. Pope and Joseph D. Davis. 96 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Bulletin No. 41.

The Properties of Saturated and Superheated Ammonia Vapor. By G. A. Goodenough, and William Earl Mosher. 94 pages, 6 by 9 inches. Published by the University of Illinois Experiment Station, Urbana, Ill. Price, 50 cents.

The Evaporation Test for Mineral Lubricating and Transformer Oils. By C. E. Waters. 13 pages, 7 by 10 inches. Published by the Department of Commerce and Labor, Washington, D. C., as No. 13 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Action of the Salts in Alkali Water and Sea Water on Cements. By P. H. Bates, A. J. Phillips and Rudolph J. Wig. 157 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 12 of the Technologic Papers of the Bureau of Standards. S. W. Stratton, director.

Scientific Road Construction. 31 pages, 6 by 9 inches. Illustrated. Published as Bulletin No. 5 by the Department of Asphaltum, Standard Oil Co. of California.

The bulletin is of interest to all concerned with good roads. It gives the reasons for road failures and treats of the advantages of asphaltum as a road-making material when incorporated with broken rock.

Industrial Arts Index—A Cumulative Index to Engineering and Trade Periodicals. 6¾ by 9¾ inches. Published by the H. W. Wilson Co., Minneapolis, Minn.

The index is issued five times a year and each number is cumulated for the year to date of issue. The December number will contain the annual cumulation. The contents of all magazines reviewed are indexed by author and under as many subject heads as the contents demand. This plan of subject indexing brings articles on any one subject to one place in the alphabet and cross references make easy the finding of material on allied subjects.

Tests of Reinforced Concrete Buildings Under Load. By Arthur N. Talbot and Willis A. Slater. 104 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 64. Price 50 cents.

The bulletin gives a detailed description of the methods developed at the University of Illinois for measuring stresses produced in steel and concrete in reinforced buildings under load. By the use of measuring apparatus, the minute stretches and shortenings which occur in the beams, columns and floor slabs of a reinforced concrete building while under load, were measured. The results of the tests on three large buildings located in three cities are recorded. The data obtained are of a character to permit a discussion of the correctness of the methods of design and of the mathematical formulas in use. The bulletin is of special use to engineers, structural designers and architects, and is of general interest to manufacturers contemplating the erection of concrete structures.

NEW CATALOGUES AND CIRCULARS

C. &. C. Electric & Mfg. Co., Garwood, N. J. Bulletin 513C on electric arc welding apparatus.

New Jersey Foundry & Machine Co., 90 West St., New York City. Circular of cranes, tracks, trolleys, and hoists.

James Clark, Jr., Electric Co., Louisville, Ky. Circular of "Willey" electrically-driven sensitive drills and grinders.

Spray Engineering Co., 201 Devonshire St., Boston, Mass. Bulletin No. 51 illustrating and describing "air washers."

Edgemont Machine Co., 2700 National Ave., Dayton, Ohio. Catalogue "E" describing several new types of friction clutches.

Gardner Governor Co., Quincy, Ill. Catalogue of Gardner-Rix vertical air compressors and Gardner horizontal air compressors.

Bullard Machine Tool Co., Bridgeport, Conn. Circular descriptive of the new turret head of the Bullard vertical turret lathe.

W. L. Bruhaker & Bros., Millersburg, Pa. Catalogue of taps, dies, reamers, special tools, screw plates, pipe stocks, end mills, etc.

American Brass Co., Ansonia, Conn. Booklet on "Tobin" bronze, containing data on tensile, torsional, crushing and corrosive tests.

Steel Specialties Co., 66 Woerd Ave., Waltham, Mass. Leaflet on the new Worth clamp wedge washer, a nut lock and washer combined.

Lennox Throatless Shear Co., Marshalltown, Iowa. Circular of the Lennox throatless shear for cutting straight and serpentine shapes from sheet metal.

Chambersburg Engineering Co., Chambersburg, Pa. Wall calendar for 1913 illustrating examples of hydraulic machinery for every variety of forging.

Keuffel & Esser Co., Hoboken, N. J. Circular of the Smith fountain drawing pen which eliminates the time lost through constantly refilling drawing pens.

Baldwin Locomotive Works, Philadelphia, Pa. Record Nos. 73 and 74, on "Recent Development of the Locomotive" and "Gasoline Locomotives," respectively.

International Oxygen Co., 115 Broadway, New York City. Booklet illustrating a number of oxygen and hydrogen plants in operation installed by the company.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 127, on pneumatic drills, reamers, wood borers, flue rolling and tapping machines and grinders.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Bulletin 119 on selective-head engine lathes built in 14-, 16-, 18-, 20-, 22-, 24-, 27-, 30-, 36-, 42-, and 48-inch sizes.

Richmond Stay-Bolt Drilling Machine Mfg. Co., Richmond, Va. Catalogue of multiple spindle semi-automatic stay-bolt drills for drilling detector holes in the ends of locomotive stay-bolts.

De Laval Steam Turbine Co., Trenton, N. J. Pamphlet of 108 pages on the De Laval steam turbine, containing valuable and interesting data for those interested in steam turbine equipment for power plants.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Catalogue No. 521 on Sprague steel-armored hose for railroad air brakes, steam heating tender hose and pneumatic hose.

Bristol Co., Waterbury, Conn. Bulletins 143 and 173 on Bristol recording differential pressure gages, bulletin 170 on soldering iron electric furnaces and catalogue 1300 on Bristol Class III recording thermometers.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet illustrating office buildings, municipal buildings, hotels, department stores, and other buildings in Chicago, equipped with Cutler-Hammer apparatus for controlling motors, etc.

Norton Co., Worcester, Mass. Health Bulletins Nos. 1 to 12 issued by the Norton Co.'s medical department for the information and guidance of workmen. These health bulletins contain much practical and valuable health information.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletins Nos. 128, 132 and 133 on miscellaneous equipment for pneumatic drills, pneumatic motors and pneumatic geared hoists, and cylinder air hoists and jacks, respectively.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Circular of Hisey tool-post grinders; parallel and internal grinders; hand and breast drills; feed-screw drills; portable and aerial grinders and buffers; Scotch radial drills, all electrically operated.

Joseph Dixon Crucible Co., Jersey City, N. J. Pamphlet on Dixon's graphite brushes for electric generators and motors. Directions are given for using brushes under various conditions of service, and other valuable information is included.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue of "Brownhoist" locomotive cranes containing many fine halftone illustrations of equipment furnished to railroads, manufacturers, contractors, etc., in all parts of the country.

Whitman & Barnes Mfg. Co., Akron, Ohio. Folder illustrating the company's line of twist drills, easy starting arbors, fluted shell reamers, taper shank jobbers' reamers, taper bridge reamers, expansion reamers, roughing reamers, chucking reamers, etc.

Cling Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet entitled "Is There Rosin in Cling-Surface?", containing reports from chemists showing that no rosin is contained in the belt preparation known as "Cling-Surface." A list of prominent users is also given.

Flexible Steel Lacing Co., Chicago, Ill. Circular of steel lacing for machine belting which provides a rocker hinged joint. The lacing is provided with "alligator" teeth, to engage the belt fabric, and is easily and quickly applied to leather, canvas or rubber belting.

Rockford Machine Tool Co., Rockford, Ill. Circular of the Rockford No. 44 vertical milling machine having capacity of 44 inches table feed, 16½ inches cross feed, and 19 inches vertical feed. This machine has a non-adjustable knee, the spindle being mounted in a vertical slide.

Asbestos Protected Mētal Co., Beaver Falls, Pa. Circular of asbestos protected metal for roofing, siding, etc., of manufacturing plants. The material consists of metal sheet covered with a protective coating to prevent rust, over which is applied the asbestos surfacing.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular of Garvin cam or form milling machines of 6, 12, 24 and 36 inches capacity. The line of form milling machines illustrated covers a wide range and variety of cam and form milling, embracing both disk and barrel cams.

Beaudry & Co., 141 Milk St., Boston, Mass. Booklet on Beaudry power hammers built in two types: The "Champion" for light and heavy railroad, machine and general forging, and the "Peerless" for plating, drawing, swaging, collaring, spindle-making and general manufacturing.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa. Pamphlet on fuel costs, being a comparison of the cost of burning fuel oil, producer gas, natural gas and powdered coal in furnaces. The data contained is of interest to all concerned with the operation of heating furnaces for metal treatment.

Queen City Machine Tool Co., Cincinnati, Ohio. Circular of the Queen City plain cylindrical grinder, 12 and 14 inches swing, 36, 48, 60, 72 inches and up, between centers. The features of this grinder are all steel gears, centralized control, large protected bearings, massive and self-contained design, good lubrication, etc.

Dodge Mfg. Co., Mishawaka, Ind. Folder entitled "Over-the-Seas," illustrating how Dodge transmission machinery is packed and crated for foreign shipment. This important detail of marketing goods abroad has been thoroughly worked out by the Dodge people, and very substantial crating is provided for all goods shipped abroad.

Ideal Casehardening Compound Co., United States Rubber Bldg., New York City. Fifth edition of treatise on casehardening and heat-treating steel, containing much useful information and many practical rules. This little treatise, which is sent to any address on application, will be found very useful by all concerned with the heat-treatment of steel.

J. Faessler Mfg. Co., Moberly, Mo. Catalogue illustrating and describing the Faessler line of boiler tools, comprising several types of hand-operated and power-driven roller flue expanders, sectional beading expanders, flue cutters, patch bolt countersinking tools, etc. The new Faessler safety sectional expander with quick-acting knock-out is shown.

Cooper Hewitt Electric Co., Hoboken, N. J. Pamphlet on industrial lighting, illustrating shops, mills and factories illuminated with a Cooper Hewitt light, and containing a general discussion of illumination, conditions of distinct vision, effect of glare, faults of individual lighting, cause of industrial accidents, importance of diffusion, effect of color on distinctness of vision, etc.

McKenna Bros. Brass Co., Pittsburg, Pa. Circular of the Keen impact ball tester for testing the hardness of steels. This simple device combines some of the features of the Brinell and Shore instruments for testing. It substitutes dynamic force for static force to impress a hardened ball into the material to be tested and measures the width of the indentation with a special form of scale.

Julius King Optical Co., 10-12 Maiden Lane, New York City and 7 W. Madison St., Chicago, Ill. Catalogue on King safety goggles for use in steel mills, foundries, factories, etc., where workmen's eyes are endangered by flying particles. These goggles, known as the "Saniglas," are fitted with the strongest, toughest glass that can be manufactured. While the glass may be fractured, it holds together and very seldom shatters.

Sprague Electric Works of the General Electric Co., 527-531 West 34th St., New York City. Circular of Sprague electric equipment for printing machinery; Catalogue 439 on Sprague conduit products, comprising stamped steel boxes and covers, multilets, G. E. receptacles, switches, sockets and rosettes, flexible steel conduits (galvanized), rigid conduits, watertight floor outlet boxes, cast-iron outlet and junction boxes, etc.

Structural Card Index Systems. E. R. Monroe, manager, 512-514 Phoenix Block, Bay City, Mich. Catalogue of card index systems for cast-iron columns, steel plates, standard angles of even legs, standard angles of uneven legs, channels and I-beams, cast-iron plates, requisition blanks, flexible leather covers, etc. These structural card index systems are being used by manufacturers, engineers, architects and others, with satisfaction.

New Britain Machine Co., 64 Bigelow St., New Britain, Conn. Circular of the No. 2½ five-spindle full automatic. The company has purchased the patents and manufacturing rights covering the Universal screw machine formerly made by the Universal Machine Screw Co., of Hartford, Conn. This screw machine, with the line of Prentice chucking machines for castings, forgings and second operation work, completes a line of multiple-spindle automatics covering a wide range of work.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 34L on general pneumatic engineering information, containing instructions for intending purchasers, air compressor data, quarrying and mining data, general pneumatic tool data

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WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—I

Gage	Thickness in Inches	$\frac{1}{16}$-inch	$\frac{1}{8}$-inch	$\frac{3}{16}$-inch	$\frac{1}{4}$-inch	$\frac{5}{16}$-inch	$\frac{3}{8}$-inch	$\frac{7}{16}$-inch	$\frac{1}{2}$-inch
0000000	0.5000	0.1063	0.2126	0.3189	0.4252	0.5315	0.6378	0.7441	0.8504
000000	0.4688	0.0996	0.1992	0.2988	0.3984	0.4980	0.5976	0.6972	0.7968
00000	0.4375	0.0930	0.1860	0.2790	0.3720	0.4650	0.5580	0.6510	0.7440
0000	0.4063	0.0864	0.1728	0.2592	0.3456	0.4320	0.5184	0.6048	0.6912
000	0.3750	0.0797	0.1594	0.2391	0.3188	0.3985	0.4782	0.5579	0.6376
00	0.3438	0.0731	0.1462	0.2193	0.2924	0.3655	0.4386	0.5117	0.5848
0	0.3125	0.0664	0.1328	0.1992	0.2656	0.3320	0.3984	0.4648	0.5312
1	0.2813	0.0598	0.1196	0.1794	0.2392	0.2990	0.3588	0.4186	0.4784
2	0.2656	0.0565	0.1130	0.1695	0.2260	0.2825	0.3390	0.3955	0.4520
3	0.2500	0.0531	0.1062	0.1593	0.2124	0.2655	0.3186	0.3717	0.4248
4	0.2344	0.0498	0.0996	0.1494	0.1992	0.2490	0.2988	0.3486	0.3984
5	0.2188	0.0465	0.0930	0.1395	0.1860	0.2325	0.2790	0.3255	0.3720
6	0.2031	0.0432	0.0864	0.1296	0.1728	0.2160	0.2592	0.3024	0.3456
7	0.1875	0.0399	0.0798	0.1197	0.1596	0.1995	0.2394	0.2793	0.3192
8	0.1719	0.0365	0.0730	0.1095	0.1460	0.1825	0.2190	0.2555	0.2920
9	0.1563	0.0332	0.0664	0.0996	0.1328	0.1660	0.1992	0.2324	0.2656
10	0.1406	0.0299	0.0598	0.0897	0.1196	0.1495	0.1794	0.2093	0.2392
11	0.1250	0.0266	0.0532	0.0798	0.1064	0.1330	0.1596	0.1862	0.2128
12	0.1094	0.0233	0.0466	0.0699	0.0932	0.1165	0.1398	0.1631	0.1864
13	0.0938	0.0199	0.0398	0.0597	0.0796	0.0995	0.1194	0.1393	0.1592
14	0.0781	0.0166	0.0332	0.0498	0.0664	0.0830	0.0996	0.1162	0.1328
15	0.0703	0.0149	0.0298	0.0447	0.0596	0.0745	0.0894	0.1043	0.1192
16	0.0625	0.0133	0.0266	0.0399	0.0532	0.0665	0.0798	0.0931	0.1064
17	0.0563	0.0120	0.0240	0.0360	0.0480	0.0600	0.0720	0.0840	0.0960
18	0.0500	0.0106	0.0212	0.0318	0.0424	0.0530	0.0636	0.0742	0.0848
19	0.0438	0.0093	0.0186	0.0279	0.0372	0.0465	0.0558	0.0651	0.0744
20	0.0375	0.0080	0.0160	0.0240	0.0320	0.0400	0.0480	0.0560	0.0640
21	0.0344	0.0073	0.0146	0.0219	0.0292	0.0365	0.0438	0.0511	0.0584
22	0.0313	0.0067	0.0133	0.0201	0.0268	0.0335	0.0402	0.0469	0.0536
23	0.0281	0.0060	0.0120	0.0180	0.0240	0.0300	0.0360	0.0420	0.0480
24	0.0250	0.0053	0.0106	0.0159	0.0212	0.0265	0.0318	0.0371	0.0424
25	0.0219	0.0047	0.0094	0.0141	0.0188	0.0235	0.0282	0.0329	0.0376
26	0.0188	0.0040	0.0080	0.0120	0.0160	0.0200	0.0240	0.0280	0.0320
27	0.0172	0.0037	0.0074	0.0111	0.0148	0.0185	0.0222	0.0259	0.0296
28	0.0156	0.0033	0.0066	0.0099	0.0132	0.0165	0.0198	0.0231	0.0264
29	0.0141	0.0030	0.0060	0.0090	0.0120	0.0150	0.0180	0.0210	0.0240
30	0.0125	0.0027	0.0054	0.0081	0.0108	0.0135	0.0162	0.0189	0.0216
31	0.0109	0.0023	0.0046	0.0069	0.0092	0.0115	0.0138	0.0161	0.0184
32	0.0102	0.0022	0.0044	0.0066	0.0088	0.0110	0.0132	0.0154	0.0176
33	0.0094	0.0020	0.0040	0.0060	0.0080	0.0100	0.0120	0.0140	0.0160
34	0.0086	0.0018	0.0036	0.6054	0.0072	0.0090	0.0108	0.0126	0.0144
35	0.0078	0.0017	0.0034	0.0051	0.0068	0.0085	0.0102	0.0119	0.0136
36	0.0070	0.0015	0.0030	0.0045	0.0060	0.0075	0.0090	0.0105	0.0120
37	0.0066	0.0014	0.0028	0.0042	0.0056	0.0070	0.0084	0.0098	0.0112
38	0.0063	0.0013	0.0026	0.0039	0.0052	0.0065	0.0078	0.0091	0.0104

Contributed by G. W. Linn

No. 168, Data Sheet, MACHINERY, July, 1913

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—II

Gage	$\frac{9}{16}$-inch	$\frac{5}{8}$-inch	$\frac{11}{16}$-inch	$\frac{3}{4}$-inch	$\frac{13}{16}$-inch	$\frac{7}{8}$-inch	$\frac{15}{16}$-inch	1-inch	2 inches
0000000	0.9567	1.0630	1.1693	1.2756	1.3819	1.4882	1.5945	1.7008	3.4016
000000	0.8964	0.9960	1.0956	1.1952	1.2948	1.3944	1.4940	1.5936	3.1872
00000	0.8370	0.9300	1.0230	1.1160	1.2090	1.3020	1.3950	1.4880	2.9760
0000	0.7776	0.8640	0.9500	1.0368	1.1232	1.2096	1.2960	1.3824	2.7648
000	0.7173	0.7970	0.8767	0.9564	1.0361	1.1158	1.1955	1.2752	2.5504
00	0.6579	0.7310	0.8041	0.8772	0.9505	1.0234	1.0965	1.1696	2.3392
0	0.5976	0.6640	0.7300	0.7968	0.8632	0.9296	0.9960	1.0624	2.1248
1	0.5382	0.5980	0.6578	0.7176	0.7774	0.8372	0.8970	0.9568	1.9136
2	0.5085	0.5650	0.6215	0.6780	0.7345	0.7910	0.8475	0.9040	1.8080
3	0.4779	0.5310	0.5841	0.6372	0.6903	0.7434	0.7965	0.8496	1.6992
4	0.4482	0.4980	0.5478	0.5976	0.6474	0.6972	0.7470	0.7968	1.5936
5	0.4185	6.4650	0.5115	0.5580	0.6045	0.6510	0.6975	0.7440	1.4880
6	0.3888	0.4320	0.4752	0.5184	0.5616	0.6048	0.6480	0.6912	1.3824
7	0.3591	0.3990	0.4389	0.4788	0.5187	0.5586	0.5985	0.6384	1.2768
8	0.3285	0.3650	0.4015	0.4380	0.4745	0.5110	0.5475	0.5840	1.1680
9	0.2988	0.3320	0.3652	0.3984	0.4316	0.4648	0.4980	0.5312	1.0624
10	0.2691	0.2990	0.3289	0.3588	0.3887	0.4186	0.4485	0.4784	0.9568
11	0.2394	0.2660	0.2926	0.3192	0.3458	0.3724	0.3990	0.4256	0.8512
12	0.2097	0.2330	0.2563	0.2796	0.3029	0.3262	0.3445	0.3728	0.7456
13	0.1791	0.1990	0.2189	0.2388	0.2587	0.2786	0.2985	0.3184	0.6368
14	0.1494	0.1660	0.1826	0.1992	0.2158	0.2324	0.2490	0.2656	0.5312
15	0.1341	0.1490	0.1639	0.1788	0.1937	0.2086	0.2235	0.2384	0.4768
16	0.1197	0.1330	0.1463	0.1596	0.1729	0.1862	0.1995	0.2128	0.4256
17	0.1080	0.1200	0.1320	0.1440	0.1560	0.1680	0.1800	0.1920	0.3840
18	0.0954	0.1060	0.1166	0.1272	0.1378	0.1484	0.1590	0.1696	0.3392
19	0.0837	0.0930	0.1023	0.1116	0.1209	0.1302	0.1395	0.1488	0.2976
20	0.0720	0.0800	0.0880	0.0960	0.1040	0.1120	0.1200	0.1280	0.2560
21	0.0657	0.0730	0.0803	0.0876	0.0949	0.1022	0.1095	0.1168	0.2336
22	0.0603	0.0670	0.0737	0.0804	0.0871	0.0938	0.1005	0.1072	0.2144
23	0.0540	0.0600	0.0660	0.0720	0.0780	0.0840	0.0900	0.0960	0.1920
24	0.0477	0.0530	0.0583	0.0636	0.0689	0.0742	0.0795	0.0848	0.1696
25	0.0423	0.0470	0.0517	0.0564	0.0611	0.0658	0.0705	0.0752	0.1504
26	0.0360	0.0400	0.0440	0.0480	0.0520	0.0560	0.0600	0.0640	0.1280
27	0.0333	0.0370	0.0407	0.0444	0.0481	0.0518	0.0555	0.0592	0.1184
28	0.0297	0.0330	0.0363	0.0396	0.0429	0.0462	0.0495	0.0528	0.1056
29	0.0270	0.0300	0.0330	0.0360	0.0390	0.0120	0.0450	0.0480	0.6960
30	0.0243	0.0270	0.0297	0.0324	0.0351	0.0378	0.0405	0.0432	0.0864
31	0.0207	0.0230	0.0253	0.0276	0.0299	0.0322	0.0345	0.0368	0.0736
32	0.0198	0.0220	0.0242	0.0264	0.0286	0.0308	0.0330	0.0352	0.0704
33	0.0180	0.0200	0.0220	0.0240	0.0260	0.0280	0.0300	0.0320	0.0640
34	0.0162	0.0180	0.0198	0.0216	0.0234	0.0252	0.0270	0.0288	0.0576
35	0.0153	0.0170	0.0187	0.0204	0.0221	0.0238	0.0255	0.0272	0.0544
36	0.0135	0.0150	0.0165	0.0180	0.0195	0.0210	0.0225	0.0240	0.0480
37	0.0126	0.0140	0.0154	0.0168	0.0182	0.0196	0.0210	0.0224	0.0448
38	0.0117	0.0130	0.0143	0.0156	0.0169	0.0182	0.0195	0.0208	0.0416

Contributed by G. W. Linn

No. 168, Data Sheet, MACHINERY, July, 1913

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—III

Gage	3 inches	4 inches	5 inches	6 inches	7 inches	8 inches	9 inches	10 inches	11 inches
0000000	5.1024	6.8032	8.5040	10.2048	11.9056	13.6064	15.3072	17.0080	18.7088
000000	4.7808	6.3744	7.9680	9.5616	11.1552	12.7488	14.3424	15.9360	17.5296
00000	4.4640	5.9520	7.4400	8.9280	10.4160	11.9040	13.3920	14.8800	16.3680
0000	4.1472	5.5296	6.9120	8.2944	9.6768	11.0592	12.4416	13.8240	15.2064
000	3.8256	5.1008	6.3760	7.6512	8.9264	10.2016	11.4768	12.7520	14.0272
00	3.5088	4.6784	5.8480	7.0176	8.1872	9.3568	10.5264	11.6960	12.8656
0	3.1872	4.2496	5.3120	6.3744	7.4368	8.4992	9.5616	10.6240	11.6864
1	2.8704	3.8272	4.7840	5.7408	6.6976	7.6544	8.6112	9.5680	10.5248
2	2.7120	3.6160	4.5200	5.4240	6.3280	7.2320	8.1360	9.0400	9.9440
3	2.5488	3.3984	4.2480	5.0976	5.9472	6.7968	7.6464	8.4960	9.3456
4	2.3904	3.1872	3.9840	4.7808	5.5776	6.3744	7.1712	7.9680	8.7648
5	2.2320	2.9760	3.7200	4.4640	5.2080	5.9520	6.6960	7.4400	8.1840
6	2.0736	2.7648	3.4560	4.1472	4.8384	5.5296	6.2208	6.9120	7.6032
7	1.9152	2.5536	3.1920	3.8304	4.4688	5.1072	5.7456	6.3840	7.0224
8	1.7520	2.3360	2.9200	3.5040	4.0880	4.6720	5.2560	5.8400	6.4240
9	1.5936	2.1248	2.6560	3.1872	3.7184	4.2496	4.7808	5.3120	5.8432
10	1.4352	1.9136	2.3920	2.8704	3.3488	3.8272	4.3056	4.7840	5.2624
11	1.2768	1.7024	2.1280	2.5536	2.9792	3.4048	3.8304	4.2560	4.6816
12	1.1184	1.4912	1.8640	2.2368	2.6096	2.9824	3.3552	3.7280	4.1008
13	0.9552	1.2736	1.5920	1.9104	2.2288	2.5472	2.8656	3.1840	3.5024
14	0.7968	1.0624	1.3280	1.5936	1.8592	2.1248	2.3904	2.6560	2.9216
15	0.7152	0.9536	1.1920	1.4304	1.6688	1.9072	2.1456	2.3840	2.6224
16	0.6384	0.8512	1.0640	1.2768	1.4896	1.7024	1.9152	2.1280	2.3408
17	0.5760	0.7680	0.9600	1.1520	1.3440	1.5360	1.7280	1.9200	2.1120
18	0.5088	0.6786	0.8480	1.0276	1.1872	1.3572	1.5264	1.6960	1.8656
19	0.4464	0.5952	0.7440	0.8928	1.0416	1.1904	1.3192	1.4880	1.6368
20	0.3840	0.5120	0.6400	0.7680	0.8960	1.0240	1.1520	1.2800	1.4080
21	0.3504	0.4672	0.5840	0.7008	0.8176	0.9344	1.0512	1.1680	1.2848
22	0.3216	0.4288	0.5360	0.6432	0.7504	0.8576	0.9648	1.0720	1.1792
23	0.2880	0.3840	0.4800	0.5760	0.6720	0.7680	0.8640	0.9600	1.0560
24	0.2544	0.3392	0.4240	0.5088	0.5936	0.6784	0.7632	0.8480	0.9328
25	0.2256	0.3008	0.3760	0.4512	0.5264	0.6016	0.6768	0.7520	0.8272
26	0.1920	0.2560	0.3200	0.3840	0.4480	0.5120	0.5960	0.6400	0.7040
27	0.1776	0.2368	0.2960	0.3552	0.4144	0.4736	0.5328	0.5920	0.6512
28	0.1584	0.2112	0.2640	0.3168	0.3696	0.4224	0.4752	0.5280	0.5808
29	0.1440	0.1920	0.2400	0.2880	0.3360	0.3840	0.4320	0.4800	0.5280
30	0.1296	0.1768	0.2160	0.2592	0.3024	0.3536	0.3888	0.4320	0.4752
31	0.1104	0.1472	0.1840	0.2208	0.2576	0.2974	0.3312	0.3680	0.4048
32	0.1056	0.1408	0.1760	0.2112	0.2464	0.2816	0.3168	0.3520	0.3872
33	0.0960	0.1280	0.1600	0.1920	0.2240	0.2560	0.2880	0.3200	0.3520
34	0.0864	0.1152	0.1440	0.1728	0.2016	0.2304	0.2592	0.2880	0.3168
35	0.0816	0.1088	0.1360	0.1632	0.1904	0.2176	0.2448	0.2720	0.2992
36	0.0720	0.0960	0.1200	0.1480	0.1680	0.1920	0.2160	0.2400	0.2640
37	0.0674	0.0896	0.1120	0.1348	0.1568	0.1792	0.2016	0.2240	0.2464
38	0.0624	0.0832	0.1040	0.1248	0.1456	0.1664	0.1872	0.2080	0.2288

Contributed by G. W. Linn

WEIGHTS OF FLAT ROLLED STEEL PER LINEAL FOOT IN POUNDS—IV

Gage	12 inches	13 inches	14 inches	15 inches	16 inches	17 inches	18 inches	19 inches	20 inches
0000000	20.4096	22.1104	23.8112	25.5120	27.2128	28.9136	30.6144	32.3152	34.0160
000000	19.1232	20.7168	22.3104	23.9040	25.4976	27.0912	23.6848	30.2784	31.8720
00000	17.8560	19.3440	20.8320	22.3200	23.8080	25.2960	26.7840	28.2720	29.7600
0000	16.5888	17.9712	19.3536	20.7360	22.1184	23.5008	24.8832	26.2656	27.6480
000	15.3024	16.5776	17.8528	19.1280	20.4032	21.6784	22.9536	24.2288	25.5040
00	14.0352	15.2048	16.3744	17.5440	18.7136	19.8832	21.0528	22.2224	23.3920
0	12.7488	13.8112	14.8736	15.9360	16.9984	18.0608	19.1232	20.1856	21.2480
1	11.4816	12.4384	13.3952	14.3520	15.3088	16.2656	17.2224	18.1792	19.1360
2	10.8480	11.7520	12.6560	13.5600	14.4640	15.3680	16.2720	17.1760	18.0800
3	10.1952	11.0448	11.8944	12.7440	13.5936	14.4432	15.2928	16.1424	16.9920
4	9.5616	10.3584	11.1552	11.9520	12.7488	13.5456	14.3424	15.1392	15.9360
5	8.9280	9.6720	10.4160	11.1600	11.8040	12.6480	13.3920	14.1360	14.8800
6	8.2944	8.9856	9.6768	10.3680	11.0592	11.7504	12.4416	13.1328	13.8240
7	7.6608	8.2992	8.9376	9.5760	10.2144	10.8528	11.4912	12.1296	12.7680
8	7.0080	7.5920	8.1760	8.7600	9.3440	9.9280	10.5120	11.0960	11.6800
9	6.3744	6.9056	7.4368	7.9680	8.4992	9.0304	9.5616	10.0928	10.6240
10	5.7408	6.2192	6.6976	7.1760	7.6544	8.1328	8.6112	9.0896	9.5680
11	5.1072	5.5328	5.9584	6.3840	6.8096	7.2352	7.6608	8.0864	8.5120
12	4.4736	4.8464	5.2192	5.5920	5.9648	6.3376	6.7101	7.0832	7.4560
13	3.8208	4.1392	4.4576	4.7760	5.0944	5.4128	5.7312	6.0496	6.3680
14	3.1872	8.4528	3.7184	3.9840	4.2496	4.5152	4.7808	5.0464	5.3120
15	2.8608	3.0992	3.3376	3.5760	3.8144	4.0528	4.2912	4.5296	4.7680
16	2.5536	2.7664	2.9792	3 1920	3.4048	3.6176	3.8304	4.0432	4.2560
17	2.3040	2.4960	2.6880	2.8800	3.0720	3.2640	3.4560	8.6480	3.8400
18	2.0552	2.2048	2.3744	2.5140	2.7144	2.8632	3.0568	3.2224	3.3920
19	1.7856	1.9344	2.0832	2.2320	2.3808	2.5296	2.6384	2.8272	2.9760
20	1.5360	1.6640	1.7920	1.9200	2.0480	2.1760	2.3040	2.4320	2.5600
21	1.4016	1.5184	1.6352	1.7520	1.8688	1.9856	2.1024	2.2192	2.3360
22	1.2864	1.3936	1.5008	1.6080	1.7152	1.8084	1.9296	2.0368	2.1440
23	1.1520	1.2480	1.3440	1.4400	1.5360	1.6320	1.7280	1.8240	1.9200
24	1.0176	1.1024	1.1872	1.2720	1.3568	1.4416	1.5264	1.6112	1.6960
25	0.9024	0.9776	1.0528	1.1280	1.2032	1.2784	1.3536	1.4288	1.5040
26	0.7680	0.8320	0.8960	0.9600	1.0240	1.0880	1.1920	1.2460	1.3800
27	0.7104	0.7696	0.8288	0.8880	0.9472	1.0064	1.0658	1.1248	1.1840
28	0.6336	0.6864	0.7392	0.7920	0.8448	0.8976	0.9504	1.0032	1.0560
29	0.5760	0.6240	0.6720	0.7200	0.7680	0.8160	0.8640	0.9120	0.9600
30	0.5184	0.5616	0.6048	0.6480	0.7072	0.7344	0.7776	0.8208	0.8640
31	0.4416	0.4784	0.5152	0 5520	0.5948	0.6256	0.6624	0.6992	0.7360
32	0.4224	0.4576	0.4928	0.5280	0.5632	0.5984	0 6336	0.6688	0.7140
33	0.3840	0.4160	0.4480	0.4800	0.5120	0.5440	0.5760	0.6080	0.6400
34	0.3456	0.3744	0.4032	0.4320	0.4608	0.4896	0.5184	0.5472	0.5760
35	0.3264	0.3596	0.3808	0 4080	0.4352	0 4624	0.4896	0.5168	0.5440
36	0.2960	0.3120	0.3360	0.3600	0.3840	0.4080	0.4320	0.4560	0 4800
37	0.2796	0.2912	0.3136	0.3360	0.3584	0 3808	0.4032	0.4256	0.4480
38	0.2496	0.2704	0.2912	0 8120	0.3328	0.3536	0.3744	0.3952	0.4160

Contributed by G. W. Linn

MACHINERY

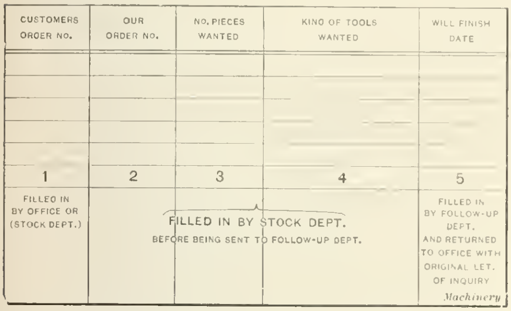
AUGUST, 1913

AN EFFECTIVE FOLLOW-UP SYSTEM*

A SYSTEM FOR RECORDING THE PROGRESS OF SMALL MANUFACTURED PARTS

BY A. L. VALENTINE

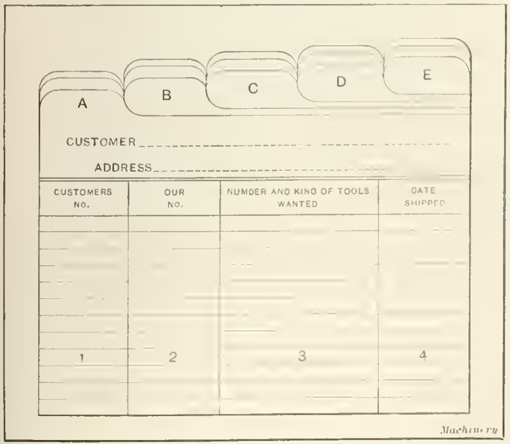
THE primary consideration in introducing new methods of management, is whether or not an adequate remuneration will be derived from the expenditure involved. Such remuneration may be either direct or indirect, but it must be sufficient to offset both the cost of introducing the new method and the operating and maintenance costs, and still leave the required margin of profit. When the project is of a size which involves a large outlay of money, it is obvious that the most careful study must be given to every detail of the proposed plan.



CUSTOMERS ORDER NO.	OUR ORDER NO.	NO. PIECES WANTED	KIND OF TOOLS WANTED	WILL FINISH DATE
1	2	3	4	5
FILLED IN BY OFFICE OR (STOCK DEPT.)	FILLED IN BY STOCK DEPT. BEFORE BEING SENT TO FOLLOW-UP DEPT.			FILLED IN BY FOLLOW-UP DEPT. AND RETURNED TO OFFICE WITH ORIGINAL LET. OF INQUIRY

Fig. 1. Form used to follow up an Inquiry Regarding Date of Shipment

It is the purpose of this article to outline a follow-up system which was recently developed by the writer for keeping an account of the materials used in a factory engaged in small interchangeable manufacture, and also of the progress made by different orders in passing from department to department in the course of manufacture. This new system was introduced to remedy certain evils that are likely to arise in any manufacturing establishment, and the writer was particularly fortunate in that he was not hindered by considerations of expenditure. This fact is mentioned because, had considerations of expenditure been carefully weighed before the benefits derived from the change had been demonstrated, it is probable that the new system would have been one of the many useful ideas "adorning the shelf," owing to the large initial and up-keep expenses. It may be mentioned that lack of perception on the part of the management is often responsible for discarding valuable ideas from failure to see the advantages which they possess, and unwillingness to bear the burden of what appear to be unreasonable expenses.



A
B
C
D
E

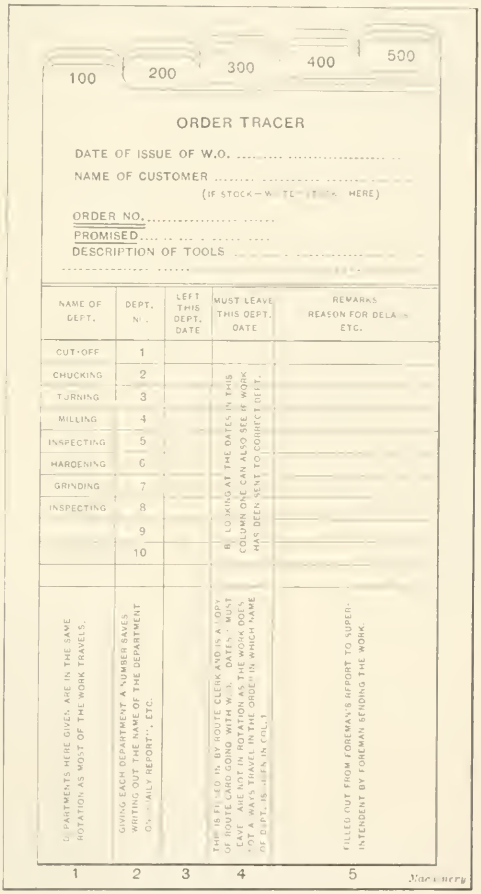
CUSTOMER
ADDRESS

CUSTOMERS NO.	OUR NO.	NUMBER AND KIND OF TOOLS WANTED	DATE SHIPPED
1	2	3	4

Machinery

Fig. 2. Card Index kept by Stock Department

Before explaining the workings of the present follow-up system, it will be of interest to outline briefly the conditions which were responsible for bringing it about. As previously mentioned, this system was introduced through necessity and the same may be said of the changes which are made in many industrial establishments. When a factory is engaged in the manufacture of small tools or similar products, turned out in large quantities, a great many letters are received containing the vexing question, "When will you ship?" If these inquiries are not answered promptly and truthfully, the people waiting for the shipment of their orders will often be put to considerable inconvenience, as it is likely that they have planned and laid out their work with such promises of shipment in



100
200
300
400
500

ORDER TRACER

DATE OF ISSUE OF W.O. ....
NAME OF CUSTOMER ....
(IF STOCK—W[illegible] HERE)
ORDER NO. ....
PROMISED ....
DESCRIPTION OF TOOLS ....

NAME OF DEPT.	DEPT. NO.	LEFT THIS DEPT. DATE	MUST LEAVE THIS DEPT. DATE	REMARKS REASON FOR DELAY ETC.
CUT-OFF	1			
CHUCKING	2		BY LOOKING AT THE DATES IN THIS COLUMN ONE CAN ALSO SEE IF WORK HAS BEEN SENT TO CORRECT DEPT.	
TURNING	3			
MILLING	4			
INSPECTING	5			
HARDENING	6			
GRINDING	7			
INSPECTING	8			
	9			
	10			
DEPARTMENTS HERE GIVEN ARE IN THE SAME ROTATION AS MOST OF THE WORK TRAVELS.	GIVING EACH DEPARTMENT A NUMBER SAVES WRITING OUT THE NAME OF THE DEPARTMENT ON "DAILY REPORT", ETC.		THIS IS FILLED IN BY ROUTE CLERK AND IS A COPY OF ROUTE CARD GOING WITH W. O. DATES MUST LEAVE ARE NOT IN ROTATION AS THE WORK DOES NOT ALWAYS TRAVEL IN THE ORDER IN WHICH NAME OF DEPT. IS GIVEN IN COL. 1	FILLED OUT FROM FOREMAN'S REPORT TO SUPERINTENDENT BY FOREMAN SENDING THE WORK.
1	2	3	4	5

Fig. 3. Order Tracer Card Index kept by Follow-up Department

view. If these promises are not kept, the orders will frequently be cancelled or repeat orders, at least, will not be received by the manufacturer. It was due to the distrust created among prospective purchasers, through giving evasive answers to inquiries about dates of shipment, and failure to keep promises, which led to the writer being given free hand to develop a follow-up system without being handicapped by considerations of the expenditure involved. This system is, with some modifications, in use in one of the largest factories of its kind in the United States, and after more than three years' experience, it has demonstrated its ability not only to remedy the evils which previously existed, but also to improve manufacturing conditions, so that the work of the sales department has been made far more efficient.

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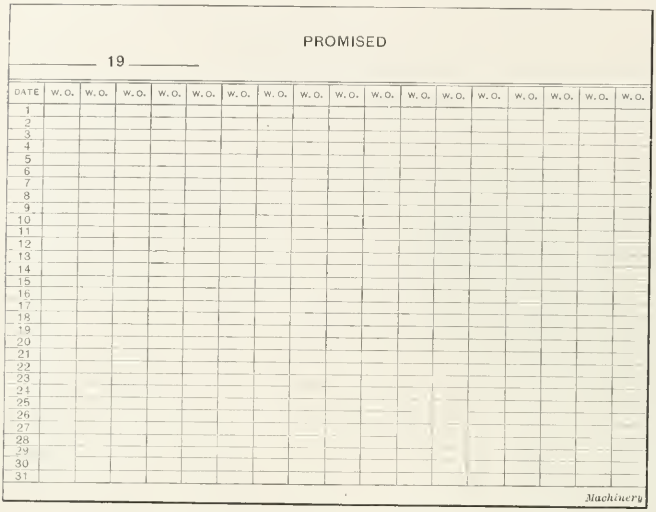
* For articles on system previously published see: "System for Drafting Room, Office, Pattern Shop and Foundry," July, 1913; "Shop System," July, 1911, and other articles there referred to.



PROMISED

________ 19______

DATE	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.	W. O.
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
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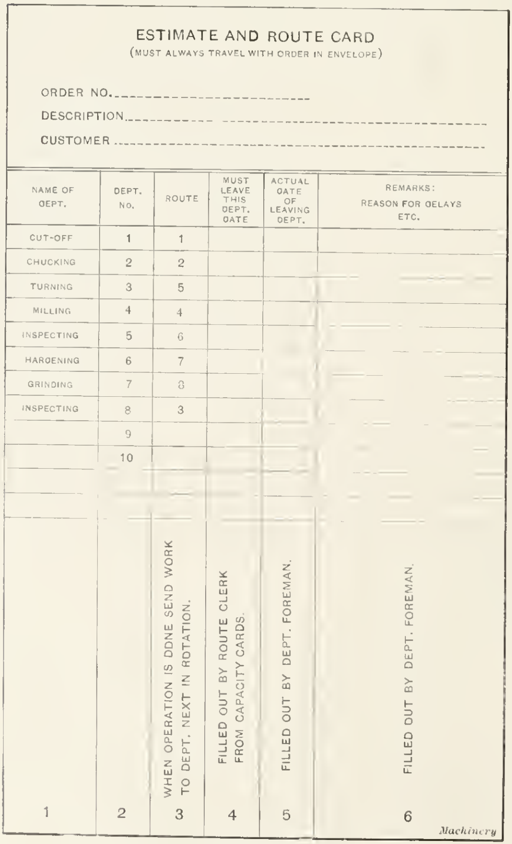
29																	
30																	
31																	

Machinery

Fig. 4. Work Calendar showing Dates on which Orders must be finished



ESTIMATE AND ROUTE CARD
(MUST ALWAYS TRAVEL WITH ORDER IN ENVELOPE)

ORDER NO.________________________

DESCRIPTION____

CUSTOMER ____

NAME OF DEPT.	DEPT. NO.	ROUTE	MUST LEAVE THIS DEPT. DATE	ACTUAL DATE OF LEAVING DEPT.	REMARKS: REASON FOR DELAYS ETC.
CUT-OFF	1	1			
CHUCKING	2	2			
TURNING	3	5			
MILLING	4	4			
INSPECTING	5	6			
HARDENING	6	7			
GRINDING	7	8			
INSPECTING	8	3			
	9				
	10				
		WHEN OPERATION IS DONE SEND WORK TO DEPT. NEXT IN ROTATION.	FILLED OUT BY ROUTE CLERK FROM CAPACITY CARDS.	FILLED OUT BY DEPT. FOREMAN.	FILLED OUT BY DEPT. FOREMAN.
1	2	3	4	5	6

Machinery

Fig. 5. Estimate and Route Card which follows an Order through the Factory

Benefits of a Follow-up System

The benefits derived from this system may be briefly outlined as follows: (1) It enables the management to tell the date on which any order will be finished and ready for shipment, without having to go out into the different manufacturing departments, and with a minimum expenditure of time. (2) To systematically follow up all work—promised and unpromised—from one department to another, and thus receive warning of any delays or mishaps which may occur. (3) To tell at short notice in *which* department *any* order is at *any* time. (4) To tell at equally short notice how long an order has been in any department at a given time, thus making it possible to investigate causes of delay and take steps to remedy them. (5) To find out how many orders a department has on hand, thus making it possible to trace congestion and investigate the cause, *i. e.*, shortage of help, equipment, etc. (6) To afford a means of creating watchfulness on the part of department heads in regard to the time taken in the execution of orders.

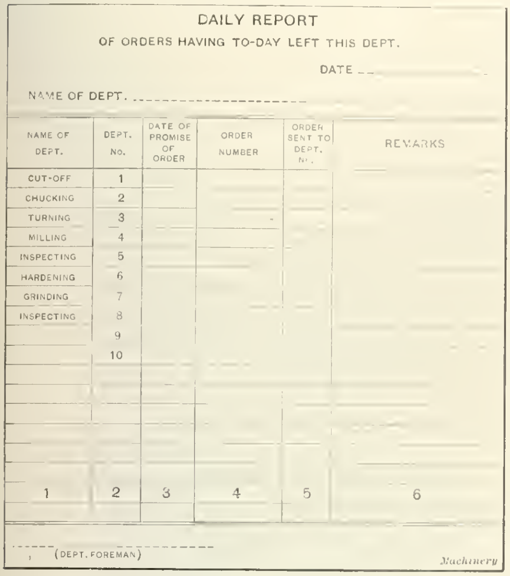
As a result, it is impossible for men who are responsible for delays to avoid censure by such time-worn excuses as, "I did not understand it that way," "I mislaid the instructions," "I did not know," etc. As the foremen know that the follow-up system affords a sure method of placing responsibility for any hitch that may arise in the execution of an order, they are quite careful to make investigations on their own account before their superiors have been advised in regard to any delinquency that may have occurred in their respective departments.

To those who are intimately in touch with the details of operating a modern plant, it may seem that any follow-up system is a needless expense, especially if the goods manufactured are of a standard kind (not necessarily size). In most lines of manufacture, however, even standard articles consist of several parts, and in order to turn out the finished product these parts must be finished and made ready for the assembling department long before the supply of finished product has been exhausted. In such cases, a follow-up system is necessary for tracing the parts of the completed product through the different departments of the factory. Under these conditions, the system can be reduced to its simplest and most inexpensive form, its chief function being to follow up orders, consisting of a limited number of either parts or complete articles, finishing them before the supply is exhausted

The system has its greatest usefulness, and is, in fact, an absolute necessity in establishments manufacturing small products of many sizes and many kinds, where a great variety of stock must be kept on hand at all times. It will also prove itself of more than ordinary value to an establishment where the departments have been grouped according to operations as is now nearly universally the case. The advantage of this method is that each department is run by an exeprt who operates the type of machines used in his department according to the most economical method, thus making them produce more and better work than would be possible if the product were made complete in a single department. The saving effected by this method is limited by the loss of time which is involved in moving the work from one department to another, in getting started in each department and by such necessary operations as counting, inspecting, etc. Where a factory is run on this method, without the use of an efficient follow-up system, it will not be long before trouble will be encountered from failure to keep promises in regard to shipment dates, through finding the supply of raw material suddently exhausted, etc.

Causes of Delay in finishing Orders

The most important features governing deliveries in any manufacturing plant are the stock and store-rooms for either finished parts or the complete product. Such being the case, it will be well to investigate some of the causes which are responsible for failure to supply these departments with goods in the required quantity and at the specified time. The causes may be outlined as follows: (1) Non-anticipation of large orders and the receipt of a number of small orders at the same time. (2) Shortage of raw material and failure to get in a fresh supply in time to meet existing requirements. (3) Failure to obtain additional equipment in time to meet existing requirements. (4) Lack of system in ordering stock, resulting in failure to issue orders to the factory in time to allow them to be completed before the stock on hand has been exhausted. The department having this work in hand should have intimate knowledge of the capacity of each department, as well as of the entire factory, so that it is possible to foretell exactly the amount of time required to complete any order which is issued. (5) Delays resulting from resetting automatic machinery to adapt it for a new class of work. (6) Delays caused by premium or contract systems where department foremen evade changing machines from one kind of work to another, in order to secure the greatest possible financial gains for themselves and their men. (7) Failure of the management to see the advantage of investing money in finished material blanks, castings, and raw material. This condition is most pronounced in times of depression, which are best suited for "stocking up," as labor is cheapest at such times and manufacturing can progress unhampered by special orders that must be completed by a specified time.


DAILY REPORT
OF ORDERS HAVING TO-DAY LEFT THIS DEPT.
DATE ___
NAME OF DEPT. ___

NAME OF DEPT.	DEPT. No.	DATE OF PROMISE OF ORDER	ORDER NUMBER	ORDER SENT TO DEPT. No.	REMARKS
CUT-OFF	1				
CHUCKING	2				
TURNING	3				
MILLING	4				
INSPECTING	5				
HARDENING	6				
GRINDING	7				
INSPECTING	8				
	9				
	10				
1	2	3	4	5	6

___ (DEPT. FOREMAN)

Machinery

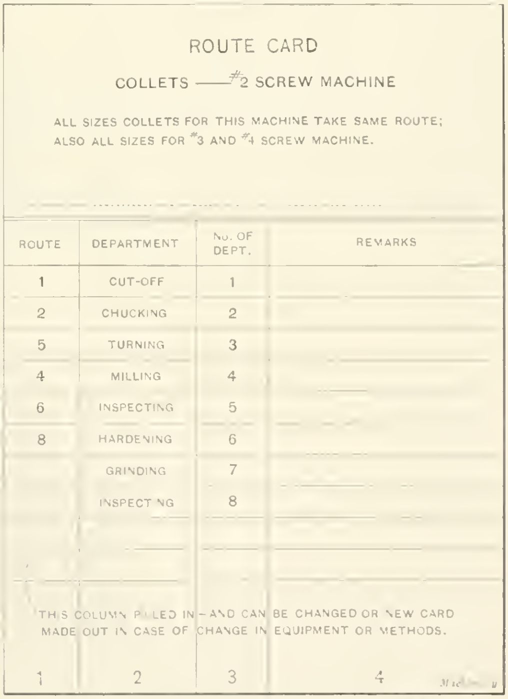
Fig. 6. Form used by Foremen in making Daily Reports

Nearly all of these causes of delay were remedied in less than eighteen months by the follow-up system which was introduced by the writer. This was due to the fact that the system automatically calls attention to conditions responsible for delays, and keeps everyone from the manager and superintendent to the foreman and his assistant, informed of the conditions that have to be met in order for shipments to be made at a specified time. After a careful investigation of the causes of delay outlined in the preceding paragraph, it may be stated that the failure to keep an adequate supply of materials on hand is responsible for the greatest amount of trouble. The other reasons outlined suggest methods of avoiding them, so that little comment is necessary. It will prove worth while in the long run to keep a few surplus machines and a reserve quantity of finished parts, blanks and raw material on hand. This will make it possible to take care of large orders that come in unexpectedly or a number of small orders received simultaneously, without impairing the operation of the factory in any way.

The writer can see no excuse for any plant manufacturing a product for which there is a continued demand, not providing itself with a surplus supply of finished product. It is a conceded fact that the growth of any industry is dependent upon its ability to meet the demands of its customers, both as regards quality and prompt service. The customer scarcely considers whether his order is too large for your establishment or whether there are other orders on hand which must be filled before his receives attention. The result is that the factory which is able to fill orders promptly usually gets the business. The question of quality is taken for granted, and the manufacturer who neglects this feature will find himself unable to meet the keen competition that exists in practically all lines.

Value of Surplus Stock and Equipment

The preceding may be summarized by stating that in order to meet possible demands of customers for immediate delivery, one of two conditions must exist in the factory. The stockroom must either be well filled with finished product or finished parts of which the product consists, so that it is merely a matter of assembling them for prompt shipment, or else the factory must have an equipment large enough to take care immediately of large orders and finish them without delay. The first condition may be fulfilled by issuing orders to the factory in sufficient quantity and far enough ahead to enable the parts to be finished before the supply of stock on hand is exhausted. (The writer would suggest, in this connection, that when the supply on hand has been reduced to an amount equal to the number of pieces sold during any previous year, another order for an equal quantity should be issued immediately. The machine and tool equipment should also be large enough to produce such a number of pieces in a year.) While most manufacturers are willing to invest in reserve equipment, they are unwilling to keep a surplus stock of product on hand. It is reasonable to assume that the capital invested in extra equipment provided to meet emergencies is equal at least to


ROUTE CARD
COLLETS — #2 SCREW MACHINE
ALL SIZES COLLETS FOR THIS MACHINE TAKE SAME ROUTE;
ALSO ALL SIZES FOR #3 AND #4 SCREW MACHINE.

ROUTE	DEPARTMENT	No. OF DEPT.	REMARKS
1	CUT-OFF	1	
2	CHUCKING	2	
5	TURNING	3	
4	MILLING	4	
6	INSPECTING	5	
8	HARDENING	6	
	GRINDING	7	
	INSPECTING	8	
1	2	3	4

THIS COLUMN FILLED IN—AND CAN BE CHANGED OR NEW CARD MADE OUT IN CASE OF CHANGE IN EQUIPMENT OR METHODS.

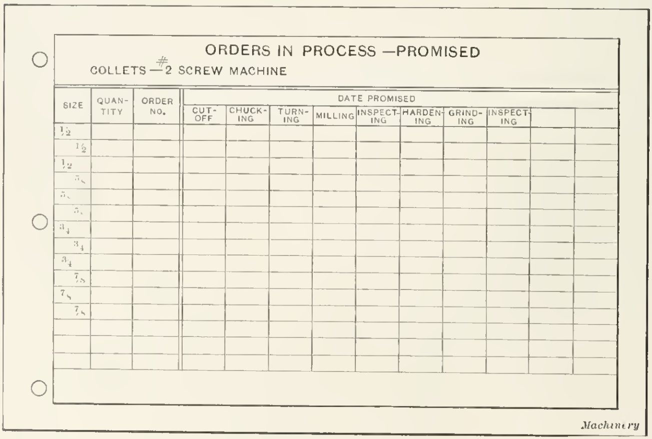
Machinery

Fig. 7. Route Card for Collets for No. 2 Screw Machine

that necessary for keeping a sufficient quantity of finished product on hand to meet such emergencies. In most cases, however, the capital invested in finished product is less than that required for a sufficient reserve equipment, and this advantage is further emphasized by the fact that shipments can be made immediately upon the receipt of orders, when the product is on hand in the store-room. In addition, the capital will be turned more rapidly, as it is not necessary to wait while the product is being made before it can be shipped on a given order. It seems scarcely possible that this fact can escape the attention of the management of so many manufacturing establishments, especially when the product so "stocked" can generally be produced at less expense than when made under average conditions. The solution is seemingly found in the fact that equipment does not show up on the books in the same way as finished product. In considering this subject, it should also be borne in mind that immediate shipment is a means of adding to the list of satisfied customers, who will send in repeat orders as the result of efficient service.

The Follow-up System

Having thus outlined some of the more important reasons for the use of a follow-up system, and the conditions over which it has control, the writer will describe a system which has many original features, and which has been proved to be more efficient than other systems coming under his observation. In order to make the explanation readily understood, certain minor details such as shipping and factory order forms will be omitted. Suffice it to say that the forms in general use for such purposes can be adapted to almost any system with satisfactory results. In starting upon an explanation of the workings of this system, it will be assumed that any inquiry as to the date of shipment of an order is received by the office. This inquiry usually carries the customer's order number, and is generally given a factory order number by which it is known until the order has been completed and shipped. The inquiry is immediately turned over to the stock department with the tag shown in Fig. 1 attached to it. The customer's order number is generally filled in by the office, but in certain cases where the customer's original order number is on file in the stock department, the tag is left to be filled in when it reaches that point.



ORDERS IN PROCESS —PROMISED

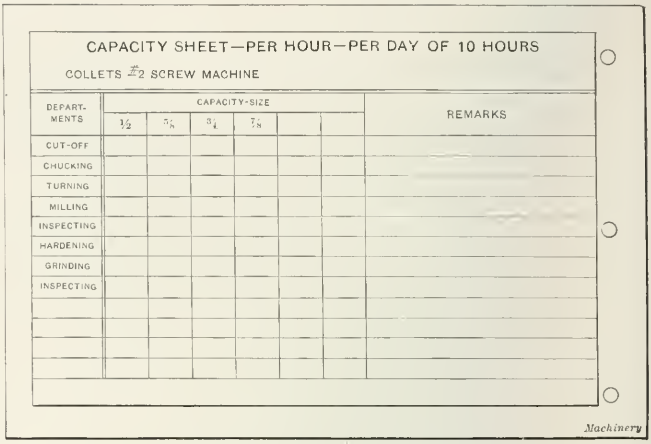
COLLETS—#2 SCREW MACHINE

SIZE	QUANTITY	ORDER NO.	DATE PROMISED									
			CUT-OFF	CHUCKING	TURNING	MILLING	INSPECTING	HARDENING	GRINDING	INSPECTING		
½												
½												
½												
⅝												
⅝												
⅝												
¾												
¾												
¾												
⅞												
⅞												
⅞												

Machinery

Fig. 8. Capacity Sheet for No. 2 Screw Machine Collets

The stock department keeps a card index, of the form shown in Fig. 2, on which the factory order number is given opposite the customer's order number in cases where the goods are not in stock and have to be made. If no number appears on the card opposite the customer's order number, it signifies that the goods have already been shipped, the date of shipment being recorded in the column marked, "Date Shipped." If shipment has not been made, which is shown by the fact that no notation appears in column 4, and if no number appears in column 2 it shows that shipment can be made from surplus stock on hand. These cards are indexed according to names, and it will be noticed that one or more cards are used for each customer and that each card takes care of several orders.



CAPACITY SHEET—PER HOUR—PER DAY OF 10 HOURS

COLLETS #2 SCREW MACHINE

DEPARTMENTS	CAPACITY-SIZE						REMARKS
	½	⅝	¾	⅞			
CUT-OFF							
CHUCKING							
TURNING							
MILLING							
INSPECTING							
HARDENING							
GRINDING							
INSPECTING							

Machinery

Fig. 9. Sheet giving Record of Orders in Process of Manufacture

If the order is special (not in stock and not finished), the inquiry, with the tag shown in Fig. 1 attached to it, is immediately turned over to the follow-up department for answer in regard to the date on which delivery will be made. All of the columns on the tag, shown in Fig. 1, except the last one, have been filled out by the stock department, the date being taken from what is known as the shipping order which includes all details in regard to the items covered by the order.

The follow-up department refers to the order tracer card file, the form of which is shown in Fig. 3. These cards are filed in numerical order, one card being provided for each order number, and show the location of any order in the factory at any specified time. Consequently it is known how far the work has advanced, and also the date on which the work will be finished. A record is also kept on this file of any delay that has occurred, the department in which it occurred and the reasons for the delay, reference being made to the superintendent's "Reasons for Delayed Orders" file for this information. Every foreman is required to report to the superintendent at the end of each day's work in regard to every order which could not be finished and sent on to the next department as required by the schedule. When a department foreman receives an order, he marks the number of the order on his work calendar in the column opposite the date on which the operation must be finished by his department. One of these calendars, shown in Fig. 4, is generally hung up in the office of the foreman to afford him a means of looking ahead to make sure that all orders will be finished on time, according to the schedule laid out by the route clerk.

The date on which the work or operation must be completed by any department or foreman will be found on the "Route and Estimate" card shown in Fig. 5. These cards are filled out by the route clerk before the orders for the work are sent out to the factory, and follow the orders for the work from one department to another until the order is completed. These route cards not only show when each operation must be finished, but also the order in which the work is passed along from department to department, as shown in column 3. Referring to Fig. 5, it will be seen that after the chucking operation is completed in Department 2, the work must be sent to Department 5 for inspection, then to Department 4 for the milling operation, and so on until it is completed. Before the work leaves any department, the actual date of leaving is filled out on the route and estimate card by the foreman of the department. This is done at the same time that the daily report, shown in Fig. 6, is filled out, and the foreman receiving the work will be certain to report any errors in these dates to the follow-up department, if the route cards are dated unfavorably to him. This affords a method of checking the accuracy of the daily reports when they are being recorded on the tracer card file by the follow-up clerk.

The plan of having the foremen report any delinquincies or causes for failure to complete an order in accordance with the schedule, is one of the best guarantees that the work will be finished on time. As the superintendent is kept constantly in touch with the progress of each order by this method, he is able to take the necessary steps to prevent a constant recurrence of delays in any department, and this is largely responsible for the success which has been obtained from the use of this system.

With the data available through the records kept by this system, it is possible to answer inquiries in regard to the date of shipment immediately and with a reasonable degree of accuracy, without having to go out into the manufacturing plant new order is isued an accurate estimate of its date of completion may be made.

The follow-up clerk checks the number of each order which has been passed on to a new department and the departments to which the work was sent from the daily reports, when checking up the tracer cards each morning. In so doing, he finds any discrepancy between the date on which the work was finished and the date when it should have been finished, according to the schedule. He may refer to the superintendent's file to obtain the reason in case of delay.

Although this system may be said to fill all of the requirements of following up the progress of orders through the factory, and keeping them moving according to schedule, it is lacking in certain respects. For example, how can a factory manager or superintendent determine the number of orders that a certain department has on hand at any time from a card index? How are such officials going to find out (without the assistance of a lot of clerical help and a lot of red tape) how long an order has been held in a given department? How are they going to know if promises are kept? For this purpose, the "Follow-up Rack" was designed, of which two sections are shown in Fig. 10, and which the writer believes to be an entirely new feature in follow-up systems.

This rack consists of twelve sections, one being provided for each month in the year, and is used to keep a record of progress of the work in the factory. A small card, of the form

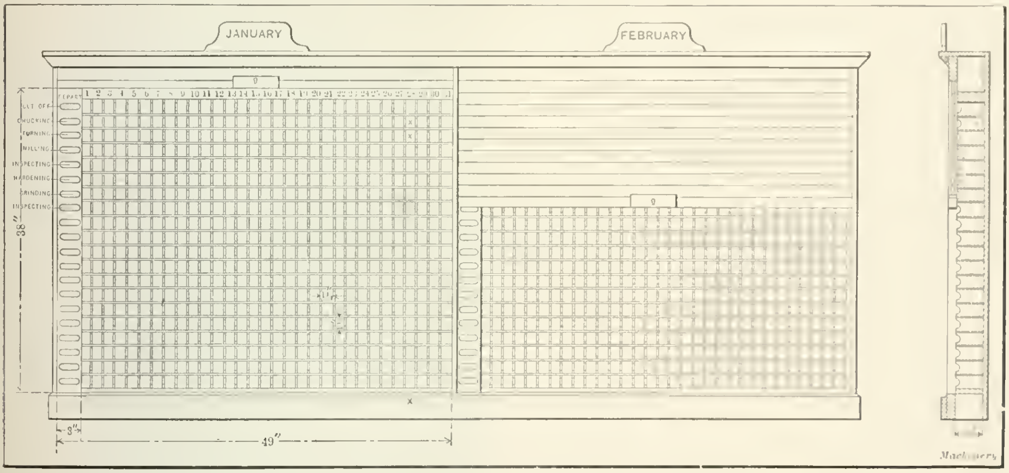


Fig. 10. Follow-up Rack which shows Progress of All work in the Factory

for the purpose. It will be seen that the tracer card file, shown in Fig. 3, is the key to the whole situation. As previously mentioned, these tracer cards are made out before the orders go to the factory and are checked every day from the daily reports shown in Fig. 6. The route outlined on the route and estimate card, shown in Fig. 5, is, of course, an exact exact copy of the route card illustrated in Fig. 7 for the particular class of work which is being made. In this connection, it may be mentioned that the routes followed through the factory by many classes of work are practically the same.

Determining the Capacity of the Factory

The capacity sheet, shown in Fig. 8, although not directly connected with the follow-up department, plays an important part in the operation of the factory. These sheets show the capacity of each department for all the different operations which it handles. They are kept in a special loose-leaf binder, so that changes may easily be made in case of the addition of new machinery or methods in any department. The left-hand pages of the sheets kept in this binder enable the route clerk to determine the capacity of any department for a given operation at a glance, and the right-hand pages, shown in Fig. 9, give a record of all the orders in the factory that must be handled by the different classes of tools, the capacities of which are given on the capacity sheets. The dates on which these operations must be completed are recorded so that when a shown in Fig. 11, is made out at the same time that the estimate card is made out when an order is sent to the factory. Referring to Fig. 11, it will be seen that one side of this card has spaces for the order number, the name of the customer, the date on which delivery is promised and a description of the product called for by the order. The opposite side shows the different operations that must be performed on the work, the dates when the work should leave the different departments according to the schedule, and the actual dates upon which it did leave these departments. Fig. 12 shows both sides of the form of card used for stock goods. This card is of a different color from that shown in Fig. 11, which is used for special goods, and the customer's name is omitted. The reverse side is the same as that of the card described in connection with Fig. 11.

To illustrate the purpose of these cards, it will be assumed that Order No. 7001 is received from Jones & Co. for 500 collets on November 2, 1912. After the card is filled out in Column 2 by the route clerk, at the same time that he is filling out the estimate and tracer card, the clerk refers to the capacity sheet, Fig. 8, and to the promised order sheet, Fig. 9, to find if the order can be completed by January 28, which is the date specified for delivery. He then files the card in the 28th column of the January rack, opposite the department in which the first operation is performed. The card is then moved up or down in this column, keeping it opposite the department to which the work has been transferred until the work is completed. The proper location for the card is found from the daily report, which not only indicates to which department the work has been sent, but also the date on which the order was promised for delivery. This enables the position of the card in the rack to be immediately found, and also the date on which it was promised for completion.

The card remains in the 28th column until the order is completed, after which it can either be thrown away or filed for future reference. This arrangement enables one to see at a glance just how many orders are promised to be completed, and if they are not finished on time this is immediately indicated by the appearance of the cards in the rack for dates already passed. This naturally causes everyone concerned to push the work along with all possible speed, and constitutes a gage of efficiency for both the department foremen and the follow-up department. This rack also makes it possible to look ahead, and if there appears to be any doubt in regard to a given order being unfinished by the specified date, there is ample time to take the necessary steps to avoid such a contingency.

All twelve racks are arranged in a single horizontal row, and by looking along the row it is possible to form an accurate estimate of how many orders a given department has on hand at any time, which could not otherwise be easily done. By looking at the back of the card, it is possible to see just when the work should have been completed in a given department, and when it actually was finished, the backs of the cards being filled out by the follow-up clerk from the daily reports sent in by the foremen. These data are especially valuable in cases where delay has occurred, as the department where the delay occurred can be instantly located without having to refer to the order tracer file.

It will readily be seen that the capacity records involve a good deal of expense, not only in getting them up but in keeping them up-to-date. It has been found however, that these records are an actual necessity, whether a follow-up system is used or not, and consequently this expense cannot justly be entered on the books against the follow-up system. The advantages secured through the follow-up system and follow-up rack which have been described are far-reaching in their results. The heads of manufacturing companies have not generally much time for details, and the use of this system keeps them informed of nearly all the conditions in the plant that are of vital importance. Very little time is required to secure this information, and, best of all, they can determine just what these conditions are without spending valuable time in going about the factory. Figures and data are often misleading and errors or unintentional deceptions entering into the reports of subordinates are very frequently responsible for serious complications. Where this system is used, however, such deceptions are impossible and the management is thus protected from both deserved and undeserved criticism of customers, which leads to the loss of future orders. Hence, this follow-up system may be said to constitute one of the most productive non-productive departments in any manufacturing establishment.

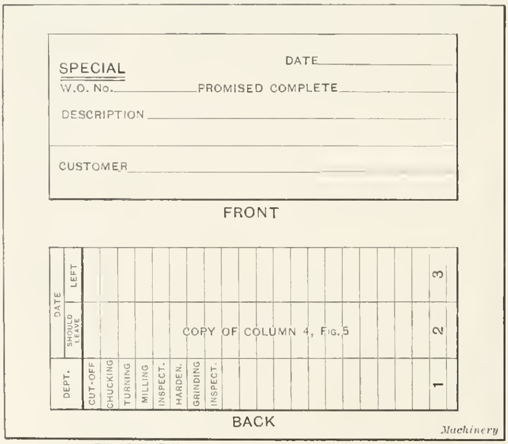


Fig. 11. Follow-up Rack Card for Special Orders

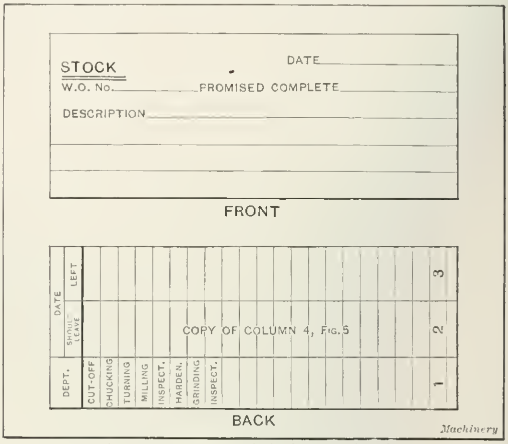


Fig. 12. Follow-up Rack Card for Stock Orders

* * *

MACHINERY'S NEW HOME

The building where the offices of MACHINERY are now located is on a part of the new Court House site which has been taken over by the City of New York, and all the buildings thereon will soon be demolished. The Industrial Press, publisher of MACHINERY, has taken a twenty-one-year lease of the four top floors in the Bradstreet Building, corner of Lafayette and Howard streets, a few blocks north of the present location, where the entire business will be moved in November. The new building, which is 90 by 115 feet, will be especially adapted to the requirements of the business, having light on three sides, and being close to the machinery center and to the various subways and surface lines. It will be fire-proof, of heavy steel construction, with brick and granite exterior, twelve stories high. MACHINERY'S offices will occupy the top floor.

Bradstreet Building, Corner of Howard and Lafayette Sts., New York City

SPECIALIZED MACHINE TOOL EQUIPMENT

SPECIAL MACHINES USED BY THE HOEFER MFG. CO. IN THE MANUFACTURE OF DRILLING MACHINES

BY DOUGLAS T. HAMILTON*

The Hoefer Mfg. Co., Freeport, Ill., manufacturers of upright and special drilling machinery, has a number of special machines and fixtures that were designed particularly for performing certain operations on different parts of its drilling machines. Some of these machines incorporate in their construction interesting features which are worthy of description.

Special Machine for milling and drilling Machine Columns

In Fig. 1 is shown a special fixture applied to an ordinary engine lathe for turning the column of the 21-inch upright drilling machine. This fixture consists of a steadyrest *A* having a swinging cap and provided with a circular groove in which the circular end of the bracket *B* rotates. This bracket is screwed onto the nose of the spindle, and is provided with two projecting arms through which an arbor *C* passes, this serving to locate the column from the bearing caps. The column is prevented from slipping, and is also locked by two adjustable sleeves *D*, which are held by set-screws to the arbor *C*. The other end of the drill column *E* is supported on the tail-stock center in the usual manner. The column is turned down to the proper diameter with an ordinary lathe cutting tool, the fixture being the chief point of interest.

The special machine which is utilized for performing a series of operations on the drilling machine column after it comes from the lathe shown in Fig. 1 is illustrated in Figs. 2 and 3. In Fig. 2, which shows a front view of the machine, it can be seen that the column *A* is clamped in bearings by swinging straps to an adjustable table *B*, and is held down on the other end by a strap *C* which is tightened down on this member of the column with sufficient pressure to hold it rigidly without springing it out of shape. The operations performed on this machine consist in splitting the lower spindle bearing, and cutting the clearance slot for the rack that is used for raising and lowering the drill spindle. The bearing is split by means of the milling cutter *D*, held and driven by a special attachment. This consists of a bracket *E* fitting on dove-tailed ways on the bed of the machine and provided with a projecting member machined to carry the cutter arbor and the mechanism necessary for driving it. This mechanism is more clearly shown in Fig. 3, where it can be seen that the power is received by a pulley *G* which ordinarily runs free until the clutch is thrown in by operating the handle *H*. This connects up the pulley with the shaft and drives the cutter arbor through a pinion and the large gear *I*. The bracket carrying this arbor is operated by power through a worm and worm-wheel shown at the right end of the machine in Fig. 3. The head can be also operated by the handle located on the end of the screw.

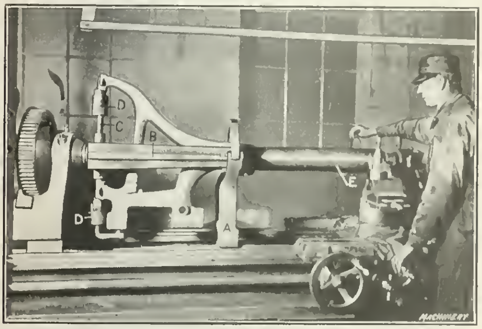


Fig. 1. Fixture used on the Lathe for holding Upright Drilling Machine Columns while turning

The clearance slot for the rack is cut in the lower spindle bearing by means of a broach *J*, shown in Fig. 2, which receives its oscillating motion through a connecting-rod *K* and the crank disk *L*. Power is received for the operation of this broach from the pulleys shown, which transmit power through the pinion and gear forming a part of this mechanism. The broach is carried and guided by a special bracket *M*, see Fig. 3, which consists of a sliding member that is operated inwardly by the ratchet feeding device *O*. As the broach is not held rigidly on the end connected to the crank, it is possible to feed it onto the work and still retain the correct alignment. The feeding is accomplished through a link and ratchet mechanism, which in turn receives power from the crank operating the broach. Both slitting and broaching operations are carried on at the same time.

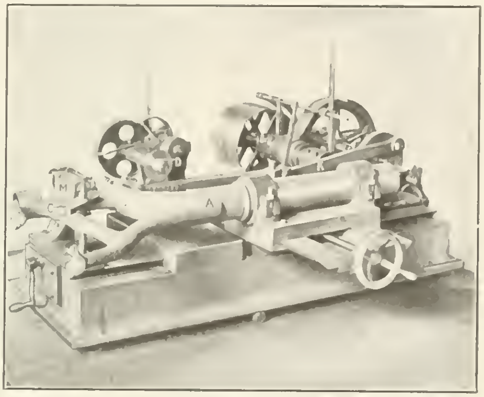


Fig. 2. Special Machine for milling and broaching Upright Drill Spindle Columns

Another type of special machine for performing milling and drilling operations on drilling machine columns is illustrated in Figs. 4 and 5. Fig. 4 shows what might be called a rear view of the machine, while Fig. 5 shows a front view. This machine is provided with five special heads, only three of which are used on this particular column. The head *B* which carries an inserted tooth milling cutter is used for milling the top faces of the caps. This head as illustrated, is driven by a pulley through gearing, and is fed longitudinally by a feed screw through the ordinary type of feeding mechanism. The head *C* is used for drilling the holes in the caps, and can be moved into the required position by means of the hand wheels shown in Fig. 5.

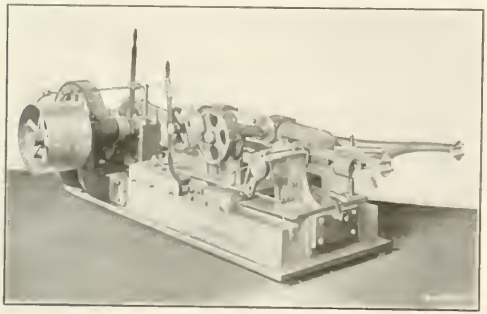


Fig. 3. Another View of the Special Machine shown in Fig. 2

The plates *D* carrying the bushings, swing on a pivot thus allowing the milling machine cutter to finish off these faces of the caps without removing the column from the fixture. The vertical head *E*, which is similar in construction to a regular drill head, is used for drilling and reaming several holes through the column, as indicated by the jig plates *F*. These plates are also hinged and can be thrown back in order to remove the work from the jig. Practically all of the milling and drilling operations are completed on this special machine without removing the column from the fixture once it has been set in place.

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*Associate Editor of MACHINERY.

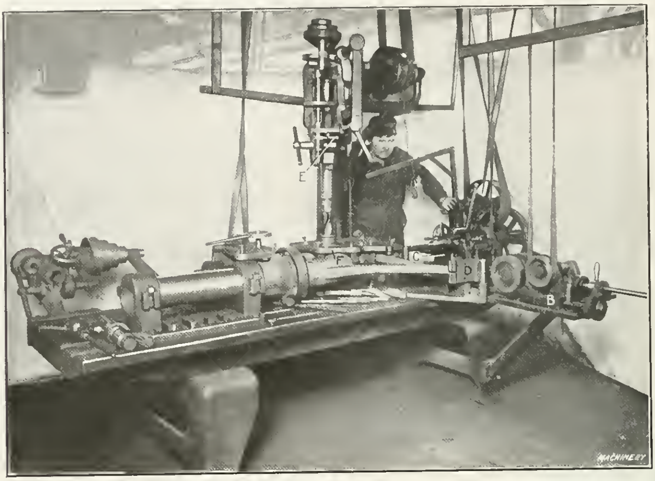

Fig. 4. Special Machine for drilling and milling Columns for Upright Drilling Machines

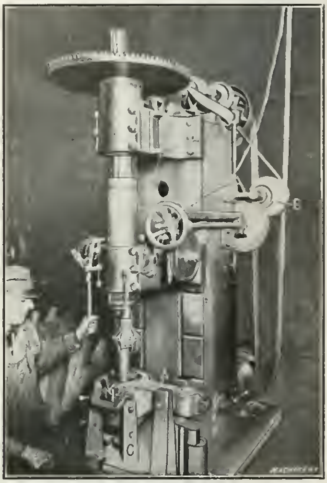

Fig. 6. A Boring and Milling Machine set up for boring the Arm used in holding Drill Tables

Special boring and milling Machine

A special machine which is used for both boring and milling operations is shown in Figs. 6 and 7. In Fig. 6, this machine is shown at work boring the arm for the drill column. The machine consists mainly of a box-shaped column carrying a sliding head and a spindle used in holding the cutting tools. This spindle is driven from a countershaft attached to the machine, through a pinion and the large bevel gear shown. The downward feed for the spindle is obtained through a cone pulley *B* receiving power from the countershaft on the top of the machine, and transmits motion through spur gears and a worm and worm-wheel to the rack on the spindle. The fixture *C* used in holding the arm *A* consists of an iron casting provided with five projecting arms in which set-screws are inserted for holding the work, the latter being located by bosses in the jig. Before placing this arm in the jig, the cap is held on it by screw clamps as illustrated. The boring is accomplished with a fly-cutter retained in the holder of the spindle. One-quarter inch of material is removed from the diameter of the bore with a roughing and finishing cut. The finished diameter is 5½ inches and the length of bore is 8 inches. The bore is chambered for 3½ inches of its length and the time required to complete the operations mentioned is ten minutes.

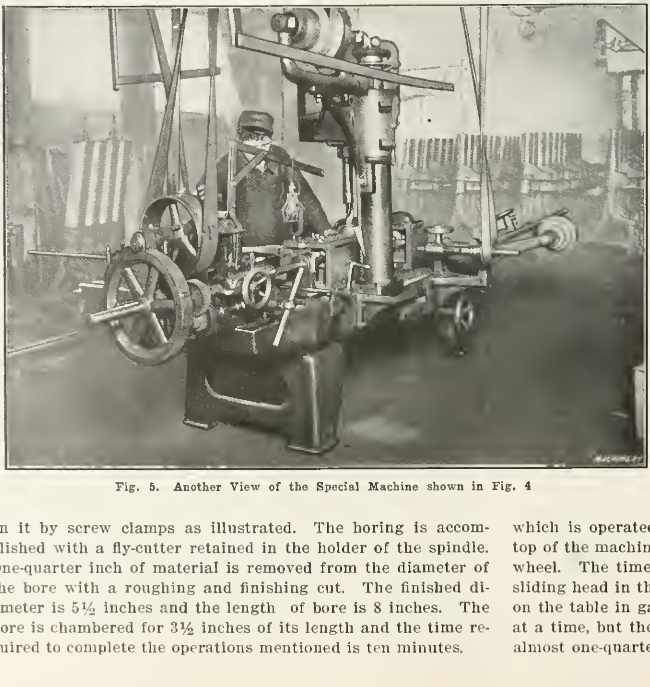

Fig. 5. Another View of the Special Machine shown in Fig. 4

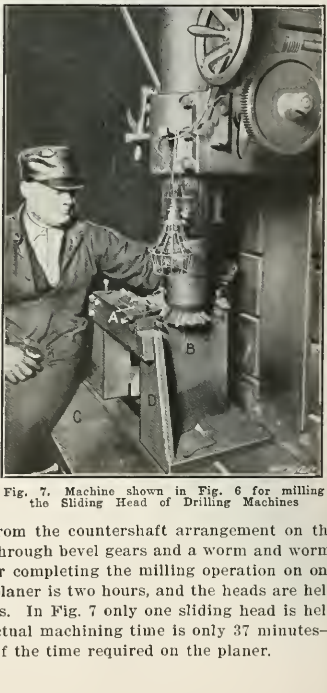

Fig. 7. Machine shown in Fig. 6 for milling the Sliding Head of Drilling Machines

In Fig. 7 the machine shown in Fig. 6 has been converted into a vertical milling machine simply by the addition of the milling cutter on the spindle instead of the fly-cutter, and the unlocking of the table *C*. The work *A* which is handled in this illustration is a sliding head for a drill press, the operation consisting in milling the 45 degree bearing surfaces that fit on the corresponding projections on the column of the sliding head tpye of upright milling machine. The cutter *B* is provided with high-speed steel inserted teeth and removes ⅛ inch of material from each side. The length of the surfaces milled is 10 inches and two cuts are taken—one from each side. The cutter is set in the desired position by steel buttons which are inserted in the jig. When performing this operation, the vertical spindle of the machine is firmly locked. Power is transmitted to the table *C* carrying the fixture *D*, in which the work is located, through the regular type of feeding mechanism which is operated from the countershaft arrangement on the top of the machine through bevel gears and a worm and worm-wheel. The time for completing the milling operation on one sliding head in the planer is two hours, and the heads are held on the table in gangs. In Fig. 7 only one sliding head is held at a time, but the actual machining time is only 37 minutes—almost one-quarter of the time required on the planer.

Machine for grinding the Crown on Cone Pulleys

The cone pulleys which are roughed out in an engine lathe are brought to the special machine shown in Fig. 8, where the crown is ground to produce a smooth surface quickly. This special machine is designed on the principle of a lathe, the work being held on an arbor on the centers and driven by a dog in the usual manner. Attached to the bed of the machine is a bracket *B* carrying a countershaft and also an arm in which the grinding wheel *C* is held. Power is obtained from a countershaft, not shown, to the pulley *D* and from this by a belt running on pulleys *E* and *F* to the grinding wheel *C*.

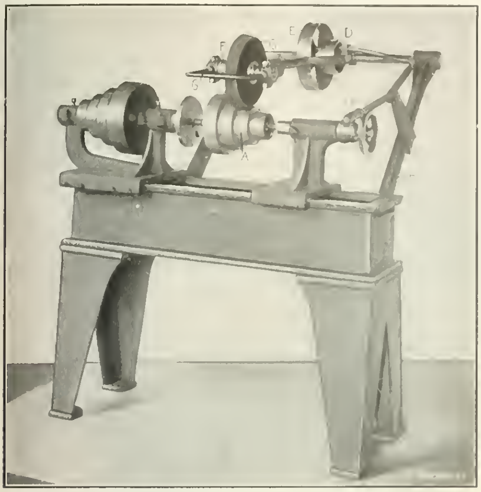

Fig. 8. Grinding External Diameter of Cone Pulleys in Special Machine built for that Purpose

The manner of operating this machine is as follows: The operator grips the handle *G* with his left hand and handle *H* with the right hand. Then by means of handle *G* he keeps the wheel in contact with the step of the cone pulley that it is desired to grind, and at the same time operates the handle *H* which transmits a longitudinal movement to the attachment carrying the grinding wheel. The pulley *A* at the same time is rotated by a belt running on the cone pulleys of the machine.

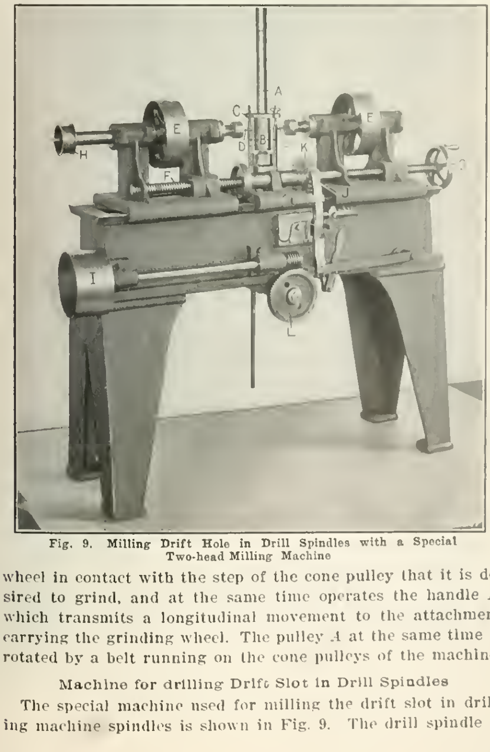

Fig. 9. Milling Drift Hole in Drill Spindles with a Special Two-head Milling Machine

Machine for drilling Drift Slot in Drill Spindles

The special machine used for milling the drift slot in drilling machine spindles is shown in Fig. 9. The drill spindle *A* is held down on a taper arbor fitting the hole in the spindle by two arms *B* and a swinging clamp *C* that rests on the shoulder of the drill spindle. The slot is cut by two end mills *D* held in chucks as shown and rotated by belts running on pulleys *E*. The heads carrying the end-mills are operated (or brought together) by a right-hand and left screw *F*, which can be operated either by a hand-wheel *G* or by power. The power feed for the end-mills is accomplished as follows: Pulley *H* is belted to a pulley *I*, which through the worm and worm-wheel shown at the front of the machine and through a cam on the worm-wheel hub, operates the ratchet pawl *J*, this engaging with the ratchet wheel *K* on the feed screw and rotating it automatically to feed the end-mills into the work. The worm-wheel *L*, through a gear and rack, also transmits a vertical movement to the chuck carrying the drill spindle and in this manner enables the drift slot to be milled elongated.

* * *

THE OPEN SHOP

This is not on the open shop as defined by labor unions, in which many believe and others see a menace. It is on the open shop in which all mechanics who like to see their trade prosper and progress, believe. Recently, in a Massachusetts city prominent in manufacture, we saw the following sign over an entrance to a machine shop:

> FACTORY.
>
> You are invited to visit our factory. We have original and improved methods, but no secrets. We take pride in our excellent equipment and experienced mechanics. We want you to know the reason for our quality. Ask to be shown.

The sign is the more remarkable as this particular factory is engaged in a manufacture about which, in many places, extreme secrecy prevails; and yet with their doors open to all visitors and their methods and processes freely shown to any caller, this factory maintains a standard apparently above that of many of its competitors. It does not depend on a few cherished trade secrets (which are more than likely known anyway to anyone well versed in the trade), but seems rather to depend upon the personnel of its organization, the intelligence of its employees, and its broad and liberal policy towards its competitors, for the success that it enjoys. A business built up on a few trade secrets rests on flimsy ground. Any day someone may leave the concern and carry off all the secrets; but a business that is built on no secrets and yet maintains a standard of manufacture equal or superior to that of its competitors, is built on so firm a foundation that it need not fear that an occasional visitor is going to steal its "secret of success."

* * *

AN IMPROVED METHOD OF METAL SPINNING

The trade of metal spinning is generally recognized as one which requires considerable skill on the part of the operator and a large amount of physical strength. The latter condition is so marked in spinning the larger sizes of work that belts or other devices are attached to the spinning lathe to afford a brace for the operator in order that he may apply his full weight on the forming tool. Needless to say, this work is extremely fatiguing and is likely to bring on liver trouble and other physical disorders.

Fig. 1 shows a view in a German metal spinning shop. In this illustration, workman A is using the old-fashioned equipment in which the method of providing a belt for him to lean against is clearly shown. Workman B is using an improved form of equipment which is the invention of Hermann Rahn of the Siemans-Schuckert Works (an electrical manufacturing company in Germany, which compares in importance with the General Electric Co. in America). The characteristic feature of this equipment lies in the fact that the forming tool is fulcrumed in such a way that it is not necessary for the workman to apply an excessive amount of physical strength in the performance of his work. The average man is able to provide ample pressure with his arms, it being unnecessary to throw the weight of his body against the work. Consequently, he is able to stand in a natural position in front of his lathe and is not excessively fatigued. A second advantage of the equipment is obtained through the provision of a mechanical guide for the outer edge of the work. This guide is held in contact with the work by a spring and prevents the outer edge of the disk from vibrating. As the operator is not required to hold his hand close to the edge of the rotating disk, the danger of his being badly cut is eliminated. As a result, a scarred left hand need no longer be regarded as characteristic of the metal spinning trade.

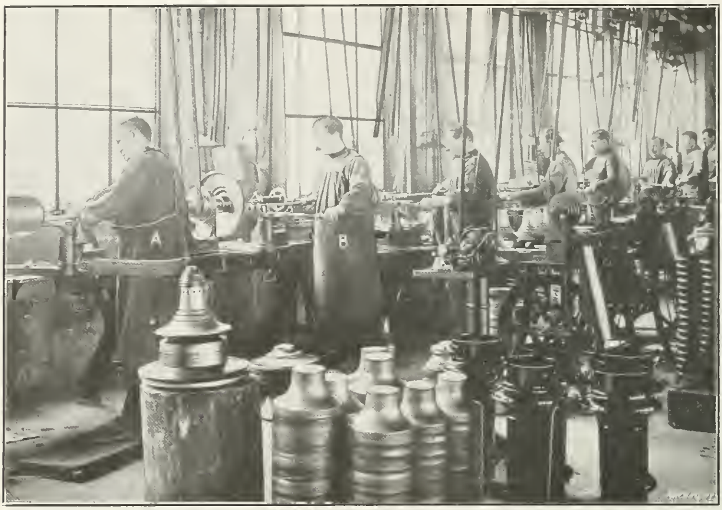

Fig. 1. Old and Improved Methods of Metal Spinning

Fig. 2 shows a detailed view of this improved spinning apparatus. Referring to the illustration, it will be seen that the work is clamped to the spindle by a suitable nut, the usual type of form being used to secure the desired shape for the work. It will be seen that there are two hand levers on the apparatus. The left-hand lever may be screwed into any one of the threaded holes which are seen around the edge of the disk. This disk is pivoted on the vertical support so that it may be rotated by means of the lever previously referred to, to bring the forming tool into the desired position. The right-hand lever has the forming tool mounted on it. It will be seen that this lever is provided with a series of notches, these notches being used to fit over a pin in the forked support which carries the lever. The idea of this is to provide for the disengagement of the lever from the support in case the tool catches in the work. The forked support may be pivoted in either of the holes shown around the periphery of the disk, and by adjusting its position in these holes and putting a suitable notch in the lever over the pin in the support, the forming tool may be brought to practically any desired position in relation to the work. The position of the operator is clearly shown in Fig. 1. By means of the two levers he is able to make the tool follow any desired line, and also apply the required amount of pressure to the work. The support for the guide used to steady the outer edge of the disk is shown in Fig. 2. This view is incomplete, however, as a sliding member which is held in contact with the work by a spring carried in the support, is not shown here.

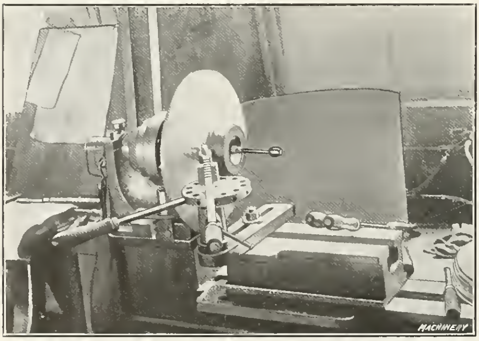

Fig. 2. Equipment used in Improved Method of Metal Spinning

At least three months is required to teach a man the metal spinning trade, if the old type of equipment is used. After such a period of training he still has a great deal to learn, as the trade is one which requires a considerable amount of judgment and dexterity on the part of the operator. Using the form of equipment described in this article, a man can be taught to do satisfactory work in a period of time ranging from a few hours to two days at the utmost. Furthermore, he is able to turn out more work and to handle heavier classes of work than is possible where the old method of spinning is used. Fig. 3 shows a number of examples of spun metal parts and by referring to this illustration, in connection with the table, a good idea of the relative output of a skilled man using the old-fashioned equipment and that of an unskilled man using the Rahn equipment, will be readily appreciated. The sale of this apparatus is being handled by Eugene Eichel, Charlottenburg 4—Berlin, Waitzstrasse 7, Germany.

* * *

A large manufacturing concern in Bridgeport making small electrical devices has found that small taps with rolled threads will retain their size five times as long as ordinary taps threaded and finished with regular thread cutting tools.

WAGES PER 100 PIECES AND TIME OF PRODUCTION

No.	Wages per 100 Pieces in Marks: Of Skilled Men	Wages per 100 Pieces in Marks: Of Unskilled Men	Time per Piece in Minutes: By Skilled Men without Apparatus	Time per Piece in Minutes: By Unskilled Men with Apparatus	No.	Wages per 100 Pieces in Marks: Of Skilled Men	Wages per 100 Pieces in Marks: Of Unskilled Men	Time per Piece in Minutes: By Skilled Men without Apparatus	Time per Piece in Minutes: By Unskilled Men with Apparatus
1	53	18	40	15	10	110	40	75	35
2	50	20	40	17	11	45	15	35	12
3	25	10	20	8	12	15	5	12	4
4	30	10.50	25	6	13	100	35	75	30
6	15	6	12	5	15	45	18	35	15
7	18	7	17	6	17	35	9	25	8
8	16	7	15	6	18	15	5	12	4
9	100	30	75	25	20	70	10	55	8

Machinery

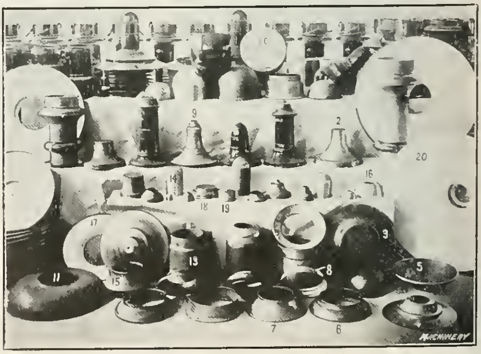

Fig. 3. Examples of Spun Metal Parts

KNOCK-OFF ARBORS FOR THREADED WORK

ARBORS ADAPTED FOR VARIOUS OPERATIONS WHICH ILLUSTRATE PRINCIPLES OF DESIGN

BY ALBERT A. DOWD*

There are numerous instances in the manufacture of parts for interchangeable work, where a certain portion of the particular piece in question must be absolutely true and concentric with a thread which has been previously cut upon the other end. Sometimes an external thread has been chased or possibly cut with a die-head, while in other cases an internal part may have required the use of a tap to cut the thread. Occasionally both ends are threaded and must be concentric. Taper or pipe threads are found at times on a variety of work, and they also may be obliged to conform to the same conditions. On some pieces the end adjacent to the threaded portion is left unfinished, which increases the difficulty in handling for any subsequent operations which may be necessary in the production of the work.

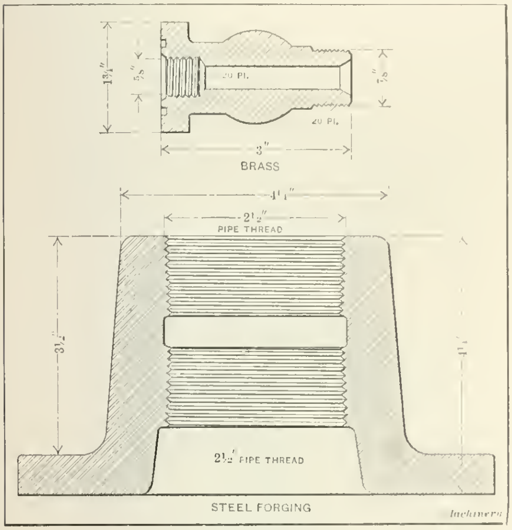

Fig. 1. Examples of Work handled on Knock-off Arbors

The machine tools available for the work being of various types, and the work itself of widely different forms, obviously bring about the design of holding devices to meet the particular requirements of each condition. The horizontal turret lathe is probably more frequently used for this class of work than any of the other machines, although the shaving machine or short bed facing and turning lathe is also decidedly adapted to some operations. Our good old friend, the engine lathe, is frequently called upon in an emergency or otherwise, while the vertical boring mill and the vertical turret lathe are used somewhat less frequently.

The work may range in size from a piece like the small brass pressure valve body shown in the upper portion of Fig. 1, up to the large steel boiler nozzle in the lower part of the same drawing. Larger pieces than this, and possibly still more difficult to handle, may be met with occasionally, but the fundamental points will be the same and will require the same methods of machining.

Elementary Design of Arbors

Let us take the simplest condition possible, for example, the threaded collar shown at *A* in the upper part of Fig. 2, in which it is only necessary to face the end *B* so that it will be square with the thread. A plain arbor such as that shown, with a shoulder against which the collar may be screwed, seems to meet the requirements of this case. But after the end has been faced, it is highly desirable to be able to remove the piece and put on another, and here lies the difficulty, for the wedging action at *C*, caused by the slight twisting of the work under the strain of the cut, has tightened the collar to such an extent that the assistance of a pipe-wrench (or some other method which may suggest itself) is needed before the work can be started. Even after this has been done it will be found that the outer surface is considerably injured.

The arbor shown in the central illustration, Fig. 2, is a refinement of the first, in that the check nuts *D* and *E* permit the easy removal of the piece after the work has been accomplished. No longitudinal stop for these nuts is provided, however, and therefore the length *F* is susceptible to variations, unless each piece is carefully measured to obtain the correct length while facing.

The lower arbor shown in Fig. 2 overcomes the faults found in the two others and for lathe work it answers the purpose for which it is intended. The work *G* comes to a positive longitudinal stop against the face of the collar at *H*, and the collar itself has a fixed location in the shoulder *J*. A left-hand thread is provided on the arbor at *M*, and this effectually resists any tendency to unscrew, as the action of the tool upon the work is in the right direction to force it into this position. It should be noted that the two lugs *K* and *L* are integral with the collar, and forged as shown. After the machining operations have been completed, the work is released by a sharp blow with a babbitt hammer or a billet of wood, on either of the two lugs.

In designing an arbor of this type, remember that the left-hand thread for the knock-off portion should be of very much coarser pitch than that of the work itself, because the wedging action is much less in the coarser pitch thread, and consequently the releasing may be more readily accomplished. A ratio of 1 to 2 is usually sufficient. For example, if the work is threaded 20-pitch right hand, it is advisable to thread the knock-off 10-pitch left hand or even coarser if desired.

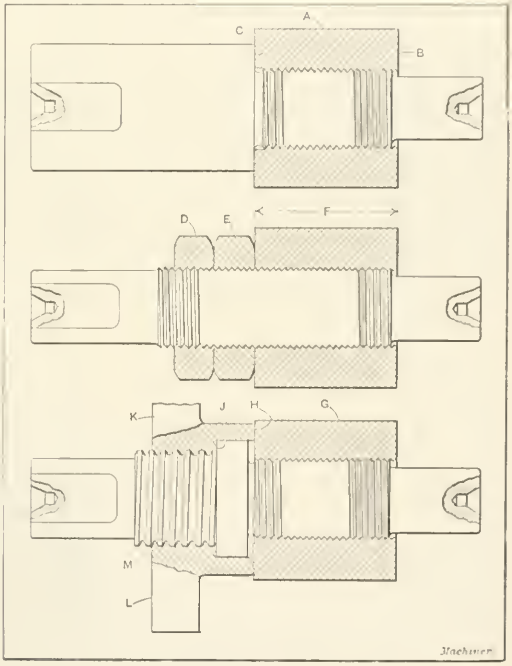

Fig. 2. Three Types of Arbor for machining the Piece A

The following are three important points to be observed in the design of arbors of this type:

First: Positive longitudinal location of the work.

Second: Means for minimizing wedging action and at the same time allowing quick and easy release.

---

* Address: 84 Washington Terrace, Bridgeport, Conn.

Third: Construction of the arbor in such a way that no chance for springing out of truth is possible.

Arbors for Small Work

A small piece requiring a knock-off arbor, is the brass valve body shown in the upper portion of Fig. 1. In this case it was necessary that the threaded portions should be concentric and true with each other, and it was not practical to make the piece from the bar, complete in one setting. The arbor shown in Fig. 3, was applied to the spindle of a small turret lathe, and a Geometric die-head mounted on the turret, was used to cut the thread. The construction of the arbor was as follows: A special nose-piece *A* was mounted on the end of the spindle *B*, and a retaining screw *C* prevented it from unscrewing. The screw arbor *D* was keyed in position and drawn back firmly against the nose-piece by the nut shown. The knock-off portion in this instance, was (for assembling purposes) made in two pieces *E* and *F*, these being held together by three screws 120 degrees apart. The threaded portion of the work, shown at *H*, was 20-pitch right hand, while the knock-off, at *G*, was made 8-pitch left hand in order to minimize the wedging action and make releasing easier. In using this arbor, the knock-off was brought up against the shoulder *J*, which constitutes the positive stop, and the work screwed on at *H*, the end bringing up firmly on the ring at *K*. The shoulder *L* and thread *M* were then machined in their correct relation, by turning and threading tools located on the turret. To release the work after the machining had been accomplished, a sharp blow with the babbitt hammer on either of the two lugs *N* or *O* was all that was necessary. After this the work could be readily unscrewed by hand.

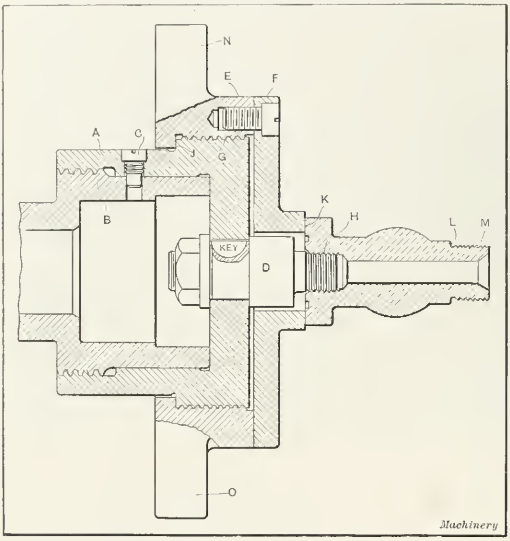

Fig. 3. Arbor for machining Valve Body shown in Fig. 1

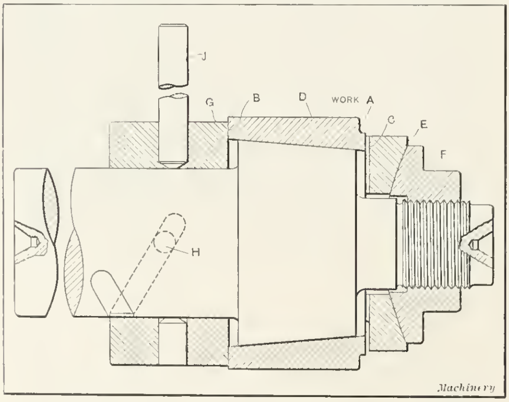

Fig. 4. Male Type of Knock-off Arbor

Fig. 4 shows a knock-off arbor which is not used for threaded work, but its construction is along the same general lines and brings in some of the same principles, so that it is included in order that the salient features of its design may be noted. The conditions responsible for its design are somewhat peculiar, in that a taper hole—⅛-inch taper per foot—has been reamed in the work *A*, and as this piece was made from the bar on a screw machine and then cut off, it is obvious that while the end of the work *B* is approximately square with the taper (as it is faced at the same setting) the other end *C*, where the piece is cut off, will very likely be out of truth. The purpose of the arbor was to hold the work while refinishing the surfaces *D*, *B*, and *C*, so that they would run in perfect truth with the taper. The cup-shaped collar *E*, having a three-point-bearing against the work, is held in position by the ball-nut *F*, thereby avoiding any cramping action that would tend to distort the arbor. This nut is released, after the periphery has been turned and the end *B* faced, so that a cut may be taken across the face *C*, thus finishing the piece. As the tapered portion is of such an angle that the wedging action is sufficient to hold the work firmly, no trouble in the matter of driving is experienced, but in removing the work from the arbor, the knock-off collar *G* is brought into use. This collar has an internal pin *H*, working in the right-hand spiral slot shown. The end of the rod *J*, removable at will, acts as a lever by means of which the collar is operated, thus forcing the work from the arbor.

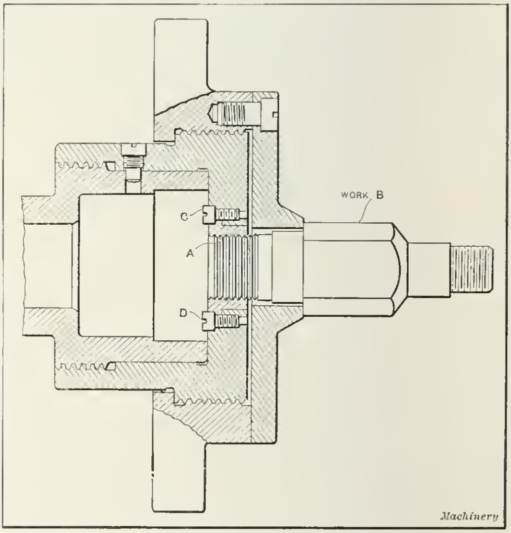

Fig. 5. Female Type of Knock-off Arbor

Fig. 5 shows a female arbor of somewhat similar construction to the male arbor which has been noted in Fig. 3. In this case the threaded bushing *A* receives the end of the work *B*. The bushing itself is held in place by the two screws *C* and *D*, but aside from this difference, the arbor is about the same as the other.

An Unsuccessful Knock-off Arbor

It is fully as important, in designing any piece of mechanism, to understand what not to do, as it is to know just what to do. For this reason, an instance is given of an arbor which was not successful, partly because of careless handling when in use on a turret lathe, but chiefly on account of faulty design. The arbor, shown in Fig. 6, was designed for the purpose of turning and facing milling machine arbor nuts, and it was intended to take care of nuts from ¾-inch up to and including 1½-inch thread diameter, and of various lengths. The body *A* was made of tool steel, hardened and ground to fit the spindle ring of the turret lathe, and it was drawn up against the shoulder *C* by a rod *B* passing completely through the spindle *D*. The slot *E*, which is tapered on the rear end, receives the knock-out wedge *F*, and this in its turn, bears against the slip-collar *G*. The screw-arbor *H*, shown also in detail in the upper left-hand portion of the illustration, was a ground fit in the cylindrical hole *J*, and held in place by the screw *K*. The slip-collars and threaded arbors, shown in detail, were made in various sizes and pitches to suit the nuts which were to be handled. This entire equipment was unsuccessful, and its use was discontinued after attempting in every way to ensure its truth. Although all the parts were very carefully made and fitted, there were certain inherent faults in the design which could not be remedied. After the work had been placed in position and the wedge tapped lightly to make sure that it was firmly seated, it was noted that there was frequently a decided wobble at the end of the arbor, which should obviously have run in perfect truth. Undoubtedly the action of the wedge had a tendency to throw unequal strains upon the structure, while the screw *K* also helped the matter along, so that the whole arbor was faulty in these particular points, and it was therefore considered a failure.

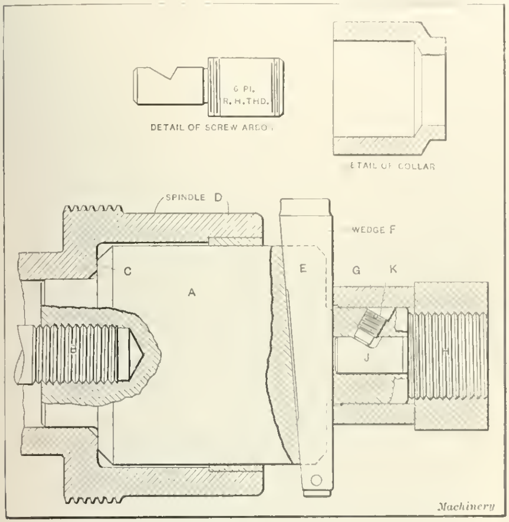

Fig. 6. Arbor that was not a Success for turning and facing Milling Machine Arbor Nuts

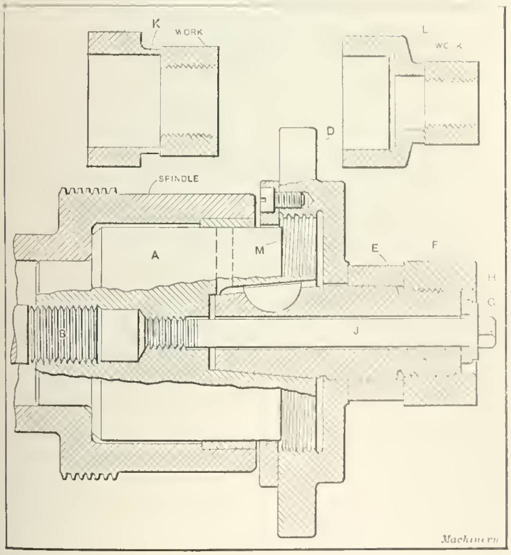

Fig. 7. Arbor designed to replace Design shown in Fig. 6

The Successful Design for the Same Purpose

A decidedly improved construction for the same purpose is shown in Fig. 7, although its cost was considerably greater than the other. The body *A* in this arbor was located and secured in the spindle in the same manner as the other, i. e., by a threaded draw-back rod *B*, running through to the rear end of the spindle. Every precaution was taken to ensure a true running arbor, all essential points and surfaces being ground or lapped in position, in order to avoid all chances for error. The threaded interchangeable arbor *C* was accurately fitted to the conical hole in the body, and was keyed to resist the torsion of the cut. As in a previous instance the knock-off portion consisted of two parts, shown at *D*, in order to permit assembling while the thread at *M* was 6-pitch left hand thus making removal easy. *E* is an interchangeable sliding collar, and it interposes between the shoulder of the knock-off and the work *F*, obviously acting as a spacer and longitudinal stop at the same time. The ball and cup arrangement of the bolt and washer *G* and *H* serve the purpose of obviating any tendency to "cock" the arbor when it is placed in position. To obtain as rigid a construction as possible, the taper is of generous dimensions and the cylindrical portions of the various arbors are made uniform in size. By referring to the upper left-hand illustration in Fig. 7, it will be noted that the collar *K* is shouldered for a short distance back of the work, to allow the turning tool to perform its function. For some of the smaller sizes a collar like *L*—upper right hand—was found necessary, due to the difference in the shoulder diameters between *J* and *C*.

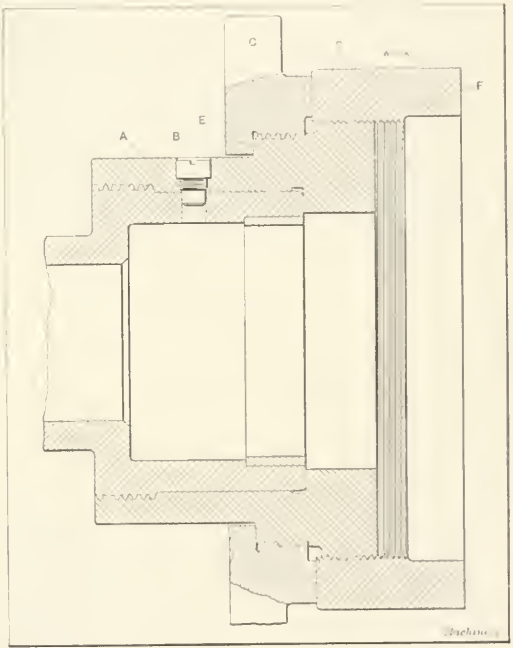

Fig. 8. Knock-off Arbor adapted to Large Sized Work

Arbors for Larger Work

When the work is as large as that shown in Fig. 8, a somewhat different construction is necessary. In the case shown, the piece is a threaded steel collar 7½ inches in diameter, in which the end *F* is to be faced square with the threaded portion. This arbor is applied to the spindle of a large horizontal turret lathe, and its use is obviously restricted to work of a diameter somewhat larger than the turret lathe spindle. The body *A* is screwed directly onto the spindle as a face plate would be, and it is prevented from turning by the teat screw *B*. The knock-off portion *C* is threaded with a 4-pitch left-hand thread of the Acme type, running on the body portion and having the usual projecting lugs for releasing purposes. As it brings up against the shoulder *E*, it forms a positive stop for the work, which locates on the ring at *D*. The action of this arbor is very evident, while its extreme simplicity, it being composed of only two parts, makes it one of the best.

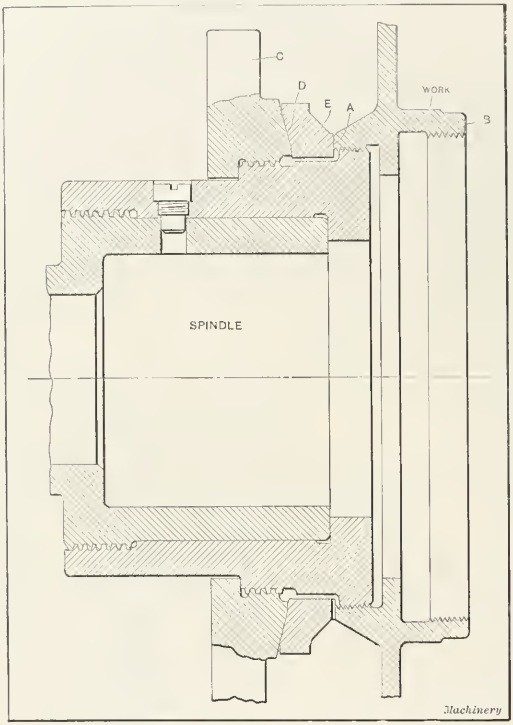

Fig. 9. Another Type of Knock-off Arbor for Large Work

Another large piece of threaded work is shown in Fig. 9, which is considerably harder to handle, in that the ends *A* and *B* are unfinished, and the threads shown must be square and concentric with each other. The construction of the arbor for this piece is similar to that shown in Fig. 8, except that the knock-off portion *C* has the forward face formed to a radius *D*, generated on the center-line of the arbor. The cup-shaped washer *E*, has a three-point-bearing against the work at *A*, thereby equalizing the strains and preventing distortion so that the end of the work *B* may be bored and threaded in the correct relation to the other end.

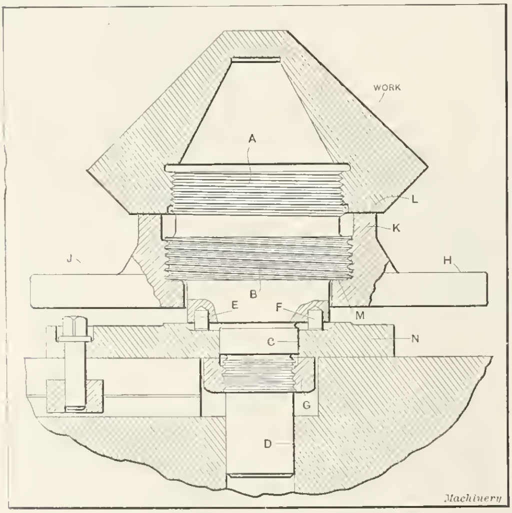

Fig. 10. Knock-off Arbor for Use on Vertical Turret Lathe

Vertical Knock-off Fixtures for Heavy Work

The application of the arbors previously mentioned has been entirely in a horizontal plane and in the majority of cases, for comparatively small work, but we will take up something of a little heavier nature, and in its application we will construct our fixture in the vertical plane for use in the vertical turret lathe or vertical boring mill.

Fig. 10 illustrates a heavy knock-off fixture which was designed for use on a vertical turret lathe, and the work shown in position on the fixture is a large bevel cone of chrome nickel steel, the conical surfaces of which are required to be in perfect truth with the interior threaded portion. This fixture is called upon to resist the strains incident to very heavy cutting and is necessarily of very rigid construction throughout. The steel arbor is threaded on its upper end at *A*, with an 8-pitch right-hand thread, upon which the work is screwed. Below this, marked *B* in the illustration, is another thread of much coarser pitch, *viz.*, 4-pitch left hand, and with the Acme type of thread. The cylindrical portion *C* passes down through the body of the fixture, and is ground to fit the hole in the table at *D*, thus acting as a locating plug. The two pins *E* and *F* are obviously used to prevent the arbor from turning, while the nut *G* draws it down against the shoulder. It may be noted that the fixture body *N* is firmly secured to the table by the bolts shown, these being screwed into shoes in the table T-slots. The knock-off portion is a steel forging, having an upper cylindrical section *K* which bears against the work at *L*. A positive vertical stop is assured by the shoulder *M* on the arbor. When using the fixture, the knock-off forging is always brought up against this shoulder before the work is screwed onto the arbor. After the piece has been machined, a sharp blow is given to either of the two lugs *J* or *H*, thus reducing the friction at *L* and permitting the easy removal of the completed cone.

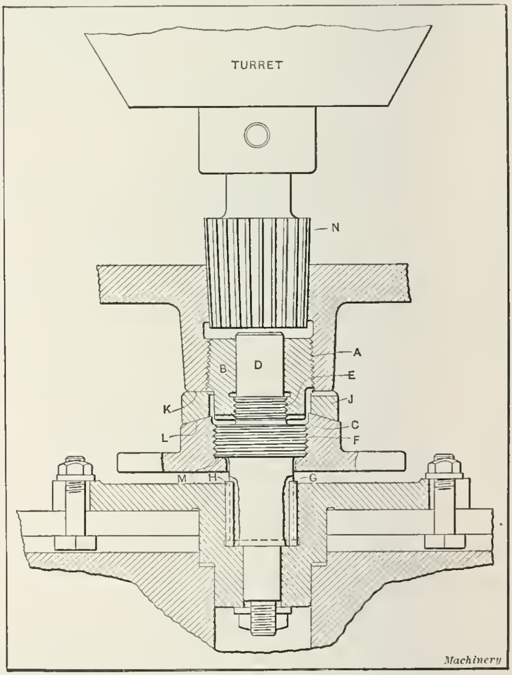

Fig. 11. Another Style of Vertical Knock-off Arbor

Fixture for a Large Taper Thread

Another vertical fixture which requires in its design, the solution of the most difficult problems in the construction of knock-off arbors and fixtures is illustrated in Fig. 11. The work is a large steel forging, a detail of which is shown in the lower part of Fig. 1, and it will be noted that the threaded ends are pipe thread taper and must be in line with each other. To make the conditions worse, the end of the hub is unfinished, necessitating careful handling and clamping in order to avoid distortion. In order to understand the situation thoroughly, it may be stated that, in a previous setting of the work, a straight hole has been bored entirely through the piece, and the taper hole on the hub end has been reamed and threaded to the correct pipe thread taper. The taper bushing *B* is threaded on the outside to the pitch of the pipe thread, and it is screwed in place in the work before placing it in position on the fixture. Two slots in the end, shown at *C*, permit the use of a spanner. The interior cylindrical portion is ground to an easy running fit at *D*, and is threaded somewhat loosely on *E*, which is a 6-pitch Acme right-hand thread. The centering and alignment are governed entirely by the upper cylindrical bearing.

The arbor itself has a 4-pitch left-hand Acme thread cut upon it at *F*, and it is driven through the square keys *G* and *H* in the body of the fixture. As the lower end of the work is unfinished, it is necessary to support it in such a way that it will not be distorted, or thrown out of the vertical position. To obtain this result, the collar *J* must be designed to give a three-point-bearing to the piece on the surface *K*. The collar is therefore slightly relieved leaving three high points which bear against the hub, and the cup-shaped bottom allows a rocking action upon the spherical portion of the knock-off at *L*. Except for the spherical surface, this knock-off is about the same as that shown in Fig. 10. Attention is called to the manner in which the positive vertical location of the work is assured, irrespective of the tapered portion, as this is one of the important features of the fixture. It will be readily seen that the clearances between the bushing *B* and the shoulders on the arbor are sufficient to allow for considerable variation in the depth of the tapered hole, and still keep the relation between the surfaces *M* and *K* constant. The taper reamer shown at *N* helps to make clearly apparent the actual working conditions while the fixture is in use.

The majority of the most common conditions have been noted in the illustrations shown in this article, and while more difficult problems may arise occasionally, they may be successfully handled by adaptations of the foregoing.

* * *

VANADIUM STEEL FOR REDUCING MAINTENANCE COSTS

An interesting example of the advantages of vanadium steel in reducing maintenance and production costs has been furnished by one of the largest bolt manufacturing companies in this country. This company has had considerable experience with vanadium steel, having used it for a variety of purposes for over two years. Some of its most troublesome and costly maintenance problems have been solved by the use of vanadium steel for machine parts.

One of the principal applications of vanadium steel in the line of machine repair parts is chrome-vanadium steel crank shafts for bolt heading machines. Prior to the adoption of chrome vanadium steel, $3\frac{1}{2}$ per cent nickel steel has been used for these parts and the nickel steel had in turn replaced the carbon steel shafts with which the machines were originally equipped. The service is severe, the crankshaft being subjected to repeated shocks and vibrations which tend to cause fatigue. In addition to the strains of ordinary service the crankshaft frequently must resist excessive and suddenly applied loads as a result of carelessness of the operators, causing accidents that are practically unavoidable in machines of this type working under usual shop conditions. A material of high dynamic strength or resistance to fatigue is required. The use of nickel-steel shafts failed to satisfactorily overcome the troubles experienced with carbon steel, breakages of the nickel-steel shafts being frequent. The failure of nickel-steel shafts led to the use of chrome-vanadium steel shafts forged by the Erie Forge Co., Erie, Pa. Since the beginning of the use of chrome-vanadium steel two years ago, not one of the shafts has failed. Each shaft is stamped with the name of the material and date of its application to the machine.

MILLING DIE-BLANKS ON AUTOMATIC GEAR CUTTERS

At the Wells Bros. Co.'s plant in Greenfield, Mass., there are two E. J. Flather Mfg. Co.'s gear-cutting machines which are employed for doing work that is so foreign to that usually performed upon gear cutters that they are worthy of description. Fig. 1 shows a general view of the two machines and Fig. 2 shows the details of the work being performed.

Upon the arbor of the machine where the gear blank is usually mounted, a magazine turret has been fitted. The small steel blocks which are to be milled are held in eight slots equidistantly spaced about the turret. These blocks are blanks for threading dies, and nine pieces are held in each slot. These are clamped in position by a cam grip and a cutter of the proper contour placed upon the cutter spindle of the machine. The machine is geared to index to eight positions and the form milling is thus rapidly performed without other attention from the operator than loading the turret. This operation of the machine is not confined to any one piece, for by substituting different holding guides, pieces of different dimensions may be held and, of course, cutters of any shape may be used upon the cutter spindle. In this way there are many jobs which can be handled by these machines.

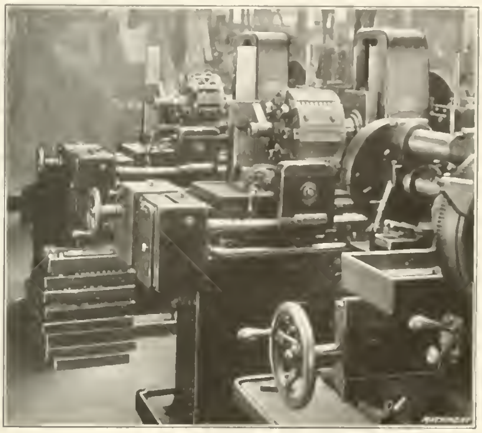

Fig. 1. Automatic Gear-cutters used for milling Die-blanks

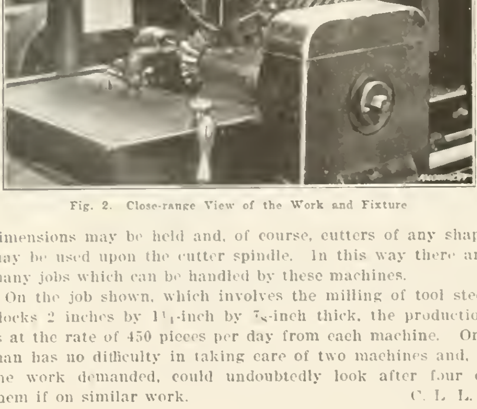

Fig. 2. Close-range View of the Work and Fixture

On the job shown, which involves the milling of tool steel blocks 2 inches by $1\frac{1}{4}$-inch by $\frac{7}{8}$-inch thick, the production is at the rate of 450 pieces per day from each machine. One man has no difficulty in taking care of two machines and, if the work demanded, could undoubtedly look after four of them if on similar work. C. L. L.

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THE BENEFITS OF STEADY PRODUCTION

Irregularity of demand for American manufactured products has created conditions inimical to general prosperity. The tendency of late years is to manufacture to order only, thereby avoiding the tying up of capital in stock. While this practice enables a manufacturer to concentrate a large percentage of his capital in the means of production, it has the great disadvantage of producing irregular demands for product and a consequent unsettled labor market. At one period in the year, the demand for goods may be so heavy that shops, mills and factories are unable to supply it even though working to full capacity and running over time. Under such conditions, labor is at a premium and men are hard to get at any price. In six months, the conditions may have so changed that the plants are running with reduced force, and men are thrown out of employment and leave town to seek work elsewhere.

Aside from the moral side of the question, this is bad business. An efficient corps of workmen is formed only at considerable cost. To ruthlessly break it up is to lose money for the concern. The workman's loss is obvious, but the money loss to the employer is concealed by the apparent saving due to reduction of the pay-roll.

The ideal plan of running a manufacturing plant where men are working an eight-hour day is to run three shifts twenty-four hours a day. Obviously, with efficient superintendence the yearly capacity of a plant run on this plan is three times that of one running on one shift only. The capital invested in machinery and buildings yields three times the return on three daily shifts that it does on one. The bad social effects of the three-shift plan as well as the difficulty of obtaining and maintaining competent foremen probably will always prevent this plan of operation being generally adopted. It is one, however, that offers relief to the manufacturer who would maintain a permanent organization and at the same time have working capital available to invest in stock during dull periods. With comparatively little capital invested in machinery earning three times that of the equipment of the common concern of the same capacity, more capital can be safely tied up in stock, thus steadying the labor market and providing goods to fill orders immediately.

If more goods were made during dull times to supply orders in brisk times, these periods of abnormal demand would decrease in intensity. The benefits that would follow are too evident to require argument.

THE RECORDING OF ENGINEERING DATA

Many engineers of exceptional ability in carrying on experimental work and in determining data of importance in engineering, lack the ability to place these data on record in such a way as to make them easily available for general reference. To be able to take a mass of miscellaneous data, and put them in such shape that others may be able to use the data without wasting a great deal of time in "digging it out," is a valuable asset for an engineer. Reports are often presented by committees before engineering societies in which the essentials are so hidden among a mass of words that it is impossible to quickly grasp the subject. Tabulations are often made in a form from which it is difficult to obtain the essential information. Committees that are to present reports containing a great deal of engineering data should endeavor to have their data put in satisfactory shape by someone who is capable of properly arranging it in the most comprehensive and simple manner. The value of papers presented before engineering societies would also be greatly enhanced if the information contained were carefully condensed and the data given, properly tabulated. The best handbooks, as well as the engineering journals, indicate the method that should be used, although many handbooks are at fault even in this respect. Sometimes it is very difficult to find the essentials among the mass of information presented. Engineers in general should give more study to this subject and take more pains to present such data as they give to the engineering world in the manner best suited to meet average needs.

* * *

MACHINE FORGING

The making of forgings by machine methods is an art about which very little has been published, although remarkable advances have been made in this direction in the last decade. The upsetting and forging machine produces forgings by a process which might be called "machine blacksmithing," as it performs the same class of work that formerly was accomplished only by hand forging. Machine forging has many advantages over the well-known hand method of producing machine and engine parts, and supercedes the old method in many progressive shops. The difference in the cost of manufacturing parts by the two methods is in many cases almost unbelievable. For instance, a certain engine part which by ordinary blacksmithing methods cost $7 to produce was handled successfully on the upsetting and forging machine at the rate of 30 cents a piece.

It is possible to produce a much greater range of work in an upsetting and forging machine than by drop forging, and one chief reason for this is the method of handling. For instance, in forging with a steam or drop hammer, only two dies, a lower and upper one, are used. The gripping dies in the forging machine perform practically the same function, but in addition to these, the forging machine is also provided with end-working plungers which greatly increase its manufacturing possibilities. Another advantage of the forging machine is the feasibility of carrying a part through the various stages of manufacture without removing it from the machine to the heating furnace. This is made possible by having a series of impressions, ranging from one to four, cut in the opposing faces of the gripping dies and a corresponding number of plungers operated by the ram of the machine. With this combination, it is practicable to turn out parts which could not be produced by any other method in anywhere near the same time.

Another feature of the forging machine which is worthy of attention is its use for the welding of parts. Welding operations can be performed just as successfully in a forging machine as by hand, and of course the former method is much more rapid. Wrought iron welds more readily in the forging machine than steel containing a high carbon content, but when handled properly, steel parts can be welded successfully, a flux being generally used for this operation. The possibility of doing general welding in the forging machine opens up a wide field, as scrap metal can be utilized in the production of expensive machine and engine parts, thus reclaiming material otherwise almost worthless. When the use of the forging machine becomes better understood, it should prove a very important factor in manufacturing.

GEAR CASINGS AND GUARDS

A generally accepted principle of machine design is that a casing concealing and protecting mechanism should conform to the shape of the mechanism. It is a rule that should be tempered with discretion, however, when its rigid observance requires casings of ungainly shape or very irregular form. In those cases the effort should be to produce a pleasing outline, even though comparatively large unfilled spaces are a result. The casing will cost less for pattern making and molding and will usually be of more convenient shape for machining.

Another point that is sometimes ignored in designing gear casings for machine tools is to provide for making the casing so that it can be readily removed without disturbing other parts. A motor should not be mounted on top of a headstock in such a manner that if the casing has to be lifted the motor must first be taken off. The principle of easy accessibility is violated by any design requiring the dismantling of one important member in order to reach another.

* * *

MEN MORE IMPORTANT THAN METHODS

When the organization of many successful manufacturing concerns is carefully analyzed, the most impressive fact is that men composing the organization are more important factors in its success than the methods employed. What we mean is that while the methods used must be good to be successful, they are not necessarily the only ones that the same men could employ with success. The same methods, used by another organization of men unfamiliar with the conditions under which they were developed and not working in harmony, might easily fail.

Many concerns which have developed successful manufacturing methods are naturally conservative about disclosing them to competitors. They argue that as the knowledge acquired cost them considerable time and labor to develop, it would be giving away an advantage to furnish a competitor with that knowledge free of cost. While this view is quite human, the actual result of publishing information about improved methods works out differently. Mere knowledge of improved machines and methods is of little value to competitors if they have not the men to put them into use. Certain elements of knowledge can only be acquired by actual experience. To tell a man how to perform an operation and for him to actually do it are quite different. Team work is essential for success, and every concern must develop it in its own works.

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THE DEVELOPMENT OF BROACHING

The cutting of keyways and machining of holes in metal to shapes other than round by broaching is an old practice, but one that has attracted comparatively little attention until within the past ten years. While machines were built and used for broaching they were not in common use until about 1900, when the automobile business developed rapidly.

Now the broaching process is used very extensively, not only by automobile manufacturers but by many other concerns. Such parts as vise jaws are advantageously shaped for the rectangular bar by broaching, and while this is relatively large work, the trend of practice indicates that much larger and heavier parts will be machined in this manner when the quantity of work warrants the necessary investment in machines and tools. The keyways of "paracentric" locks are broached; the peculiarity of this operation lying in the irregularity of the slot which forbids the use of practically every other machine operation. On the other hand the broaching machine is becoming a recognized means of cutting external shapes that are readily machined with standard tools. The reason for this is the high rate of production and low cost.

The advantages of the broaching process are speed, interchangeability of work, adaptability to irregular forms, employment of comparatively unskilled labor, and adaptability to a great variety of work. The chief disadvantage is the high cost of broaches and the uncertainty of their life. One broach may cut 20,000 holes while another made of the same steel and tempered in the same manner may fail before 2000 are cut. While chiefly applied now to interior work, exterior work is also being successfully done, and one of the possibilities is broaching spur gears when the quantity of duplicate gears is large.

CHARACTERISTICS OF FRICTION CLUTCHES

BY J. W. BRASSINGTON[*]

It is not the intention of the writer to discuss the relative merits of any of the different types of friction clutches now on the market, nor is this article written as an exposition of the theory of the friction clutch. The intention is to attract attention to the importance of the friction clutch as a part of many types of machines, and also to call attention to the lack of adequate technical information covering the principles that must underlie the design of a successful friction clutch. Take any friction clutch catalogue, as at present issued by a manufacturer of clutches, and on turning the pages you will probably find a table giving what purports to be the horsepower capacity of the various sized clutches, for a given number of revolutions per minute. Such a table will probably show that the manufacturer believes the horsepower capacity of each clutch varies directly with the number of revolutions per minute. In no case, within the writer's knowledge, is any information given covering the "pick-up" capacity of a clutch at any given speed, nor has he yet come across a trade catalogue giving the starting torque of any clutch.

The wonderful development of the automobile that has taken place in the last few years has thrown a great deal of light upon the qualities that are essential for a successful clutch. It is somewhat of a shock to the mill or shop man to realize that some of the automobile manufacturers equip their machines with clutches that, in spite of the exceptionally severe service they are subjected to, actually outlast the automobile, of which they are a part, without requiring any special attention or repairs. The purchaser of an automobile is an unreasonable fellow and he would not, as a rule, submit to the infliction of a clutch that would make him conscious of its existence by giving any trouble whatsoever. Will any mill or shop man, using a friction clutch to start up and run heavy machinery, expect to buy a clutch at a reasonable price that will not require a new disk, collar, brake band or such like repair, at fairly frequent intervals? Part of the trouble is caused by the fact that the buyer of the clutch, even if he takes one big enough to transmit the power wanted at the running speed of the machine in question, does not make sure that it has capacity enough to start up from rest when the machine is heavily loaded. Again, it is probably rarely realized by the buyer that the "pick-up" capacity of a clutch is inversely proportional to the speed, while its transmitting power is directly proportional to the speed.

As this is a subject full of interest from both a practical and theoretical point of view, the writer wishes to place before the readers of MACHINERY the following statements, for the truth of which he can find no confirmation in present trade catalogues, but he feels it is probable that some reader's experience with friction clutches may endorse his belief in their accuracy:

1. The starting torque of the common friction clutch is a constant up to a certain speed of the driving shaft, and beyond this point, it rapidly drops. 2. The "pick-up" capacity of a clutch varies inversely with the speed. 3. The work done by a clutch in "picking up" a load is directly proportional to the moment required to turn the mechanism to which it is attached, *i. e.*, the work done by a clutch in "picking up" a load is directly proportional to the weight of the load. 4. The work done by a clutch in "picking up" a load, is directly proportional to the square of the velocity of the mechanism to which it is attached. That is to say, if we double the speed of the driving shaft and then throw in our clutch on the same load, the work the clutch will have to do to start up the same machine from rest to double the normal speed will be four times as great as the work required of the clutch to start the same machine at the normal speed.

We may state this algebraically as follows:

$$F = \tfrac{1}{2} \times \frac{W}{g} \times V^2$$

where

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F = the amount of work done;
W = the weight moved;
V = velocity of moving parts in feet per second.

This is the well known equation expressing the work of acceleration.

Now let us refer to the work of the builders of automobiles, and find out something about their clutches. It seems to the writer that the most successful clutches in the automobile trade are those that are made to slip as well as to grip. The heavy steel 'busses in the streets of Paris are run in such a manner that their speed is controlled by the clutch; *i. e.*, at the slower speeds of the 'busses the clutch is allowed to slip. This is probably a new way of looking at a clutch to many of us, and it is wonderful how much good it does a man to look at anything from a different point of view. It is evident that a clutch that cannot be thrown in too quickly, and that will slip as it gradually picks up the load, is spared the destructive treatment that must be the lot of a clutch that is thrown in too quickly and made to destroy itself starting up a heavy load from rest to a high speed. For instance, suppose a clutch is used to start up a load of ten thousand pounds from rest to an average speed of one foot per second, then the work required to pick-up is found from the preceding equation to be:

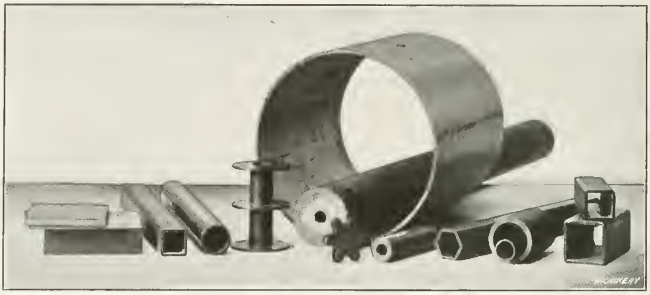
Fig. 1. Samples of Micarta Parts showing Some Shapes in which it will be Available

$$F = \frac{10,000}{64} \times 1^2 = 156 \text{ foot lbs.}$$

Now let us speed up the machine to say three feet per second and throw our clutches in. The "pick-up" power required for the same machine is expressed thus:

$$F = \frac{10,000 \times 3^2}{64} = 1410 \text{ foot lbs.}$$

This means that a clutch nine times as large is required to "pick-up" the load in the same period of time. Yet our friend, the clutch manufacturer, would probably offer a smaller clutch in the second instance than in the first because the speed or revolutions per minute is three times as large and, as per his catalogue, only requires a clutch of about one-third the size. From some data jotted down at intervals during a busy life, in a note-book that is a kind of catch-all of miscellaneous information, the writer finds that quite a number of the friction clutches now on the market have been given a rated horsepower by multiplying the number of square inches of frictional contact, by the mean radius, by the number of revolutions, by some constant, and dividing the present by 33,000. The constant is generally about 10, and it represents the number of pounds of pressure per inch of frictional contact. This figure multiplied by the coefficient of friction for the material used, and then by the number of square inches of frictional contact, gives approximately the power required from the leverage and motive power provided to throw in the clutch.

The writer does not profess to be an expert on the clutch question, although it has caused him some thought and some trouble in the past. All of the trouble could not always be traced to the want of judgment on the part of the clutch operator or purchaser in giving a clutch too much work to do. The average clutch manufacturer is not as yet sufficiently imbued with the spirit of the times to make public the engineering information covering this subject, either in his catalogue, or by the ready and courteous tongues of his salesmen.

* * *

MICARTA—A SUBSTITUTE FOR FIBER, RAWHIDE, HARD RUBBER, ETC.

A remarkable new material to take the place of hard fiber, glass, porcelain, hard rubber, built-up mica, pressboard, rawhide, molded compounds, etc., has been developed by the Westinghouse Electric and Mfg. Co., East Pittsburg, Pa. The material, which is known as "Micarta," is used for commutator bushings and brush-holder insulation, as noiseless gear blanks, as conduit for automobile wiring, as spools for spark coil and magnet windings, for refillable fuse tubes, for wireless coil separators, for arc shields in circuit-breakers, for water meter disks, etc.

Micarta is a nard, tan colored, nomogeneous material having a mechanical strength about fifty per cent. greater than hard fiber. It can readily be sawed, milled, turned, tapped, threaded, etc., if a sharp pointed tool is used and the work done on a lathe. It can be punched only in thin sheets and cannot be moulded. Micarta is not brittle and will not warp, expand, or shrink with age or exposure to the weather but takes a high polish, presenting a finished appearance.

Two grades of the material are made. The grade known as bakelite micarta will stand a temperature of 150 degrees C. (300 degrees F.) continuously, or 260 degrees C. (500 degrees F.) for a short time. It is infusible and will remain unaffected by heat until a temperature sufficient to carbonize it is reached. Heat will not warp bakelite micarta, and it will stand an electric arc better than hard fiber, hard rubber, built-up mica, or any moulded insulation containing fibrous or resinous materials. Its coefficient or expansion is low, being approximately 0.00002 inch per degree C. Bakelite micarta is insoluble in practically all of the ordinary solvents such as alcohol, benzine, turpentine, and weak solutions of acids, and alkalis, hot water and oils. It is indifferent to ozone—an advantage over hard rubber, resins, etc., for electrical purposes. It is nonhydroscopic and impervious to moisture.

The other grade designated as No. 53 micarta has the same mechanical and electrical properties as the bakelite micarta but differs in its chemical and thermal properties. The plain micarta behaves toward chemicals and heat very much as an ordinary resin. This grade is not used in plate form.

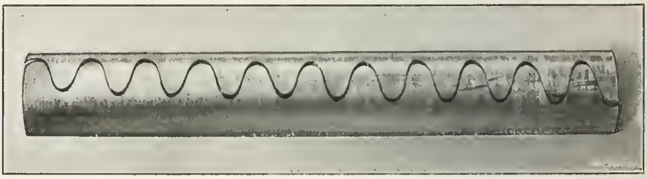
Fig. 2. Tube of Bakelite Micarta fractured by Endwise Compression to show Remarkable Homogeneity

As proof of the uniformity of structure of bakelite micarta, an illustration of a fracture is shown in Fig. 2. This is not a saw cut, but a natural break. The tube was held tight on a metal mandrel and a compressive force was applied at one end of the tube. When the force became sufficiently great the tube split as shown. The uniformity of the wavy fracture shows how homogeneous the material is. Such a break is known as a "harmonic fracture." The strains in a homogeneous material under stress follow a sine wave law. If one part of the material is weaker than the rest, the strain at this point becomes greater and the harmonic wave is distorted. However, it will be seen from the illustration, made from an actual photograph, that the strain followed the true harmonic wave almost as closely as the eye can detect, indicating that every part of the material was exactly as strong as every other part.

SHOP CRANES—THEIR DESIGN AND CONSTRUCTION[*][†]

HORSEPOWER OF MOTORS—GEARING—BRAKES—GIRDERS—END CARRIAGES—PLATFORMS, ETC.

As in all other mechanisms, the principal point to consider in connection with modern shop cranes is economic design for the greatest efficiency—in other words, the minimum of material in the right place for the greatest utility. We will first of all consider a jib crane, which is the most universal design of fixed crane. Among the various types employed for different services in shops, the simple under-braced type is the most common. In designing, we must first know all the loads that the crane will be subjected to, both moving and fixed, and then proceed to lay out the diagrams showing all the stresses to which this particular crane will be subjected. A typical crane used in shops over machines, and fixed against a wall or on a column in foundries, consists of a mast or pillar resting on a foundation and supported at the top. The jib secured to the mast or pillar is supported by a strut which is fixed to the pillar. First, we must know the load which is put on the crane. The overhang or cantilever is usually made about a quarter of the distance between the column and where the strut is connected to the jib. When the load is at the center or at the end of the cantilever the bending moment is practically the same. This ratio should be proportioned to produce the same stress in both cantilever and span. The next step is to obtain the reaction at the junction of the strut and the jib, and the jib and the column. We then draw the parallelogram of forces to scale, and measure the lines to obtain the forces for the required sections.

Overhead Traveling Cranes

The overhead traveling crane in its various forms is probably in greater demand than any other type of crane on the market. Electrically-driven overhead cranes are most universally used for heavy loads, especially when continuous running and rapidity are required. The three-motor crane is the most efficient for modern workshop practice, but until recently, the single-motor crane was considered the cheapest for engine houses and places where only an occasional lift was required. The present price of motors and the fact that single motors require more gearing are two reasons for prefering three-motor cranes. One of the principal obstacles which make standardization difficult is the various opinions as to speeds. There is no reason why this type of crane should not be worked at the same speeds by the various manufacturers, as most makers who state the speed of their standard patterns are very nearly in agreement.

In selecting the speed at which the load is to be lifted, it should not be overlooked that the nominal load is seldom more than 20 per cent of the full capacity of the crane. It is better, therefore, to consider the highest safe speed at which this load can be worked, and then select a full load speed which will give the same foot-tonnage of work done. By the use of series-wound motors, a variation up to 50 per cent above the rated speed can be obtained, so that it is unnecessary to use change gears on the main lift. On cranes, say over 20 or 25 tons, where the full load is only occasionally handled, and the crane is used frequently for light loads, it is often economical to have an auxiliary barrel fitted on the crane and worked by a separate motor with a capacity of 5 to 6 tons, and a speed of 20 to 40 feet per minute, the lift being 1/5 the full capacity of the crane and the speed such as will give the same foot-tonnage as the main lift. It is never worth while to have a change of gear to the cross traversing and traveling motors. The speeds are variable according to the work required to be done.

Obtaining the Horsepower of the Motors

The power required of the lifting motor depends purely on the work done on the load and the power absorbed in the friction of gearing, journals, etc. It varies with the number of reductions and the type of gearing. A common rule in practice is to allow 10 foot-tons of work done at the hook per B. H. P., this being equivalent to a mechanical efficiency of about 66 per cent. The power required for cross traversing and traveling must be sufficient to overcome the rolling and axle friction and the friction of the intermediate driving gears. For practical purposes, resistances of 40 to 50 pounds per ton for cross traversing and 60 to 70 pounds per ton for traveling are allowed for the best class of traveling cranes which have large diameter wheels and machine cut gears.

Framing and General Details of the Crabs

The difference in appearance of cranes is chiefly in the design of the crabs themselves. There has been a difference of opinion as to the materials adopted, some makers using cast-iron frames up to considerable sizes, but it is now almost universal practice to use a steel framing for all sizes. The chief idea in designing is to make all parts as accessible as possible in order to facilitate removals, repairs, and general attention; and to keep the structure as light as possible, and still maintain the required stability. Some makers use either double or single steel plates, but these box up the motors and gearing too much, and, what is worse, necessitate solid bearings.

The running wheels and axles are the first members to be considered and the material from which they are made is important. For first-class work, cast iron should not be used above 10 tons, as there is considerable weight that the wheels and axles are required to carry, and they will soon show signs of wear. Cast steel should be used for this purpose. The wheels should be made as large as possible, in order to reduce the tractive resistance. The axles should be made as small as possible, but care must be given to their design, as they are subject to combined bending and twisting: in the first place due to overhang, and secondly due to resistance of traction. The overhang from the center of the bearing to the center of the wheel should not exceed 5 inches, and the working strain should not exceed 5.5 tons per square inch. The length of the bearings should be designed to give a pressure of not more than 900 pounds per square inch of projected area. They are usually made of cast iron with brass bearings on the top. The most important part is the lubrication, and for crabs of over 40 tons, the use of self-oiling bearings should be adopted. Roller bearings are also sometimes adopted for this purpose on heavy cranes. For very heavy crabs, the axle bearings are sometimes put on both sides, which enables less width in bearings to be used and the gearing can be more compactly arranged. One wheel on each side would require to be geared with this arrangement

Rope Details

The barrels are usually made of cast iron, with the rope grooves turned in to suit the diameter of rope to be used. Particulars of steel ropes suitable for this work are given below, and can be taken approximately:

Loads in Tons	No. of Ropes	Circumference in Inches
3	2	1¾
5	2	2¼
7.5	4	4
10	4	2¼
15	4	2¾
20	4	3¼
25	4	3½
30	4	4
40	4	4½

The usual factor of safety is 8, which allows a good reserve strength if a few strands break. The life of a rope depends largely on the diameter of the barrel and the number of pulleys it passes round. Some makers recommend a barrel diameter 6½ times the circumference of the rope; this appears suitable for ropes under 3½ inches circumference, but above this size, 5½ to 6 times the rope circumference should be quite large enough for the barrel diameter. An important point is the spacing of the ropes on the barrel—that is, the distance between the centers of the grooves. For all ropes up to 4 inches in circumference, ⅛-inch should be left between the sides of the ropes, but above that size, 3/16-inch should be left if possible. This is to allow for the flattening of the ropes while under load, and to avoid their grinding together. The usual practice is to allow the lift to be taken in the center of the barrel to distribute the load more evenly on the girders. From 7 to 50 tons, the load should be lifted on four parts of the rope—that is, two parts in right and left hand grooves on the barrel, the other end passing around a pulley. This pulley need not exceed twice the circumference of the rope.

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[*] Abstract of a paper read by Frank W. Suffield before the Birmingham Association of Mechanical Engineers, Birmingham, England.

[†] For further information on this subject see "The Design of Jib Cranes" in the October, 1908, issue of MACHINERY; "Design and Construction of the Electric Overhead Cranes" in the January, 1909, issue of MACHINERY, and other articles there referred to. See also MACHINERY'S Reference Books Nos. 47 and 49.

For cranes up to 3 tons, the load should be lifted in a single pull of rope; 5, 6 and 7 tons with two, one coil being on the barrel; four ropes up to 50 tons, six ropes up to 75 tons, and so on. It is not so important to lift centrally with small cranes, as the load on the girders can never exceed their strength. The thickness of metal in the barrel must be considered, and the stress of bending kept within safe limits. The barrel shaft must be considered in the same way as other shafts, also the bearings with the same bearing pressure.

Gearing

Gearing is one of the most important parts of the crane design, whatever kind of crane is being considered, as the efficiency and safety of operation depend upon it. Although machine cut gears increase the cost of the equipment, the saving of current used by the electric motors will enable the cut gears to soon pay for themselves. For heavy loads it is advisable to use cast iron for the barrel gear and pinion. It is also advisable to shroud the pinion and as the speed is low, the loss due to friction is not worth considering. Rawhide motor pinions in mesh with cast-iron gears are found to be suitable for the first reduction on cranes up to 20 tons. They run very smoothly and do not require lubricating. Above 20 tons, the motor pinions ought to be machined steel running with cast-iron or steel wheels in an oil bath. It is usual to make the steel pinions from a solid steel bar or forged piece; the pinion teeth are stronger than those of the wheels. If cut from cast iron, they are of about the same strength as cast steel wheels. The barrel wheel and pinion for cranes up to 20 tons are made of cast iron, but above this size cast steel is better, and for all cranes above 7 tons the pinions should be shrouded. For cranes above 20 tons it is good practice to make all of the pinions of steel. Altogether the sizes of the pinions should be as small as possible; and no pinion should have less than twelve teeth.

In crane work, as in all other gearing, the strength of the teeth is most important. and the stress to which they are subjected varies widely in actual practice. The average ultimate strength of cast iron and cast steel subject to bending (as in a tooth) is 18 and 30 tons, respectively. Owing to the nature of the metals and the methods of manufacture, one would be justified in allowing a factor of safety of 8 for cast iron and 6 for cast steel for slow running. Reliable formulas, such as Professor Unwin's, will be found quite satisfactory in use. Involute teeth with radial flanks, which give a short tooth with a broad root, are most often used because of their great strength. The chief value of shrouding is to minimize the tendency of the teeth to break across the corners, especially in the case of cast-iron gears. Double helical gears are sometimes use for the barrel gear and pinion of cranes over 30 tons. Their relative strength, as compared with spur gears, is a debatable question, but as the points of contact are always distributed over the whole of the working face, from root to point, the leverage of the load is only half that in an ordinary spur gear. In practice it is very difficult to make the apices of these gears run in the same plane, any error in this respect causing the load to be concentrated on one side of the wheels, so that care must be taken in working out the strengths not to allow too much for the advantage that double helical-shaped teeth have over the ordinary type, although they are about 1 to 1½ times stronger. The question of design and strength of the arms, rims and hubs must be gone into carefully, for it is these details that give good results, both in the cost of manufacture and in the service obtained by the purchaser.

Brakes

Electric-driven cranes must be fitted with effective brakes, and of these there are two kinds—magnetic and mechanical. The magnetic brake is generally of the strap or clamp type, and is held off by a magnet or solenoid connected with the motor, so that when the curren is taken off, the brake comes into action. To avoid a too rapid action of the brake, the solenoid is equipped with a dash pot, the air being throttled in a small hole at the top of the body. The magnetic brake must be sufficiently strong to hold the full load in event of the mechanical brake failing. When both brakes are in use the solenoid is almost solely used for stopping the motor quickly, and as it will run both ways the clamp type of brake is found most suitable. Brake pulleys on the motors should be as large as possible, yet the peripheral speed should not exceed 2000 to 2500 feet per minute.

Girders

The consideration of the main girders, and the selection of the most suitable type for a given crane is an important point, since the general efficiency of the crane is affected by the girders, which represent the bulk of the weight. Furthermore, if the contract is to be awarded to the lowest bidder, economy has to be taken into consideration and the design worked out to make use of the lightest sections that will give a safe stress. For this purpose, a stress of 5 to 5½ tons per square inch should be the limit, and this will cover all contingencies and avoid undue deflection in the shafts, etc. There are four principal types of girders in use: (1) rolled steel joists; (2) box plate girders; (3) single web plate girder; (4) braced or lattice girders.

1. The rolled steel joist is, of course, the simplest type of girder and is frequently used for spans up to 40 feet for light loads, and in spans up to 30 feet for loads as high as 20 tons.

2. For cranes above 15 tons, in spans up to 65 feet, box girders are considered excellent, but they are at a great disadvantage, on account of the fact that they cannot be got at for painting inside.

3. For cranes up to 15 tons, say, up to 40-foot span, where rolled steel joists are not stiff enough, the single web plate girder can be used economically with one or two provisions, such as that the speed must not be excessive. Platform girders should be added and braced horizontally to the main girder.

4. For cranes up to and including 4 tons, above 40 feet, and for all 65- or 75-foot spans, braced girders of all descriptions are the most economical. From the points of cost, weight and convenience the Warren type has been found to be the best. Where the rolling load is large and heavy in proportion to the structural load, the double or partly double lattice girder is adopted.

The first step of calculation for crane girders is to obtain the bending moment in the ordinary way. This must include the forces due to (1) rolling load; (2) weight of crabs; (3) structural load—that is, the weight of girder, platform and cross shaft—if the driving motor is in the center this must be added. We do not propose to consider impact forces in any one case, as these are often neglected by crane builders, although, in our opinion, something should be added, especially for high-speed cranes. If the crab is symmetrically built, the rolling load may be considered as being divided equally on the four wheels; consequently it shortens the effective span of the girder by the distance between the centers of these wheels. This bending moment of the rolling load is obtained by multiplying the reaction at either support by the distance from that support to the center of the crab wheel nearest the support. The bending moment due to the structural load is found in the usual way.

The next question is the depth of the girders, and this will vary according to the size of the crane. For heavy loads it is more economical to increase the depth than to make the flanges heavy. We must first assume a suitable section, now that we can decide the depth, allowance being made for rivets. The web-plates should not be less than ¼ inch thick under any circumstances, to allow for deterioration, and for box girders this thickness can be used up to 20 tons; 5/16 inch for 30 to 50 tons, and ⅜-inch above these loads. For single web girders, ¼-inch plates can be used for cranes up to 7 tons, 5/16-inch to 20 tons, and ⅜-inch for heavier loads. These sizes are only approximate, and in some cases stiffeners, which are usually made of T-irons, will be required, but they do not need to be at such close centers as for bridge work. Stiffeners at intervals of 4 feet to 5 feet is all that is necessary in most cases, but it depends entirely on the size of the girder and the loading. It is quite unnecessary to have the full length of the girder the same depth, and it is usually made "fish-bellied."

For high-speed cranes we must consider the lateral stresses due to suddenly stopping the load. To this must be added the distributed effort, as well, which will equal about 0.95 of the stress due to momentum. We must, therefore, see that the total lateral stress does not exceed 4 tons per square inch under these conditions, so as to avoid any possibility of distortion from the concentrated load. It is obvious that the girders might fail in this way and yet be amply strong to carry the load in the span, but the fixing of the platforms often assists very materially in overcoming the difficulty.

The details of the Warren and lattice types of girders vary somewhat with the size of crane, but the stresses to be considered first are found by the same method for all conditions. This kind of framed structure is composed of a compression and a tension flange, kept in position by diagonal members, which are subject to compression and tension alternately as the load moves along. In order to minimize the extra load to which the top flange is subjected on account of the crab wheels, a vertical member is inserted to reduce the spans between the diagonals. These girders can be made parallel or fish-bellied, according to the judgment of the designer. The stresses may be obtained either by moments or diagram. For this purpose the writer's practice is to first use the graphical method and then check the results obtained in this way by the method of moments. It is economical design to use as few sections as possible, taking the section that is required to carry the maximum stress and using the same section throughout the length. A sufficient number of rivets should be allowed for at the joints to limit the stress to 5 tons per square inch in shear, and 8¾ tons per square inch of bearing.

End Carriages

In order to calculate the strength of the end carriages we must know the load of the crab at the extreme end, to which must be added the weight of the girders themselves. It is also necessary to fix the center of the girders and the traveling wheels. The first depends upon the requirements of the crabs, and the second should be about one-fifth of the span. Channels are most convenient, or plates and angles. The wheels should be from 18 inches to 30 inches in diameter, according to the size of the crane, and made of cast steel or cast iron with steel treads. The toothed wheel should, by preference, be bolted to the wheel, rather than keyed separately or cast in one piece. One of the greatest objections to the cheap crane is allowing these wheels to be bushed and run loose on the spindles, and this is one of the many bad features which are adopted to cheapen the cost of a marketable crane; and, further, it is seldom noticed by buyers, who do not trouble to look into details or get anyone who may know to assist them.

Platforms

The platforms may add to or detract from the appearance of a crane, and it is very largely a matter of opinion as to whether there shall be one, two or none at all. For light lattice or single web girders it is found cheapest to use light subsidiary girders and fix them to the main girders with diagonal bracing. In some cases of this kind, the top plate of the girder can be extended to form the platform, which practically strengthens the construction. When the crane girders are stiff enough, brackets can be attached to the sides of them, but these must be designed to be uniform with the remainder of the work. Timber is usually used for this purpose on account of its cheapness and lightness. The cab is made of a very light construction, and suspended from the end of the main girders. It should be just large enough to contain the controller, switches, and provide room for the driver to sit down. Lubrication is a very important point, and every facility must be made for fixing lubricators when oil baths are not used.

As to progress through the works, the material is usually ordered from the mills in lengths and sizes suitable for the particular order, as far as the plates are concerned, and the bar material in lengths of 30 feet or 40 feet. The detail drawings are taken into the templet shop and all the templets are made, and from these the required material is marked off for drilling, punching, trimming and cutting to lengths. After the machining has been done, all the pieces of one girder which are to be riveted are assembled, and these are bolted in their respective positions ready for the riveter. When the riveting has been done, the parts are ready for oiling or painting.

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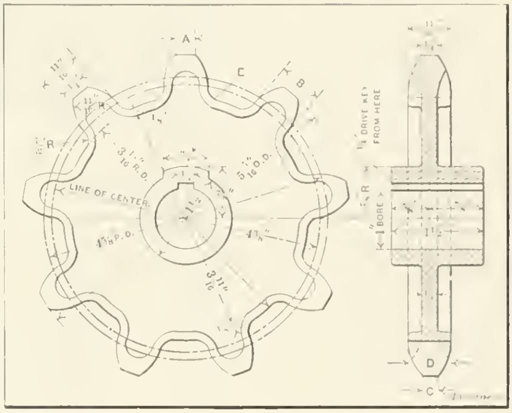
STANDARD SPROCKETS FOR DETACHABLE LINK BELTS[*]

BY J. R. BOWEN[†]

The Data Sheet supplement accompanying the current number of MACHINERY was developed by the writer to take the place of an old shop method of figuring chain drives, the object being to expedite work in the drafting-room and to develop a uniform system of sprockets. The writer has had experience both as a draftsman and patternmaker and has developed the present standard to meet the demand for sprockets that will operate smoothly and which can also be economically produced in the foundry.

The important features of these standard sprockets may be mentioned as follows: The inside width of the chain-roll is made 1/8-inch wider than the width of the tooth D to provide the necessary clearance. From the points C to D and A to B the only function of the tooth is to guide the chain to the seat. Any extra metal outside of the pitch diameter merely adds to the weight of the tooth without strengthening it, and to avoid excessive weight the design shown in the accompanying illustration was adopted. Here it will be seen that the pattern is cut away in such a manner that a sprocket is produced with a cross-section in which useless metal is eliminated. The radius E on the tooth is slightly less than the radius of the chain-roll, the radius of the chain-roll being made equal to the distance from the pitch circle to the root diameter of the sprocket. A fillet with a radius slightly less than the radius of the chain-roll should be used on the sprocket patterns at the point E in order to allow the chain to seat itself on the root circle and the tooth of the sprocket at the same time. It is not good practice to have the radius E equal to the radius of the chain-roll owing to the inevitable roughness of the castings. The writer's experience has shown that the dimensions outlined in the Data Sheet will give satisfactory results for sprocket chains used on all classes of machinery.



Nine-tooth Sprocket for No. 55 Chain, showing how Weight is reduced by removing Unnecessary Metal

* * *

The energy spent in getting even is an investment that pays poor dividends.

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[*] With Data Sheet Supplement.

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STATISTICS OF BICYCLES, MOTORCYCLES AND PARTS FOR 1909

Statistics for the bicycle, motorcycle, and parts industry have been issue by the Bureau of the Census, Department of Commerce, Washington, D. C. The number of bicycles made decreased from 1,182,691, valued at $23,656,487, in 1899, to 250,487, with a value of $3,740,923, in 1904, and 233,707, valued at $3,228,189, in 1909, while the output of motorcycles increased from 160, valued at $33,674, in 1899, to 2328, valued at $359,180, in 1904, and 18,628, with a value of $3,015,988, in 1909.

The evolution of the bicycle from primitive and unserviceable types to a useful and attractive means of travel may be said to have taken place between 1868 and 1890; and its perfection and standardization into practically one form of structure, the modern "safety," between 1890 and 1895. During this latter period the popularity of the bicycle became so widespread that the industry grew very rapidly, but after about 1897 it began to decline.

In 1889 there were twenty-seven establishments engaged in the industry, which gave employment to an average of 1797 wage earners and reported products valued at $2,568,326. At the census of 1899, after the industry had begun to decline, the average number of wage earners was nearly ten times and the value of products more than twelve times as great as in 1889.

During the five-year period ending with 1904 the industry declined very rapidly. The number of establishments decreased from 312 to 101, or 67.6 per cent; the average number of wage earners from 17,525 to 3319, or 81.1 per cent; the value of products from $31,915,908 to $5,153,240, or 83.9 per cent; and the value added by manufacture (value of products less cost of materials) from $15,123,857 to $2,525,094, or 83.3 per cent.

A considerable recovery of the industry as a whole is indicated by the statistics for 1909. While the number of establishments in that year shows a decrease from the number in 1904, the average number of wage earners increased 1118, or 33.7 per cent, and the value of products, $5,545,327, or 107.6 per cent. The most important factor in the renewal of activity in the industry has been the growing demand for motorcycles.

	Number or Amount			Per Cent of Increase*	
	1909	1904	1899	1899-1909	1904-1909
Number of establishments.	95	101	312	–69.6	– 5.9
Persons en enged in the industry.....	5,017	3,761	19,768	–74.6	33.4
Wage earners (average number).....	4,437	3,319	17,525	–74.7	33.7
Capital........	$9,780,102	$5,883,458	$29,783,659	–67.2	66.2
Wages.........	2,908,199	1,971,403	8,189,817	–64.5	47.5
Value of products........	10,698,567	5,153,240	31,915,908	–66.5	107.6

Machinery

* A minus sign (—) denotes decrease.

As already stated, the industry was declining at the census of 1899, yet more than 1,000,000 bicycles were made in that year. The output in 1904 was barely one-fifth as great, and there had been a further decline by 1909. No tandem bicycles or tricycles for adults were manufactured in 1909, although their manufacture had been reported at the two preceding censuses. On the other hand, the development of the motorcycle branch of the industry has practically all taken place within the decade 1899-1909, and more particularly in the second half of the decade.

MAKING A FIXTURE FOR MACHINING SAW-TOOTH BLADES

In making dies, jigs and fixtures, a considerable part of the time involved is occupied in changing the work from one machine to another, and getting it accurately set up for the different machining operations. It is the purpose of this article to describe the operations involved in making a fixture for machining teeth to be used in saw blades of the "inserted tooth type." The universal shaping machine made by the Cochrane-Bly Co., Rochester, N. Y., was used for this purpose. This machine was especially designed for work of this kind and effects a material saving through enabling practically all machining operations to be performed at a single setting of the work.

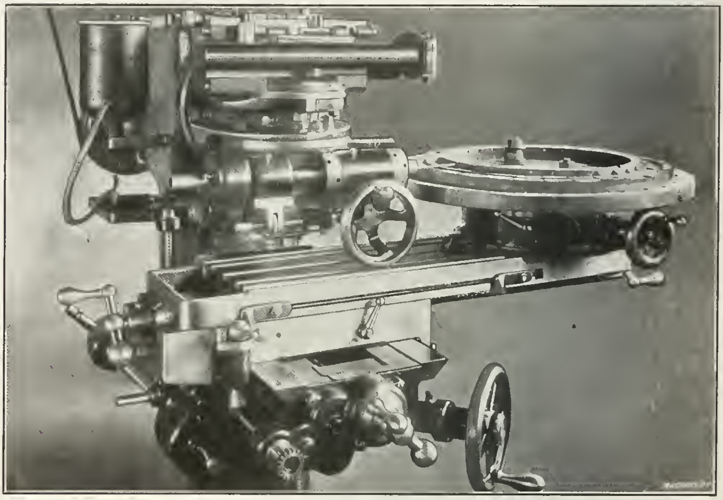

Fig. 1. Drilling Holes in the Flange of the Fixture

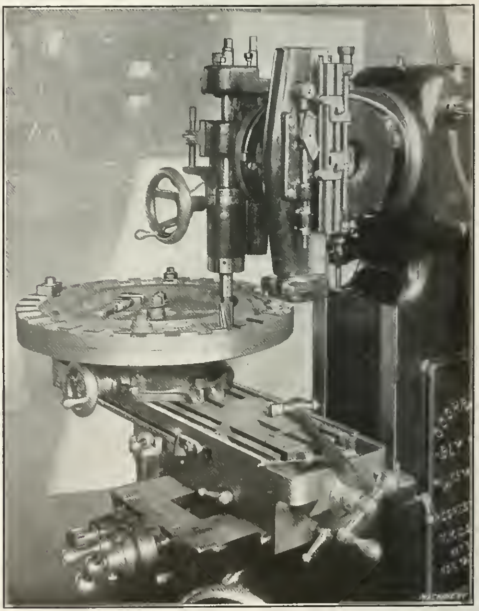

Fig. 2. Milling Alternate Pads to a Depth of 1-32 Inch

After the casting from which the body of the fixture was made had been turned up on a lathe, it was set up on the circular table of the universal shaper. The first operation performed on this machine consisted of drilling thirty holes around the flange of the fixture. For this purpose, the head of the machine was swung to a horizontal position, as shown in Fig. 1, so that these drilling operations could be performed by a drill carried in the "milling spindle" of the machine. It will be evident that these thirty holes are spaced twelve degrees apart and the indexing was done with the graduated dial on the circular table.

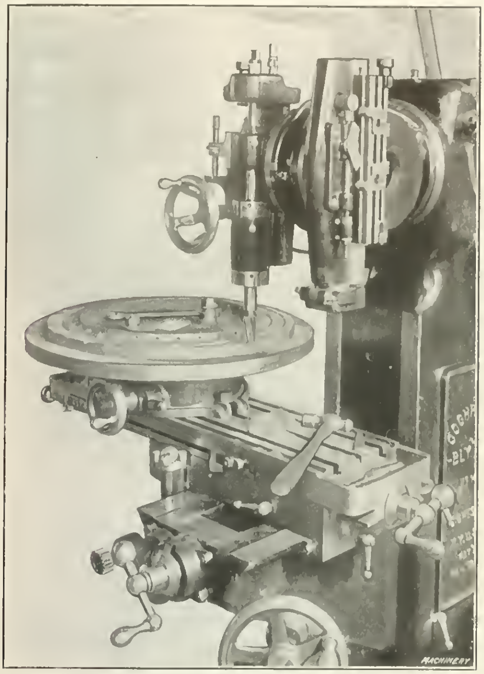

Fig. 3. Milling Recessed Radial Sections of the Fixture

The next operation consisted of machining the pads on the fixture. The face of the casting was divided into thirty sections, fifteen of which were milled in this operation to a depth of 1/32-inch below the faces of the alternate sections. Fig. 2 shows the method of milling these pads. For this purpose it will be seen that the head of the machine was brought back to the vertical position, and an end-mill inserted in the spindle. These pads come midway between the holes that were drilled in the preceding operation, and are located twelve degrees from each other.

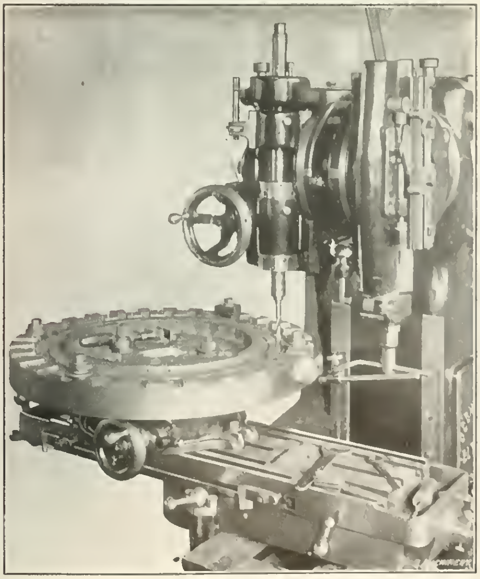

Fig. 4. Drilling Holes in Recessed Radial Sections of the Fixture

After these milling operations were completed, a ring which was turned to the proper size to fit the outside of the raised section on which the pads were milled, was placed on the fixture. After this ring was clamped in position, thirty recesses were milled on its face, as shown in Fig. 3. These recesses are 1¼-inch wide by 2 inches long by ¼-inch deep. They were milled by the same cutter which was used for milling the pads in the preceding operation. The next step consisted of drilling a hole at the center of each of the thirty recesses, for screws which are used for holding the tooth blanks during the machining operations. These holes are ½ inch in diameter by 2½ inches deep. The feed for the drilling was obtained by means of a vertical movement of the milling slide, as shown in Fig. 4. After the holes were drilled, they were tapped to receive the screws. Referring to Fig. 4, it will be seen that a dial test indicator is held in the extension toolpost of the slotter head. The use of this indicator makes it possible to determine the accuracy of the alignment of the fixture at all times, without making it necessary to change the location of the milling cutter. The final step consisted of milling the vertical faces of the thirty pads that were formed around the ring (see Fig. 5:). These faces were milled straight—not radial—and each alternate pad was left 0.030 inch longer than the adjacent pad.

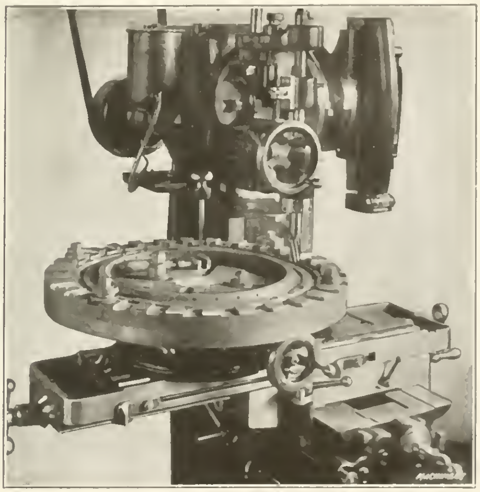

Fig. 5. Milling Faces of Pads Straight. Alternate Pads are 0.030 inch longer than Adjacent Pads

This fixture is used on the faceplate of a thirty-inch lathe for machining the anchor faces of the thirty saw teeth at one operation. The time saved through making this fixture on the Cochrane-Bly universal shaping machine will be readily appreciated when it is known that all five operations were completed without requiring more than one setting of the work. In addition to this, it was only necessary to move the circular table once, which was done between the drilling and the first milling operation, the circular table being moved from one end of the machine table to the other. This universal shaping machine was described in the October, 1912, issue of MACHINERY, so it is unnecessary to include a description of its mechanical details here.

* * *

When you walk into a factory where you hear the manager say: "I have a fine lot of men out there in the shop and I'd hate to lose any of them," and you then walk out into the shop and hear the men say: "We have good jobs here and we'd hate to be laid off," you may be pretty sure that you have walked into a concern where neither the N. A. M. nor the I. W. W. would be able to stir up distrust, discontent or strife.

ON DETERMINING SHAFT DIAMETERS

CHARTS FOR SIMPLIFYING THE CALCULATIONS OF SHAFTING FOR COMBINED TORSION AND BENDING STRESSES

BY W. G. DUNKLEY*

Numerous cases arise in the design of machinery in which shafts are under combined torsion and bending stresses. A specific case is that of a driving wheel which is overhung on the shaft in the manner illustrated in Fig. 1. In such a case it is not sufficient to design the shaft merely to withstand the torsional stress; it must be designed to withstand the combined stresses of torsion and bending. Let T represent the twisting moment on such a shaft and M the bending moment. For these conditions, it is usual to design the shaft as though it were under an equivalent twisting moment T_1, the value of which is given by the following formula:

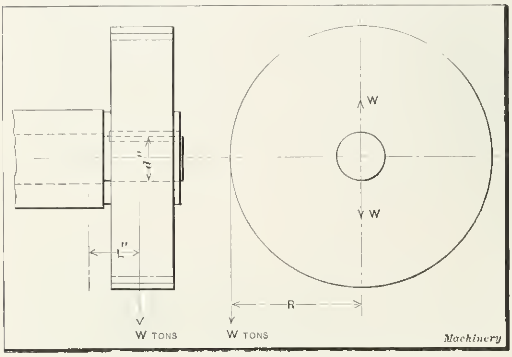

Fig. 1. Diagram showing Condition of Combined Torsion and Bending in Shaft

$$T_1 = M + \sqrt{M^2 + T^2} \qquad (1)$$

This does not mean that the shaft is actually under the twisting moment T_1, but theory shows that the value of the stress obtained by this formula is equivalent to the combined effect of the twisting and bending moments on the shaft. There are other points connected with the theory of combined stresses which will not be taken up here, but the preceding explanation will probably be of interest to those to whom the formula is new.

In order to find the required size of a shaft which is under combined bending and torsional stresses, it is first necessary to obtain the values of the bending moment M and the twisting moment T, which are then substitued in the formula to find the equivalent twisting moment T_1. The required diameter of the shaft can then be calculated in the usual way, from the formula of a shaft under torsion:

$$T_1 = \frac{\pi f D^3}{16} \qquad (2)$$

where f = safe stress in tons per square inch;

D = diameter of shaft in inches;

T_1 = equivalent twisting moment in inch-tons.

From Equation (2) we find:

$$D = \sqrt[3]{\frac{16 T_1}{\pi f}} \text{ inches}$$

The charts illustrated in Figs. 2 and 3 have been developed to do away with the necessity of calculating the value of T_1 from Equation (1) and of D from Equation (2). The use of these charts makes it possible to obtain the required shaft diameter directly from the values of the bending and twisting moments on the shaft. The method of obtaining the values of M and T will vary according to the circumferences of the shafts, but we will take the particular case of the overhung driving wheel shown in Fig. 1 as an example.

Let W = safe load in tons on the teeth of the wheel;

R = radius of the wheel in inches;

T = twisting moment on the shafting = WR inch-tons;

L = distance in inches from middle of wheel to one inch inside of bearing;

M = bending moment on shaft = WL inch-tons.

This value of M is not strictly accurate since W is the tangential load on the tooth and not the actual load. If a is the angle of obliquity of the action of the teeth of the wheel, then the actual load on the teeth is $\frac{W}{\cos a}$, and a more accurate value of M would be $\frac{WL}{\cos a}$. The value of the bending moment obtained from the equation $M = WL$ is quite accurate enough for the present design, however.

If we substitute a value of 4 tons for f in the equation

$$T_1 = \frac{\pi f D^3}{16},$$

we get

$$T_1 = \frac{4\pi D^3}{16} = 0.7854 D^3$$

D Inches	T_1 Ton Inches	D Inches	T_1 Ton Inches	D Inches	T_1 Ton Inches
1	0.701	3.5	30.07	6.0	151.6
1.5	2.367	4.0	44 89	6.5	192.6
2.0	5.611	4.5	63.92	7.0	240.6
2.5	10.95	5.0	87.68	7.5	295.9
3.0	18.94	5.5	117 2	8 0	359.1

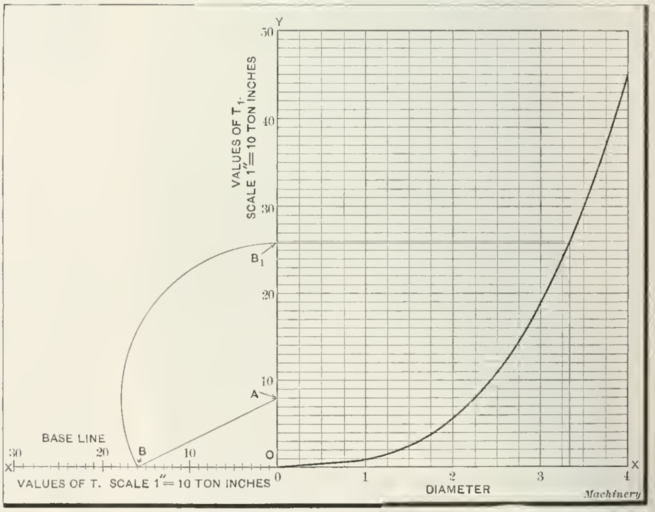

Fig. 2. Chart for obtaining Shaft Diameters from 0 to 4 Inches under Combined Torsion and Bending

From this we obtain values of D and T_1 as presented in the accompanying table. These values are then plotted to a suitable scale that gives a curve from which the value of D for any value of T_1 may be obtained. It is advisable to divide the chart into two portions according to Figs. 2 and 3. Fig. 2 covers conditions for shafts up to 4 inches in diameter, and Fig. 3 for shafts from 4 to 8 inches in diameter. However, the arrangement of the charts can easily be modified to meet the requirements of different cases. The method of constructing the charts is as follows: The values of T_1 are plotted vertically on the line OY, and the base line OX, on which the shaft diameters are laid out to the right of the vertical line, is extended to the left in the manner shown. In order to obtain values of the equivalent twisting moment T_1, the bending moment M in inch-tons and the twisting moment T in inch-tons are obtained in the manner previously described. The point A is then located on the line OY so that OA is equal to the value of M. Point B is located at such a distance from the vertical line OY that OB represents the value of the twisting moment T to the same scale. With A as a center and AB as a radius, an arc of a circle is drawn which locates the distance AB_1 on the vertical line OY. The distance OB_1 then represents the value of the combined bending and twisting moments T_1 on the shaft to the scale which was adopted in drawing the diagram. In order to show that OB_1 equals T_1, we know that $OA^2 + OB^2 = AB^2$ or substituting the equivalents of these sides we have

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$$M^2 + T^2 = AB^2.$$

Therefore,

$$AB_1 = AB = \sqrt{M^2 + T^2}$$
$$OB_1 = OA + AB_1$$
$$OB_1 = M + \sqrt{M^2 + T^2} = T_1.$$

In explaining the application of this method, we will assume an example the conditions of which are illustrated in Fig. 1.

Let $W = 2$ tons;
$R = 8$ inches;
$L = 4$ inches.
Then $T = WR = 16$ inch-tons;
$M = WL = 8$ inch-tons.

In Fig. 2 we will lay off the distance OA to represent 8 inch-tons and OB to represent 16 inch-tons; we then get the value of OB_1 by scaling off the distance on the vertical line OY and the diameter of the corresponding shaft is seen to be approximately 3 5/16 inches. If a case arises in which there is only a twisting moment on the shaft, we have $M = 0$. Consequently $T_1 = T$. Also if there is only a bending moment on the shaft, we have $T = 0$, which gives the value of

$$T_1 = M + \sqrt{M^2 + T^2} = M + \sqrt{M^2} = 2M \ (T = 0).$$

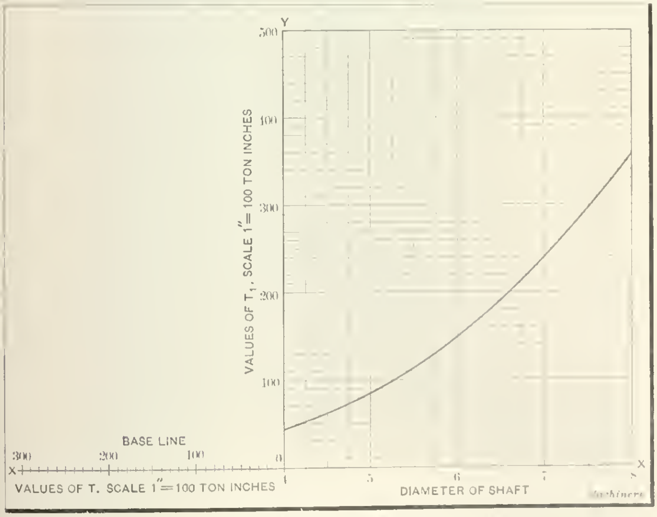

Fig. 3. Chart for obtaining Shaft Diameters of 4 to 8 Inches under Combined Torsion and Bending

This shows that the chart may be applied for the following cases. (1) For shafts under combined twisting and bending moments: $T_1 = M + \sqrt{M^2 + T^2}$. (2) When the shaft is only subjected to a twisting moment: $T_1 = T$. (3) When the shaft is only subjected to bending moment: $T_1 = 2M$. Case (1) is by far the most important, and the one most frequently encountered in machine design, as it seldom happens that a shaft is subjected merely to twisting or merely to bending moments.

Without the use of the chart, the calculation of the diameter of a shaft in which there are combined twisting and bending stresses, would be as follows:

Let $M = 8$ inch-tons;
$T = 16$ inch-tons;

Then $T_1 = M + \sqrt{M^2 + T^2} = 8 + \sqrt{8^2 + 16^2} = 8 + \sqrt{64 + 256}$
$= 8 + 17.88 = 25.88$ inch-tons.

From Equation (2) we have $T_1 = \frac{\pi f D^3}{16}$. From this we get

$$D^3 = \frac{16 T_1}{\pi f}.$$

Substituting 4 tons for f, we get

$$D^3 = \frac{25.88 \times 16}{3.142 \times 4} = 32.90$$

$$D = \sqrt[3]{32.90} = 3.205 \text{ inches.}$$

The value obtained from the chart is slightly less than 3 5/16 inches. This illustration shows the saving of time and effort which is effected by the use of the chart. It will, of course, be understood that the construction lines for combined twisting and bending moments on the shaft need not be drawn; they are merely presented here to indicate the accuracy of the theory upon which this method has been developed.

* * *

SMALL MANUFACTURERS' EXHIBITS AT PANAMA-PACIFIC INTERNATIONAL EXPOSITION

The Panama-Pacific International Exposition which will be held in San Francisco in 1915 announces through Mr. A. M. Hunt, Chief of the Department of Machinery Exhibits, that arrangements will be made by which small exhibitors can cooperate and show their exhibits in one booth at greatly reduced expense. The action was taken as the result of corresponding with manufacturers; many of the smaller ones have expressed a belief that they could not afford to exhibit because of the heavy expense of shipping the goods to San Francisco and maintaining a person in charge of a booth during the long term of the exposition. Such manufacturers will be permitted to club together and make their individual applications for space. They will be assigned space in such a way that their exhibits may be grouped together and handled and cared for by one person. By clubbing together the expense will be greatly reduced and the effectiveness of the exhibit enhanced. If shown in the manner prescribed each exhibit will be considered by the Jury for Awards in the same manner as if exhibited independently.

The management suggests that it will be unwise to include in any group directly competitive articles. On the other hand, groups of exhibitors whose products are of a non-competitive nature and such as can be harmoniously shown in conjunction should combine. For example, a manufacturer whose product is confined almost exclusively to the manufacture of ball and roller bearings could combine with certain other manufacturers in which ball and roller bearings of different forms and styles are a prominent feature, such as ball bearing jacks, and other appliances in which anti-friction bearings greatly improve the efficiency and wearing qualities. Full information will be furnished by the management to all manufacturers interested in the proposed cooperative plan.

* * *

An international exhibition will be held in Manchester, England, from May to October, 1914. This exhibition will be especially representative of the industries in which the North of England is engaged. The total area covered by the exhibition will be 90 acres and a great deal of space will be given to the machinery section, where it is expected that many classes of machinery will be shown in motion and to the best advantage.

SOME SLOTTING MACHINES AND TOOLS USED IN THE POND SHOPS

METHODS OF EQUIPPING AND TOOLING SLOTTERS FOR GREATER EFFICIENCY

BY ALFRED SPANGENBERG*

In considering the problem of increasing production on any machine tool, attention should be directed to features that will insure speed, accuracy and convenience in the machine itself, as well as to the character of the tool equipment, if the highest efficiency is to be attained. Features that will enable the operator to select instantly, or have definite knowledge of any particular speed, feed, or depth of cut are absolutely essential in the modern shop. The principles just laid down are embodied to a large extent in the slotting machine tools and methods illustrated and described in the following article, which shows the general practice on work of this character as followed at the Pond Works of the Niles-Bement-Pond Co., at Plainfield, N. J.

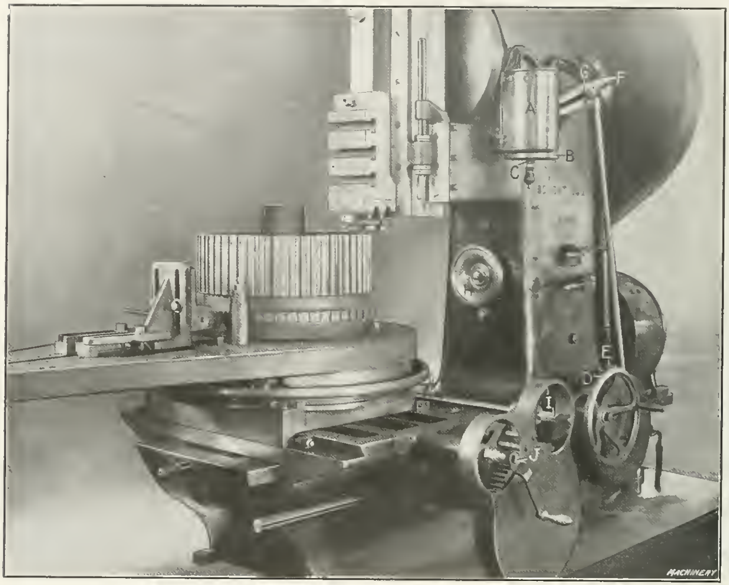

Fig. 1. Bement Slotter with Special Attachments to facilitate Operation

Referring to Fig. 1, it will be observed that the Bement slotter shown is motor driven and provided with a controller *A*, conveniently located, for starting, stopping and regulating the cutting speed of the ram. This controller is provided with a graduated brass plate *B* fastened to the controller frame, and a pointer *C* attached to the handle, by means of which any desired number of strokes per minute, within the range of the motor speeds, is accurately and instantly obtainable, the graduations reading in number of strokes of the ram per minute. A table, not shown, gives the cutting speed of the ram in feet per minute for any given length and number of strokes per minute.

Another special feature of this controller is that it is wired to the motor armature in such a way that whenever the controller handle is moved into the "off" position, the effect is to make the motor act as a powerful brake and stop the ram almost instantly. This is a great advantage, for while the machine is provided with a hand operated friction brake, the dynamic brake is more effective and does not require any extra motion on the part of the operator. Fig. 2 shows a wiring diagram from which it will be seen that the only change in the standard controller is the addition of the two contacts *A'* and *A''* and the bar *B* which is attached to the controller drum. The dynamic resistance is obtained by connections to the regular field resistance box, enough resistance being used to prevent excessive sparking at the motor brushes. This dynamic brake can, of course, be applied to any motor-driven machine tool using direct current and is particularly valuable on such machines as boring mills, drills, and lathes.

Referring again to Fig. 1, it will be observed that the handwheel *D* is machined flat on its periphery in order to provide for graduations (reading in 0.002 inch) the purpose of which is to facilitate accurate longitudinal settings of the table and work without stopping to make other measurements. A pointer *E* attached to a rigid support marks the starting point. This device is particularly valuable on work similar to that illustrated, which is a large steel gear, the teeth of which are being roughed out, after which the gear is to be finished in a gear cutter. It might be stated that the object of roughing out the teeth on the slotter is to effect a saving on the more expensive rotary cutters. The depth of cut being known, the required number and fractional parts of handwheel turns necessary for each cut are easily and quickly determined. A chalk mark made at the line representing the final depth of cut indicates to the operator when to disengage the power feed and finish by hand feed.

To facilitate accurate setting of the feeds, the rocker arm *F* is graduated on its upper face and a line on the stud bushing at *G* acts as a pointer. Each graduation on the rocker arm represents one ratchet tooth of feed. Another convenient feature for obtaining minute hand adjustments of the ram when setting cutters or adjusting strokes, is the handwheel *H* which is keyed to an extension of the intermediate driving gear shaft. As the illustration indicates, the handwheel is of the web form so that there is no danger of the operator being injured when the machine is in motion.

Special Tools and Tool-holders

In the illustration Fig. 3 some special tool-holders for the rapid and convenient machining of certain machine tool parts are shown. The general character of the work machined by the gang tool-holders *A* and *B* is suggested by their design. In the first case two tools, and in the second case four tools are available for simultaneous operation. In the same illustration at *C* is shown a special splining toolholder for cutting keyways of various widths to the bottom of blind holes. It is necessary, of course, in work of this char-

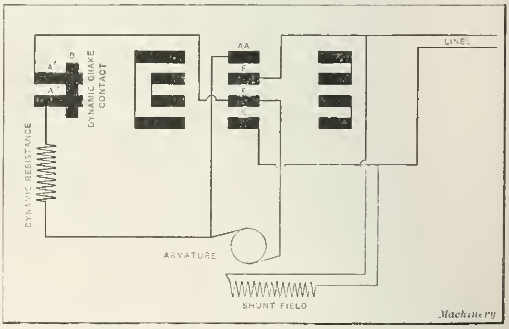

Fig. 2. Diagram illustrating Special Method of wiring the Controller

acter to provide a suitable "run-out" for the cutter in order to prevent choking from the chips and consequent breaking of the tool point. The run-out may be formed either by drilling a suitable hole in the casting to be splined, or by turning a recess at the bottom of the blind hole.

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The details of this tool are more clearly shown at *A* in Fig. 4, an inspection of which will show that the tool proper is hinged at *B* so that a relief for the tool is provided during the return stroke. Spring *C* keeps the cutter in the normal position, and cutters of various widths may be inserted in the slot *D*. The purpose of screw *E* is to keep the cutter in its proper position in the slot. Illustrated at *D* in Fig. 3 and shown in detail at *F* in Fig. 4 is a tool-holder for cutting internal ratchet wheels and small internal gears. The construction is so simple that little explanation is necessary. The cutting tool is shaped to be a driving fit in the dovetail slot in the clapper *G*.

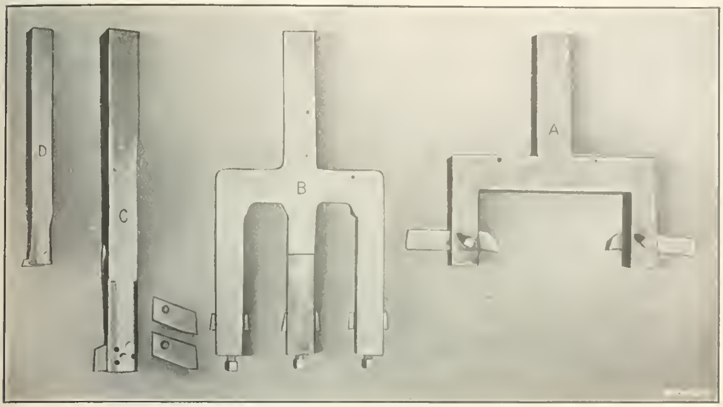

Fig. 3. Examples of Slotter Tools used in the Pond Shops

For small work of a general character the tool-holder shown in Fig. 5 is a most useful adjunct to the slotting machine. As in the case of the two holders just described, the principal feature of this one is to provide a relief for the cutting tool during the return stroke. While there is, of course, provision for tool relief in the regular ram apron, it is well known that for small cutting tools this relief is too stiff to be effective. It will be seen from the illustration that the clapper *A* which carries the cutting tool, is of trunnion form and is forged and machined out of the solid to insure strength. Both ends of the trunnion are tapped so that the set-screw *B* which clamps the cutting tool may be used in either side as the character of the work may demand. Other details of this holder are clearly defined in the illustration.

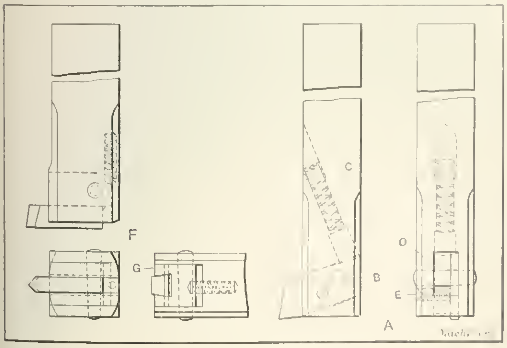

Fig. 4. Design of Tools C and D shown in Fig. 3

Fig. 6 shows a tool and holder for roughing out the teeth of large internal gears. This double cutter, as will be apparent, cuts two teeth at a time, thereby saving about one-third of the time usually required. The advantage of this holder is that the tool can cut close to a horizontal surface.

A special graduating tool for marking the graduations on lathe tailstocks is shown in Fig. 7. Before this tool was made it took about ten minutes, actual machining time, to graduate a tailstock. A single pointed tool was used, and the table had to be indexed for each line and the stroke adjusted for different lengths of lines. The work is now accomplished in one stroke of the ram and in a fraction of the former time.

Special Appliances

One of the most particular jobs the slotting machine has to handle in a machine tool shop is the cutting of large internal and external gears. It is the general practice for work of this character, to provide a special indexing fixture similar to the one illustrated in Fig. 1 for spacing the cuts. Again, a special gear may have to be cut for which there is no index plate available, in which case it is customary to place compound gears on shafts *I* and *J* and index by means of a graduated dial and pointer, the principle being similar to that used on a milling machine dividing head. Shaft *J* is merely used as a stud for the back gear. In either case inaccuracies in spacing are liable to occur and these may readily be detected by the use of a fixture as illustrated in Fig. 8. From an inspection of Fig. 8, it will be seen that the scheme is to support the meshing pinion on a stud *A*, the center distance between the pinion and gear being accurately fixed and maintained in the swiveling arm *B*. By rolling the pinion around the cut gear any inaccuracies in spacing or depth of cut are easily and quickly determined and remedied by recutting. Hole *C* is for inspecting. Of course, where accurate indexing fixtures are used and the depth of cut carefully made, this "doctoring" is seldom necessary.

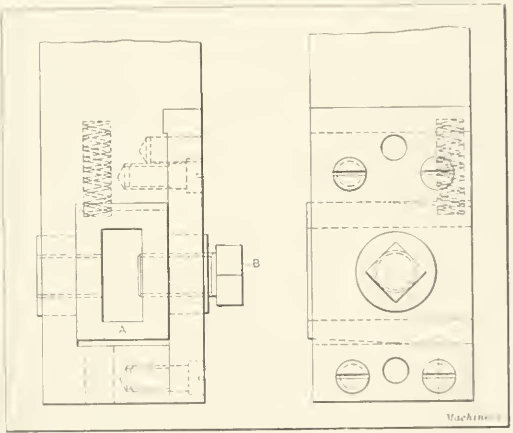

Fig. 5. Slotting Machine Tool-holder adapted for Small Work

In slotting machine practice it is necessary, in many instances, to use an auxiliary table for supporting work that is too large to be handled by the regular slotter table, such a case being illustrated in Fig 1. These auxiliary tables are usually provided with a centering pin for locating the work. A very convenient form of centering pin, which can easily and quickly be inserted or removed and which has no nut for withdrawing the pin, is shown in Fig. 9. The usual type has a nut which often interferes with the work.

In conclusion, it may not be amiss to suggest a change in the standard design of slotting machine tables from the circular form to the square or rectangular type. The writer has discussed this feature with a number of expert slotting machine operators and it seems to be the consensus of opinion that the square table would be a decided advantage in that it would, in many instances, permit the more convenient clamping of the work, and this form would frequently eliminate the necessity for an auxiliary table. The objection that the corners of a square table might interfere with its rotation by striking the frame of the machine would hold good only in very rare instances where the table has to be rotated close to the frame.

* * *

THE HABIT OF OBSERVATION

The ability to observe accurately and quickly is most valuable to men in the mechanical field, yet few men possess this faculty to any high degree. Perhaps that is the reason why those who do usually—to use a common expression—get ahead. The habit of accurate observation can be developed by simple methods. One man used to pass a store window, glance into it for a few seconds, pass by, take up his note book and jot down a brief account of what he had seen; then he would go back and compare his notes with what was actually exhibited in the window. By this simple means he developed ultimately so great an ability of rapid and accurate observation that small details would become fixed in his memory, whenever he observed anything with the intention of retaining the impression in his mind. Probably better methods for training the faculty of observation may be devised, but the example mentioned simply shows the opportunity open to anyone who recognizes the value of this training of the mind and has perseverance enough to acquire the habit of observing.

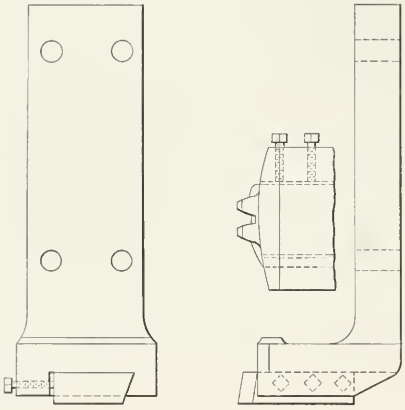

Fig. 6

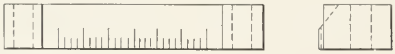

Fig. 7

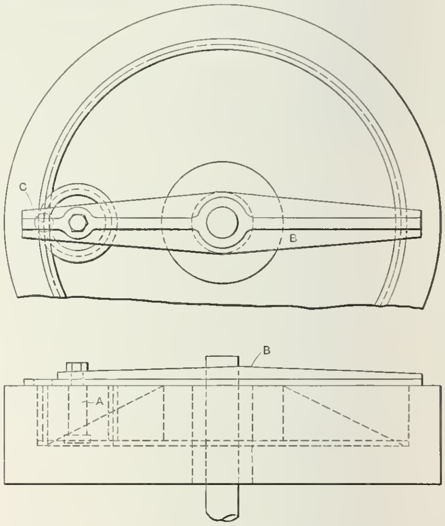

Fig. 8

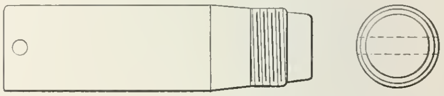

Fig. 9

Fig. 6. Tool and Holder for roughing out Teeth of Large Internal Gears
Fig. 7. Special Tool for graduating Lathe Tailstocks

Fig. 8. Tool for testing the Accuracy of Gear Teeth cut on a Slotter
Fig. 9. Convenient Form of Centering Pin for Auxiliary Slotter Table

* * *

Secretary Redfield, of the U. S. Department of Commerce, has instructed the Bureau of Standards to make a study of the causes of railroad accidents resulting from broken car-wheels and axles. The reason for this investigation is that it has been found that about four times as many wrecks are caused by broken car-wheels as by broken rails, and that twice as many wrecks are caused by broken axles as by broken rails.

A TEN-CENT PROTECTIVE SYSTEM

BY DUGALD MCKILLOP*

One of the most useful forms of welfare work which can be conducted in any factory is that of providing some voluntary or involuntary form of insurance whereby employes will be encouraged to make provision for periods of adversity at a time when their earnings are more than adequate to provide for their actual needs. The following description outlines the work of the Thomson-Houston Mutual Benefit Association of the General Electric Co., Lynn, Mass. This organization is conducted on a basis that insures protection for its members at a rate which never exceeds ten cents a week, and is usually considerably less than this.

The general plan of organization is as follows: The company appoints one officer to represent it, who is known as the general chairman, and whose duties are to act, if necessary, as a judicial intermediary between employer and employe, and to keep things running in accordance with the provisions of the constitution and by-laws. Under ideal conditions, however, the general chairman acts largely in an advisory capacity. The association is made up of sections or units of 150 members, each section having as officers a chairman, a vice-chairman and a secretary-treasurer; these three officers—with six other elected members—constitute a board of directors. The officers are elected annually by the members of each section. At the first meeting, three directors are elected for a period of one year and three for two years; and thereafter, three directors are elected annually to serve two years. The chairman and secretary are chosen annually.

In the important matter of finance, the sections are conducted independently of each other, insofar as sick benefits are concerned. When formed, the first effort of a section is to accumulate the sum of $200 which is banked as a reserve fund. Assessments are then continued until the fund reaches $300, when dues are discontinued until the calls upon the treasury reduce the sum in hand to $200, at which time dues are again levied. By having this reserve in hand, provision is made for a possible epidemic of sickness or a rush of accidents.

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* Address: 109 Pine Grove Ave., Lynn, Mass.

An applicant for membership in a section voluntarily signs an application blank which involves a pledge to abide by the constitution, and upon vote of the directors he may be elected without further formality. If admitted, he is so notified, and thenceforth the secretary-treasurer practically takes charge of the new member, collecting his dues and looking after his claims for disability. Any person over fourteen years of age who has been employed by the company for one month is eligible for membership in the junior grade, and any person over eighteen years may become a member of the senior division. The dues and benefits of the junior division are one-half those of the senior division. The initiation fee for senior membership is fifty cents and the dues are ten cents per week. A newly elected member must pay dues one month before he becomes a full member entitled to benefits in case of illness. No medical examination for entrance is required.

The sick benefits paid are at the rate of $6 per week for men and $5 per week for women, for fourteen weeks per year, no payment being made for the first week's illness. If, on account of a lingering disability, a member is unable to work, he is entitled to equal benefits for a second year, but if he does not return to work after this period his connection ceases.

Through the office of the general chairman, a levy at the rate of ten cents per member per month is made on all sections until a standing fund of $1000 is secured. Assessments are continued until the fund reaches $2000, when they are discontinued and only resumed when the drafts on the treasury bring the fund down to $1000. Additional emergency benefits are allowable in cases of proven need. The death benefit or life insurance is $100, payable to whoever is designated by the applicant, or to the legal heirs. It is important to note that the life insurance is provided by what may be called an indirect tax, the money being paid by the section treasurers from the funds in hand. The regular ten-cent weekly levy on the man in the shop or office really pays all the bills; and though this may be continuous every week of every year, a member seldom grumbles, for he knows that ten cents is the maximum. If weekly collections were not continuous and special assessments were made in cases of death, there would be dissatisfaction, as was found in the early experience of the organization. The constitution as it exists today is the result of many amendments. Each section compensates its own members in case of disability, but the death risks are pooled in order to distribute that heavy line of liability evenly.

Even a partial record of the things accomplished by this mutual benefit association shows the remarkable possibilities for good of such an organization. Started in August, 1902, by the end of 1904 there were fifteen sections in operation. While 150 is the maximum membership for a section, several sections were started with a small membership and then gradually built up by solicitation. Some sections have paid dues at the rate of ten cents per week steadily. The best record of any section for a period of years showed an average cost per member of only $2.25 per year, and in this section there was one period of fourteen months when it was not necessary to collect dues. In the meantime, adequate protection was afforded the members. The great success attained would not have been possible except for the friendly attitude of the factory management, and its unobtrusive but real patronage.

The total number of deaths from 1902 to the close of the last association year was 212; the total receipts from dues, $130,064.64; and the disability benefits paid, $102,269.79, the death benefits paid being over $20,000. The success of the association has been cumulative, the good done in individual cases being attested to by the beneficiaries. This has advertised the association and today it is the popular thing to join the "Mutual Benefit." The organization is growing so fast that new records are being made each year. At the close of the last annual tabulation the membership in forty-five sections was 5911, but in April, 1913, it had risen to 6118, or about one-half of the total number of employes. There are six female sections.

The steady growth of the association is assured, as the organization is far beyond the experimental stage. Numerous specific instances of the good cheer and indispensable aid given to those prostrated by grief or afflicted by sickness attest to the value of its work. Some join because they wish to endorse the system rather than for personal protection, but there is no class distinction laborer and foreman belong to the same section. An effort is made to have the members of any one section drawn from the same building or department, but this has been found extremely difficult to enforce, as new buildings cause a readjustment of shop departments, and it frequently happens that members of a section are suddenly moved a mile or more from their original location. To remedy this difficulty, a system of easy transfer is operated, by means of which the original rights of a member are conserved without making it necessary for the secretaries to go into many different buildings in carrying on their work.

Four features of the work of this association that could be duplicated in almost any factory seem to have been responsible for its signal success:

1. An equitable plan of collecting dues and making disbursements. Formerly, if workman A was in trouble a subscription list was passed around among his mates and a snug sum of money collected for him. Perhaps within a few days, workman B met with a bad accident, but when the subscription list was passed around for him, the men naturally felt that however worthy the case might be they simply could not contribute, and so the second man got almost nothing, even though his condition might have been more pitiful than that of the first. All members of the Thomson-Houston Mutual Benefit Association who have shown a ten-cent per week interest in its maintenance are equally provided for, and only the man who has passed through a crisis knows how much better $6 a week is than nothing.

2. The method represents insurance at cost. The running expenses of the association are almost nothing, and all contributors may feel assured that each dime they pay will be given out to some one in need.

3. The growth of true democracy is fostered. In the matter of membership it is something to know that all are on a level. Among people of many nationalities, engaged in varying daily duties, the sense of affiliation has a moral value and may serve to relieve misunderstandings. An association of over forty sections, with a membership of thousands, gives a feeling of "getting together" to some purpose.

4. As an experiment in government, the organization has been of especial value. By giving him some office, a man may be led to look at life from a new angle, and by being identified with a large institution, of which he is an acting unit, the idea of real democracy and the power of union in service are exemplified. Not only in direct results is there mutual benefit, but also in making acquaintances and as a lesson in self-help, the idea will have a useful and widening application.

To provide a method of extending financial assistance to members who are temporarily in need of money, the mutual benefit association founded a loan fund. The working method is simplicity itself. A sufficient sum was secured by means of entertainments or otherwise, the money being placed in the hands of a loan committee which receives applications for assistance and investigates each case. The present plan is to loan not more than $25 at one time, repayment being made weekly at the rate of 10 per cent of the amount secured, this sum to be deducted from the wages or salary of the borrower each week until the principal is paid. There is no publicity in case of a refusal to lend, nor any dunning of a party who has been accommodated. He simply glances at his pay-check to see that the proper deduction has been made, and his fellow workmen need not even know that such a transaction is under way. No interest is charged for the accommodation. A second or third loan may be secured by the same person in case of real need, but only after prior loans have been paid. It is probable that this method of helping the unfortunate will find wider application in the factory, with larger funds available for this purpose. It will be seen that a few hundred dollars placed at the disposal of a representative committee may be manipulated in a way to enable it to pay an endless chain of debts.

FILING ARTICLES AND DATA[*]

A SCRAP-BOOK FILE PERMITTING BOTH SIDES OF CLIPPINGS TO BE READ

BY F. C. EVERITT[†]

Every engineer, shop superintendent and foreman recognizes the value of collecting magazine articles and data pertaining to the various branches of his particular line of work. After spending years in gathering information of this sort, the collector is usually confronted with the somewhat tedious task of eliminating the useless parts of the collection and filing the remainder or binding it in book form. Flexible leather covers are available for this purpose, but the home-made scrap-book described in the present article has been found to be particularly satisfactory. The preservation of articles and data in this way is a matter that no technical man—be he engineer, superintendent, mechanic, or apprentice—can afford to neglect, and the earlier in his career that he starts his collection, the more valuable it will be in years to come.

While the idea may seem simple enough at the start, the engineer or apprentice will find that as he becomes more experienced in his work he will need to give more attention to the subject of clipping and filing information that appears in the technical journals to which he subscribes. This will include a careful study of all articles, the selection of those which are most likely to be of value in years to come, and finally the classification and indexing of these articles in such a way that the information can be readily located. Experience in this work will make it continually easier to handle, so that a great deal of time will not be required for this purpose. Different methods of filing and binding such collections have been referred to in previous articles in MACHINERY. The subject is one that has been given considerable thought and various methods have been developed, all of which have their good points.

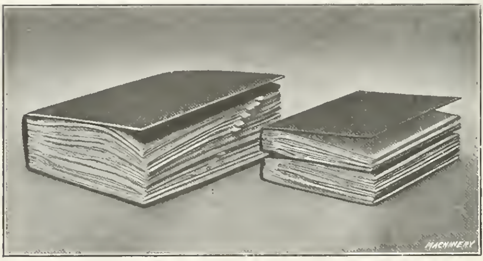

Fig. 1. Scrap-books for filing Articles and Data

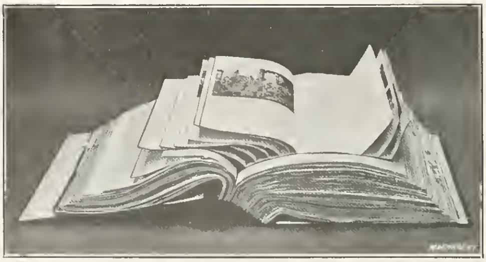

Fig. 2. Eighteen Page Article mounted on Filler Sheet of Scrap-book

The writer has been collecting data along these lines for a period of ten years and his method of preserving the material consists of pasting it in a loose-leaf scrap-book. The idea is quite general that scrap-books are unsatisfactory because it is necessary to have two copies of each article in order to paste them into the book without spoiling one side of each sheet. The method which is to be described in this article entirely avoids this difficulty and will probably be of interest to many readers.

Fig. 1 shows three bound volumes of articles and data. The large binder is 9 by 11 inches in size and is 3 inches thick when filled. "Filler sheets" made of paper of about the same thickness as ordinary letter paper are used to mount the articles on. These filler sheets are held together in the binder with an ordinary shoestring, and cardboard separators about 1/32 inch thick are used to prevent any tendency to bulge. These separators are used at intervals of five sheets. The articles are pasted on the filler sheets along the margin so that any sheet may be folded back to make both sides visible. This arrangement makes a neat and handy book; it opens readily and is practically as satisfactory as a flexible leather bound handbook. The small volumes shown in Fig. 1 contain data and articles that are referred to quite frequently. These books are 6 by 9 inches and serve practically the same purpose as a handbook. They are made up according to the method previously described.

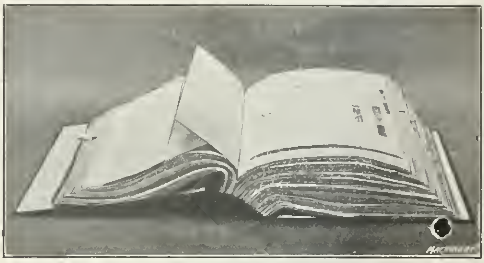

Fig. 3. Filler Sheet shown in Fig. 2 with Leaves folded back to close Scrap-book

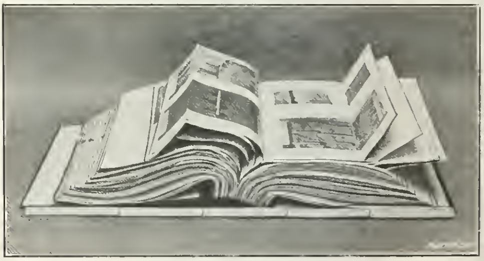

Fig. 4. Sixteen Page Article with Those Leaves that project beyond Filler Sheet turned back

It has been previously stated that the objection to scrap-books is largely due to the fact that two copies of each article are required if they are mounted in the usual manner. Reference to Fig. 2 will show that this objection is entirely overcome by the present method. This illustration shows a filler sheet on which an eighteen-page article—clipped from the *Engineering Magazine*—has been mounted. This article, folded ready for the book to be closed, is shown in Fig. 3; only one copy of the magazine was used. Fig. 4 shows a sixteen-page article cut from the *Foundry*. It will be seen that it is necessary to fold back some of the leaves before closing the book in order to prevent them from extending beyond the edge

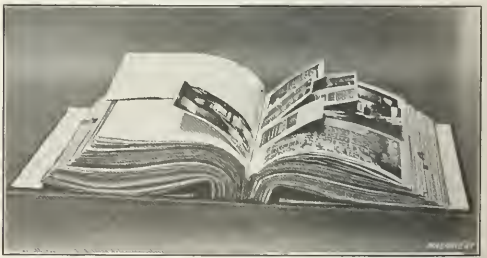

Fig. 5. Small Illustrations and "Shop Kinks" mounted in Scrap-book

of the filler sheet. Fig. 5 shows a filler sheet with several small illustrations, shop kinks and other clippings mounted on it.

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[*] For further information on this subject see "Bollinckx's Scrap Book," August, 1910; "A Systematic Scrap Book," November, 1910, and January, 1911; "The Filing and Indexing of Engineering Data," March, 1911.

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The method of pasting the sheets in the book is important. When done in this way, there will be no stiffness, the page being practically as flexible as one without anything pasted on it. Both sides of the filler sheet can be used, it being possible to paste a second article of equal size on the opposite side of the sheet without materially affecting its flexibility. Successive pages of the article are pasted on the filler sheet beginning at the binding edge in all cases. Paste is applied to about ⅜ inch along the left-hand margin of the sheet, if it is to be pasted on the right-hand page of the scrap-book, or along the right-hand margin of the sheet if it is to be pasted on the left-hand page of the scrap-book. The general construction of the book is shown in Fig. 6, where *F* represents the filler sheets, *S* the separators, and *R* and *L* the covers. The notations in this illustration will make the construction readily understood.

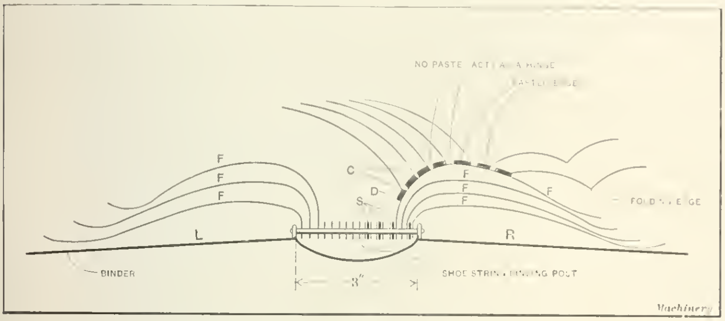

Fig. 6. Detail View of Construction of Scrap-book

The question of indexing is one that is likely to give considerable trouble until a satisfactory method has been worked out. The "subject method" will be found most satisfactory for this purpose. The following gives a brief description of the plan adopted. The original idea of starting this scrap-book was to make a factory reference book, but the idea was later extended to make its scope more general. Under the original plan, a departmental division was made and these divisions were given numbers as shown below.

General Office	No. 1
Purchasing Office	No. 2
Drafting Department	No. 3
The Plant	No. 4
General Cost Methods and Forms	No. 5
Foundry and Pattern Shop	No. 6
Machine Tools and Toolroom	No. 7
Stock Room Methods	No. 8
Non-Ferrous Metals and Methods	No. 9

(The first sheet in the book bears just such a list; but no further indexing is used.)

Each division was sub-divided into as many sections as required. For instance, the foundry and pattern shop are two departments which are combined under one heading because of their close connection, but this name in itself suggests the first sub-division. Hence, under the sub-division "foundry" we have the following subjects to consider: Cupola practice; molding methods and machinery; flasks; sands; facings; core room methods and equipment; core sands, oils, etc.; cleaning shop methods and equipment, etc. Such a subject list can be gradually increased with the growth of the collection and further indexing for the benefit of the user will be unnecessary on account of his familiarity with the method of arrangement.

As the collection grows, the first book will probably become too small, in which case a second volume may be started by transferring half of the contents of the first volume to a second binder. Additional filler sheets are then provided to fill each of the binders to its full capacity. Where the collection has grown to a considerable size, each division may be kept in a separate binder, if such a method appears to be desirable. Such a plan can be adopted at any time where this method of binding is used. Reference to Fig. 2 will show that index tabs are provided on the margins of the sheets. These tabs are made of linen and are pasted to the filler sheets; they bear the title of the division which they mark in order to facilitate finding the desired place in the book.

Figs. 2, 3 and 4 show one article mounted on a filler sheet. In such cases, a symbol is used which indicates the number of leaves in the article. For instance, the article in Fig. 2 covers nine leaves (eighteen pages). The first leaf bears the title of the article and the symbol 1-9, the remaining sheets being 2-9, 3-9, 4-9, 5-9, etc. In the case of short articles it is frequently desirable to mount three or four such articles on a single filler sheet of the scrap-book. The different articles on a sheet are indexed by letters—as *a*, *b*, *c*—and the sheets of the different articles are indicated as follows:

$$\frac{a}{3}, \frac{2a}{3}, \frac{3a}{3}; \frac{b}{2}, \frac{2b}{2}, \frac{c}{4}, \frac{2c}{4}, \frac{3c}{4}, \frac{4c}{4}.$$

Little time is required to make these notations and in cases where the first article covers succeeding articles on the same filler sheet, the symbols will indicate this fact.

It will be well to mention that whenever an article is clipped from any publication, the writer always indicates the name of that publication on the sheets and the date of the issue in which the article was published. This, of course, is only necessary where the title printed on the sheets is trimmed off to make their size conform to the requirements of the scrap-book. As time goes on, certain articles which have been preserved in the collection will become obsolete and with the present method of preservation, such articles can be removed without damaging them or destroying the filler sheet. A fresh article can then be substituted in place of the one which was removed. The easiest way to do this is to cut the article out along the edge *C* of the sheet, as indicated in Fig. 6. The new article is then substituted by pasting it along the surface *DC*. This method of preserving data has been the means of supplying the writer with information of considerable value to him in his work. The method of binding is compact and as a result a volume can be taken to any part of the factory where it is required. The expense of providing filing cabinets or other equipment of a similar nature for preserving the data is entirely eliminated.

* * *

BLUE-BLACK FINISH ON SMALL STEEL PARTS

To obtain a blue-black finish on small steel parts, use a mixture of 16 parts, by weight, saltpeter, and 2 parts black oxide of manganese. This is heated to a temperature of 750 degrees F. and the objects are immersed in it. The finish is "built on" to the metal so that if the work is round, for example, the diameter is slightly increased. The oxide of manganese is deposited on the work and must, therefore, be frequently replenished in the mixture.

* * *

The northwestern part of Germany has a very large area covered with peat bogs, and efforts have been made both by the Government and private interests to make possible the utilization of the peat. Experimental power stations that have been built indicate that it is possible that these desolate regions will prove to contain some of the most valuable natural resources of the country. There is, in that part of the country, but little hydraulic power available, and steam power must, therefore, be resorted to for all industrial undertakings. Should it prove economical to burn peat in power stations located at convenient places in the peat bog district, it has been estimated that these peat bogs would be able to supply all the power needed in the northwestern section of Germany for two centuries.

STEAM POWER PLANT PIPING DETAILS—5*

PROVIDING FOR EXPANSION AND CONTRACTION STRAINS IN PIPING SYSTEMS

BY WILLIAM F. FISCHER†

Among the numerous problems that confront the designer of a system of steam piping for a modern power plant is that of satisfactorily taking care of the expansion and contraction of the pipes which occurs after the piping system is put into operation. When designing the piping system the designer should always keep in mind the necessity of providing for expansion and contraction strains, otherwise trouble is sure to result when the station is turned over to the operating force. In power plants using superheated steam at high pressure, the problem of properly providing for expansion and contraction strains throughout the system is one of the most important of all problems encountered in the design. Take, for example, a steam main 200 feet long, which is installed during the winter months when the temperature of the surrounding atmosphere is, say, 50 degrees Fahrenheit. After steam at 175 pounds gage pressure and 150 degrees superheat is turned into the piping system, the steam main will expand or increase in length approximately eight inches, an increase in length of approximately four inches in every hundred feet of pipe. This will serve to give the reader some idea of the necessity of providing flexible pipe connections between all boilers and prime movers in a modern steam power station. Expansion and contraction strains, unless properly cared for, will invariably cause leakage at the pipe joints, and around the valve seats by straining and distorting the valve body, and in many cases they have been known to cause rupture of the valves or fittings in the line, resulting in serious damage and loss of life. Most large manufacturers of valves and fittings have an inspection and testing department where all valves made by them are tested under hydraulic pressure for leakage through the seat rings and around the disks before the valves leave the factory. If a leaky valve is found it is sent back to the machine shop to be made tight before shipment. No amount of testing and inspection, however, will prevent a gate valve from leaking after it is coupled up in the pipe lines and subjected to the severe expansion and contraction strains encountered in poorly designed piping systems. A slight distortion of the valve body is sufficient to throw the valve seats out of alignment, and in this case, especially with the solid wedge type valves, the disks will not seat properly, and leakage is sure to result. In many cases the valve manufacturer is accused of turning out poor work in this respect, when the fault lies with the designer or erector of the piping system. A valve that cannot be closed steam tight is more or less of a nuisance around a power plant, and realizing this to be true the valve manufacturers have, during the past few years, added considerably more metal to their valve bodies, not for the purpose of holding the higher pressure but simply to guard against distortion of the valve bodies when subjected to expansion strains in the pipe line.

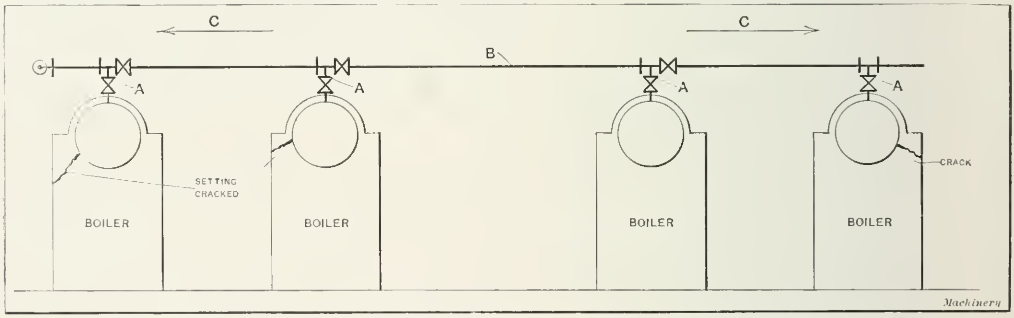

Fig. 38. Example of Cracked Boiler Setting caused by Failure to provide for Expansion and Contraction Strains in Piping

Leaky pipe joints are also a considerable source of annoyance and worry around a power station, not to mention the loss of time and the expense of repacking or repairing them. When making repairs or renewing gaskets in a steam main, it is frequently necessary to shut down part of the main and throw one or more steam driven units out of service. In some cases the engineer may repack a leaky joint, making it absolutely steam tight, only to find in a few days that it leaks as badly, if not worse, than it did before it was packed. In a case of this kind the trouble is undoubtedly caused by expansion or contraction strains in the piping system, and this condition should be relieved before spending both time and money in a useless effort to keep the joints tight. Vibration of a steam main may also cause the joints to leak by working the pipe threads loose, or by wearing the gaskets or loosening the bolts on a flanged joint. Spacing hangers too far apart is another cause of leaky joints. The weight of the pipe, fittings and valves imposes a strain on the joints sufficient to spring them slightly and cause leakage. Where a steam plant is operated during the day and shut down at night, or *vice versa*, the piping system is alternately heated and cooled each day, thus setting up expansion and contraction strains that are very apt to cause the pipe joints to leak. When a steam plant is operated continuously, as in some of the larger stations, there is less danger of leakage from this source.

In visiting small power stations in which the piping systems are improperly designed and no provision is made for expansion and contraction strains, one frequently sees boiler setting that is badly cracked. This may be caused by providing rigid piping connections between the boilers and the main steam header; Fig. 38 illustrates an example of this kind. In this case, the main steam header was placed directly above the boiler nozzles, as shown, with a gate valve between each boiler and the header. As a result of this rigid piping connection the expansion of the main header *B*, tending to lengthen it in the direction of the arrows *C*, shifted the end boiler drums sufficiently to cause the brick setting to crack as indicated.

Estimating Expansion and Contraction of Steam Mains

All metals expand when heated and contract when cooled, the actual amount of expansion or contraction depending upon the metal and the number of degrees that its temperature is raised or lowered. The amount that a piece of metal expands in proportion to its length per degree rise in temperature is known as the coefficient of expansion. The coefficients of expansion for different metals have been quite accurately determined by different experimenters and the results may be found in almost any engineer's hand-book. The coefficients as given in Table I are used by the writer when calculating expansion or contraction in steam mains and will be found sufficiently accurate for all practical purposes of design.

When a steam pipe is heated it expands or increases in length, and when it is cooled it contracts or decreases in length. The coefficient C given in the second column of the table is the expansion or contraction per unit of length per degree Fahrenheit rise or fall in temperature of the piping material. To find the amount of expansion or contraction in a steam main per unit of length, multiply the coefficient, as given in the table, by the number of degrees Fahrenheit that the pipe is heated or cooled. To find the amount of expansion or contraction in a steam pipe of a given length in feet, multiply the length in feet by 12 to reduce to inches; then multiply the length in inches by the number of degrees Fahrenheit that the pipe is heated or cooled, and multiply the result by the coefficient in the table. The final result will be the total amount of expansion or contraction of the pipe in inches.

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* Continued from May number of MACHINERY.

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TABLE I. COEFFICIENTS OF LINEAR EXPANSION FOR VARIOUS METALS TEMPERATURE RANGE 32 TO 600 DEGREES F. —AVERAGE VALUES

Piping Material	Coefficient of Expansion C	Piping Material	Coefficient of Expansion C
Cast iron.........	0.000006	Wrought iron	0.000007
Untempered steel.	0.000006	Copper..........	0.000009
Tempered steel...	0.000007	Brass............	0.0000095
Steel castings.....	0.000007	....	....

Machinery

Example:—A steam pipe of wrought iron is installed in a room in which the temperature of the air is 60 degrees Fahrenheit. After the pipe is erected it is found to be 100 feet long. How much will the pipe increase in length when steam is turned on, heating the piping material to 360 degrees Fahrenheit?

$100 \times 12 = 1200$ inches, length of the pipe as installed at 60 degrees Fahrenheit.

Rise in temperature of pipe when heated $= 360 - 60 =$ 300 degrees Fahrenheit.

Coefficient of expansion for wrought iron $= 0.000007$.

Then multiplying, we get $1200 \times 300 \times 0.000007 = 2.52$ or $2\frac{1}{2}$ inches, increase in length due to expansion when heated. If the steam is shut off and the pipe allowed to cool again to 60 degrees Fahrenheit, it will assume its original length, *i. e.*, 100 feet, due to contraction of the piping material.

The expansion or contraction of a steam main may be calculated by the aid of the following formula:

$$e = LCT \qquad (1)$$

where e = Amount of expansion or contraction in inches due to heating or cooling of piping material.

L = Original length of pipe, in inches, before being heated or cooled.

T = Number of degrees Fahrenheit pipe is heated or cooled.

C = Coefficient of linear expansion. (Table I.)

As a practical example showing the use of the formula, assume the following: Fig. 39 illustrates a 6-inch wrought iron steam main which was erected while the temperature of the room was, say, 60 degrees Fahrenheit. Assume the pipe to be anchored only at point A, and no expansion bend provided to take up or relieve the expansion. After erection, saturated steam at 200 pounds per square inch is turned into the piping system and it is desired to compute the expansion of the 6-inch main at the points B, C and D.

From Formula (1) we have $e = LCT$:

Between points A and B, $L = 200 \times 12 = 2400$ inches.

Between points B and C, $L = 60 \times 12 = 720$ inches.

Between points C and D, $L = 45 \times 12 = 540$ inches.

In order to compute the difference in temperature, T, of the pipe when cold and when heated we must assume the pipe to be heated to the same temperature as the steam which it conveys. Then from our steam tables we find the temperature of saturated steam at 200 pounds gage pressure ($200 + 15 = 215$ pounds absolute) to be 388 degrees Fahrenheit. Subtracting from this the original temperature of the pipe (the temperature when cold) we have $388 - 60 = 328$ degrees rise in temperature $= T$. Substituting the above values in Formula (1) we find the expansion between points A and B to be $e = 2400 \times 0.000007 \times 328 = 5\frac{1}{2}$ inches, making $L_1 = 200$ feet $5\frac{1}{2}$ inches. Between points B and C, $e = 720 \times 0.000007 \times 328 = 1.65 = 1\frac{5}{8}$ inch, making $L_2 = 60$ feet $1\frac{5}{8}$ inch. Between points C and D, $e = 540 \times 0.000007 \times 328 = 1.24$ inch or $1\frac{1}{4}$ inch, making $L_3 = 45$ feet $1\frac{1}{4}$ inch. (See Fig. 39.)

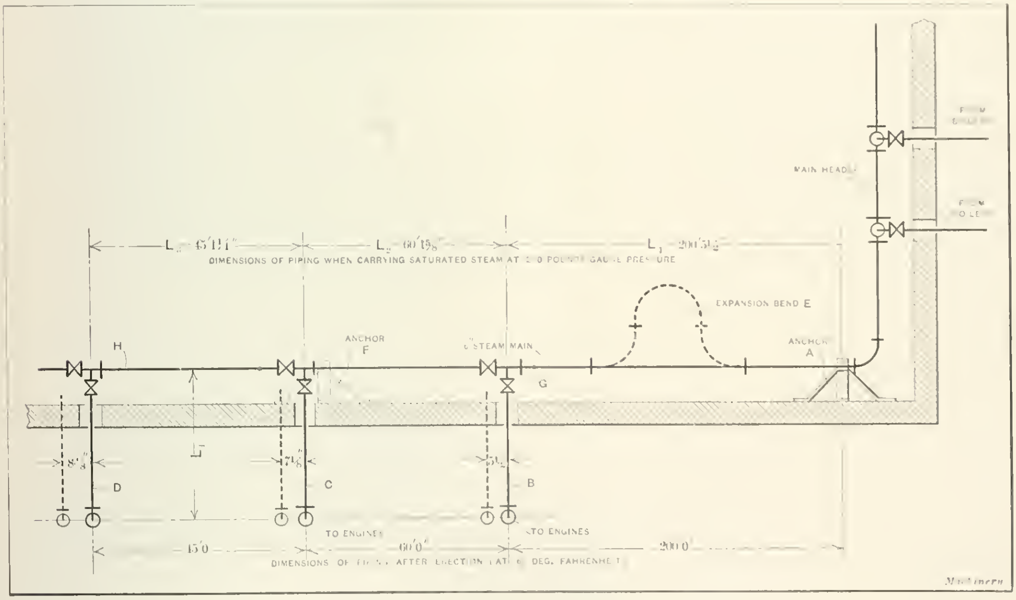
MAIN HEAD
$L_3 = 45'1\frac{1}{4}''$
$L_2 = 60'1\frac{5}{8}''$
$L_1 = 200'5\frac{1}{2}''$
DIMENSIONS OF PIPING WHEN CARRYING SATURATED STEAM AT 200 POUNDS GAUGE PRESSURE
EXPANSION BEND E
H
ANCHOR F
6" STEAM MAIN
ANCHOR A
G
$8\frac{3}{8}''$
$7\frac{1}{8}''$
$5\frac{1}{2}''$
L_4
D
C
B
TO ENGINES
TO ENGINES
15'0"
60'0"
200'0"
DIMENSIONS OF PIPING AFTER ERECTION AT 60 DEG. FAHRENHEIT
Machinery

Fig. 39. Illustration showing Difference in Length of Pipe before and after turning in Steam

In looking over Fig. 39 we find that the expansion in the 6-inch main has the following effect on branch pipes B, C and D: Branch pipe B is moved $5\frac{1}{2}$ inches out of line; branch pipe C is moved $5\frac{1}{2} + 1\frac{5}{8} = 7\frac{1}{8}$ inches out of line; and branch pipe D is moved $5\frac{1}{2} + 1\frac{5}{8} + 1\frac{1}{4} = 8\frac{3}{8}$ inches out of line as shown. If distance L_4 is short, thus making a fairly rigid piping connection between the 6-inch main header and the engines, the reader can readily realize the enormous strain that is thrown on the pipe joints in branches B, C and

D, as no provision is made to take up the irresistable expansion strains in the 6-inch header. Either one of three things must happen. The branch pipes *B*, *C* and *D* will move out of line, or "spring," as shown; the 6-inch main header will spring or bow out of shape; or the pipe joints will fail. The force of expansion and contraction, and the strains set up in the piping system will be discussed later.

In a case of this kind it would be good practice to install anchors at two points *A* and *F* and provide an expansion bend *E* (shown dotted) placed somewhere in the line between the anchors to take up or relieve the expansion. As the expansion between points *A* and *C*, as figured above, is approximately 7 inches, the expansion bend *E* will close up or be drawn together at the ends approximately 7 inches, due to the expansion in the line between the two anchors. With this arrangement, branch pipe *C* remains practically stationary, and branches *B* and *D* are each moved out of line not over 1½ inch, due to the expansion in the 6-inch main, as against 5½ and 8⅜ inches, respectively, in the previous case without the expansion bend. This example may be applied to almost any condition and arrangement of piping, and by studying the conditions as described above, the reader will be able to place his expansion bends and anchors where they will do the most good. The expansion strains in the 6-inch main could be entirely relieved by placing additional anchors at points *G* and *H* and installing expansion bends in the main header between branches *B* and *C*, and *C* and *D*. This is not necessary, however, unless distance L_4 is very short, in which case it might be necessary to do so in order to prevent strains on the pipe joints.

TABLE II. EXPANSION OF WROUGHT IRON STEAM PIPES CARRYING SATURATED STEAM AT VARIOUS PRESSURES

Initial Temperature of Pipe in Degrees Fahrenheit	Gage Pressure, Pounds per Square Inch									
	Atmospheric Pressure 0 Gage	5	50	75	100	125	150	175	200	250
	Temperature of Steam in Degrees Fahrenheit									
	212	228	298	320	338	353	366	377	388	406
	Expansion of Pipe in Inches per Foot of Length									
30	0.0153	0 0166	0 0225	0.0244	0.0259	0.0271	0.0282	0.0292	0.0301	0.0316
35	0.0149	0.0162	0 0221	0.0239	0.0255	0.0267	0.0278	0.0287	0.0297	0.0312
40	0.0145	0.0158	0.0217	0.0235	0.0251	0.0263	0.0274	0.0283	0.0292	0.0307
45	0.0141	0.0154	0.0213	0.0231	0.0246	0.0259	0.0270	0.0279	0.0288	0.0303
50	0.0136	0.0149	0.0208	0.0227	0.0242	0.0255	0.0265	0.0275	0.0284	0.0299
55	0.0132	0.0145	0.0204	0.0223	0.0238	0.0251	0.0261	0.0271	0.0280	0.0295
60	0.0128	0.0111	0.0200	0.0219	0.0234	0.0246	0.0257	0.0266	0.0275	0.0291
65	0.0124	0.0137	0.0196	0.0214	0.0229	0.0242	0.0253	0.0262	0.0271	0.0287
70	0.0119	0.0133	0.0192	0.0210	0.0225	0.0238	0.0249	0.0257	0 0267	0.0282
75	0.0115	0.0129	0.0188	0.0206	0.0221	0.0234	0.0244	0.0253	0 0263	0.0278
80	0.0111	0.0124	0.0183	0.0202	0.0217	0.0229	0.0240	0.0249	0.0259	0.0274
85	0.0107	0.0120	0.0179	0.0198	0.0213	0.0225	0.0236	0.0245	0.0255	0.0270
90	0.0103	0.0116	0.0175	0.0193	0.0208	0.0221	0.0232	0.0241	0.0250	0.0266
100	0.0094	0.0108	0.0.66	0.0189	0.0200	0.0213	0.0223	0.0237	0.0242	0.0257

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For cast-iron pipe multiply the above values by 0.91. For brass pipe multiply the above values by 1.454.

TABLE III. EXPANSION OF STEEL STEAM PIPES CARRYING SATURATED STEAM AT VARIOUS PRESSURES

Initial Temperature of Pipe in Degrees Fahrenheit	Gage Pressure, Pounds per Square Inch									
	Atmospheric Pressure 0 Gage	5	50	75	100	125	150	175	200	250
	Temperature of Steam in Degrees Fahrenheit									
	212	228	298	320	358	353	366	377	388	406
	Expansion of Pipe in Inches per Foot of Length									
30	0.0131	0.0143	0.0193	0.0209	0.0222	0.0233	0.0242	0.0250	0.0258	0.0221
35	0.0128	0.0139	0.0189	0.0205	0.0218	0.0229	0.0238	0.0246	0.0254	0.0267
40	0.0121	0.0135	0.0186	0.0201	0.0214	0.0225	0.0235	0.0243	0.0250	0.0263
45	0.0120	0.0132	0.0182	0.0198	0.0211	0.0222	0.0231	0.0239	0.0247	0.0260
50	0.0117	0.0128	0.0178	0.0194	0.0207	0.0218	0.0227	0.0235	0.0243	0.0256
55	0.0113	0.0124	0.0175	0.0191	0.0204	0.0214	0.0224	0.0232	0.0240	0.0252
60	0.0109	0.0121	0.0171	0.0187	0.0200	0.0211	0.0220	0.0228	0.0236	0.0249
65	0.0106	0.0117	0.0168	0.0183	0.0196	0.0207	0.0217	0.0225	0.0232	0.0245
70	0.0102	0.0114	0.0164	0.0180	0.0193	0.0204	0.0213	0 0221	0.0229	0.0242
75	0.0098	0.0110	0.0160	0.0176	0.0189	0.0200	0.0209	0.0217	0.0225	0 0238
80	0.0095	0.0106	0.0157	0.0173	0.0186	0.0196	0.0206	0.0214	0.0222	0.0235
85	0.0091	0.0103	0.0153	0.0169	0.0182	0.0193	0.0202	0.0210	0.0218	0.0231
90	0.0088	0.0099	0.0149	0.0165	0.0178	0.0189	0.0198	0.0207	0.0214	0.0228
100	0.0081	0.0092	0.0142	0.0162	0.0171	0.0182	0.0195	0.0199	0.0211	0.0220

Machinery

Expansion of Steam Mains carrying Superheated Steam

When figuring the expansion of a steam main carrying superheated steam the designer should not forget to add the temperature due to superheating. In the previous example the temperature of saturated steam at 200 pounds gage pressure was found to be 388 degrees Fahrenheit. If, instead of carrying saturated steam at 200 pounds gage pressure, this steam main was carrying superheated steam at 200 pounds gage pressure, superheated 100 degrees, the final temperature of the steam would then be 100 degrees higher due to the superheating, and the final temperature in this case would be 388 + 100 = 488 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe, in order to find the value of *T*, we would have 488 — 60 = 428 degrees rise in temperature which is the value to use in Formula (1) when figuring the expansion of the pipe for the preceding conditions. Tables of both saturated and superheated steam are given in the Marks & Davis steam tables, and the final temperatures may be read directly in either case. If, however, the reader possesses a table giving temperatures of saturated steam only, he may obtain from this table the final temperature of saturated steam at the same pressure as the superheated steam, and then add the number of degrees of superheat as described above. Superheating the steam as it leaves the boiler does not increase its pressure.

Tables for Estimating Expansion of Steam Pipes

Realizing the necessity of simplifying engineering calculations as much as possible, and in this case in order to save the time required to refer to steam tables, etc., the writer has prepared Tables II and III for use in calculating the linear expansion of wrought iron and steel steam pipes. A study of the tables and their use will prove a time saver in work of this kind. The coefficients of expansion given in Table I are average values, accurate enough for all practical purposes. Metals do not expand or contract uniformly throughout all ranges of temperature, but the writer has not taken this into account when preparing the tables. For example, at temperatures ranging from 32 to 100 degrees Fahrenheit, the coefficient of expansion for wrought iron pipe is approximately 0.0000065, increasing to approximately 0.000008 at 500 degrees Fahrenheit. Steam pipes, as used in modern practice, are either made of wrought iron or mild steel. The writer has therefore prepared two separate tables—Table II for wrought iron pipe and Table III for steel pipe.

These tables are to be used for saturated steam only. The steam pressures as given in the upper line of the tables are gage pressures, or the pressure as recorded on a steam gage. At atmospheric pressure (approximately 15 pounds absolute) the steam gage would record no pressure, and the pointer would stand at zero on the dial. On the second line of the table is given the temperature of the steam, in degrees Fahrenheit, corresponding to the gage pressure in pounds per square inch, and below this line is given the expansion, in decimals of an inch per lineal foot of pipe. In the first column of the tables is given the initial temperature of the pipe in degrees Fahrenheit. To find the expansion in inches of a steam pipe of a given length in feet, it is necessary to know the approximate initial temperature of the pipe, or the temperature before steam is turned into it, and the temperature of the steam which the pipe is to convey. Multiplying the constants in the tables by the length of pipe in feet will give the total amount of expansion of the pipe in inches.

Example:—A wrought iron pipe 210 feet long, installed at a temperature of 50 degrees Fahrenheit, is to convey saturated steam at 150 pounds gage pressure. How many inches will the pipe expand when steam is turned into it? In the first column of Table II, on the fifth line down, will be found 50 degrees, the initial temperature of the pipe. In the eighth column, headed 150 pounds pressure, opposite 50 in the first column, will be found 0.0265, which is the expansion in decimals of an inch per foot of length. Multiplying this constant by 210, the length of pipe in feet, we get 0.0265 × 210 = 5.57 inches, or approximately 5 $\frac{9}{16}$ inches as the elongation of the pipe due to expansion.

Cast iron or brass pipe is seldom, if ever, used for steam mains in modern steam power plant work. For all practical purposes the cast iron or brass fittings in a steam main may be assumed to expand the same as the pipe. If it is desired to obtain constants similar to those in Tables II and III for use in figuring the expansion of cast iron or brass pipe per foot of length, multiply the constants given in Table II by 0.91 for cast iron pipe and by 1.454 for brass pipe. For example, if in the previous instance the pipe was of cast iron, instead of wrought iron, the constant 0.0265 would have to be reduced to 0.0265 × 0.91 = 0.0241, the expansion in decimals of an inch per foot of length, which, multiplied by 210, the length of pipe in feet, gives 0.0241 × 210 = 5.06 or approximately 5 $\frac{1}{16}$ inches. If the pipe was of brass instead of wrought iron, the constant 0.0265 would be increased to 0.0265 × 1.454 = 0.0385, which is the expansion in decimals of an inch per foot of length. This value multiplied by the length of the pipe in feet gives 0.0385 × 210 = 8.09 or approximately 8 $\frac{1}{16}$ inches. The constants given in the second and third columns of the tables will be found useful in calculating the expansion in atmospheric exhaust and low pressure heating mains. The tables do not apply to vacuum exhaust mains—a subject which will be treated separately in a later section of this article.

The Force of Expansion and Contraction

The necessity of providing flexible piping connections for properly anchoring steam mains, and of installing expansion bends wherever necessary will be better understood when we consider the practically irresistible forces that are set up in the piping material as heat is supplied to the walls of the pipe. We can calculate very closely the thrust exerted by an expanding steam pipe by the aid of the three following formulas:

Formula (1) is used for figuring expansion and contraction, and Formulas 2 and 3 are used in finding the elongation of a bar of metal due to a given external force such as a weight suspended from the end of the bar tending to stretch it. These formulas are as follows:

$$e = LCT \qquad (1)$$

$$e_1 = \frac{PL}{AE} \qquad (2)$$

$$P = \frac{e_1 AE}{L} \qquad (3)$$

The notation in Formlua (1) is the same as that used in the previous case for expansion due to heat. The notation for Formulas 2 and 3 is as follows:

e_1 = Total elongation of body in inches;
A = Cross sectional area of body in inches;
P = Total stress on body in pounds;
L = Original length of body in inches;
E = Coefficient of elasticity of metal composing body.
For wrought iron E = 25,000,000.
For steel E = 30,000,000.
For cast iron E = 15,000,000.

In Formulas 2 and 3, e_1 is equivalent to e in Formula 1, with the exception that the elongation e in Formula 1 is caused by an internal force due to heating the piping material, and the elongation e_1 in Formulas 2 and 3 is caused by an external force, such as a weight or pull. If we substitute e in Formula 1 for e_1 in Formula 3, we get:

$$P = \frac{eAE}{L} \qquad (4)$$

By substituting for e, its equivalent LCT (see Formula 1) we get:

$$P = \frac{LCTAE}{L} \qquad (5)$$

Cancelling L we have:

$$P = CTAE \qquad (6)$$

where

P = Magnitude of thrust in pounds exerted by the pipe when expanding, or the pull exerted when contracting.
C = Coefficient of linear expansion (see Table I).
E = Coefficient of elasticity of piping material.
A = Area of metal in a cross section of the pipe or body, in square inches.
T = Difference in degrees Fahrenheit of temperature between the initial temperature of the pipe, or body, and its temperature after being heated or cooled.

From the above formulas we find that the length L has been cancelled, and is not required in the following examples. Thus, Formula (6) should give us the magnitude of the thrust exerted by the pipe, regardless of its length, providing that it is prevented from expanding freely or springing sideways. This formula should be used for approximate results only, and within given temperature limits only, as a body when heated beyond a certain temperature loses a large percentage of its strength. The formula may be safely used for steam pipes heated to 600 degrees or more, and these high temperatures are seldom reached in ordinary steam power plant work. As an example showing the application of Formula (6), assume that we have a 12-inch extra heavy steel steam main braced along its entire length to prevent it springing sideways, and firmly blocked at each end to resist linear expansion. The original or initial temperature of the pipe when installed is 50 degrees Fahrenheit. If steam at 210 pounds gage pressure (210 + 15 = 225 pounds absolute) superheated 100 degrees, is turned into the main after erection, what will be the thrust exerted by the pipe due to expansion? From Formula (6) we have $P = CTAE$. C for mild steel = 0.000006 (see Table I). The temperature of saturated steam at 210 pounds gage pressure (225 pounds absolute) is found from the steam tables, to be 392 degrees Fahrenheit. Adding 100 degrees superheat, we have 392 + 100 = 492 degrees Fahrenheit as the temperature of the superheated steam at the above pressure, superheated 100 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe, we get 492 − 50 = 442 degrees Fahrenheit for the value of T in Formula (6). From a table of properties of standard and extra heavy steam pipes, as given in most pipe manufacturers' catalogues (see Table IV) we find the area of metal in a cross-section of 12-inch extra heavy pipe, to be 19.25 square inches, which is the value of A in Formula (6). E for steel pipe, as previously mentioned, equals 30,000,000. Substituting the above values in Formula (6) we have: $P = 0.000006 \times 442 \times 19.25 \times 30{,}000{,}000 = 1{,}531{,}530$ pounds as the thrust exerted by the 12-inch pipe, due to expansion. This divided by the area of metal in a cross-section of the pipe, in square inches, gives 1,531,530 ÷ 19.25 = 80,000 pounds per square inch as the compression of the piping material, sufficient to cause rupture.

If, in the previous example, the pipe was allowed to expand freely when heated and then clamped tightly at each end to prevent it from contracting or returning again to its original length as it cooled down, the pipe material would be subjected to a tensile strain of 1,531,530 pounds or 80,000 pounds per square inch. This would be figured in exactly the same way as the previous examples, the only difference being that in the previous case the piping material is in compression due to expansion, and in this case it is in tension due to contraction. If, however, the pipe was permitted to expand and contract freely, no external resistance being offered, the above conditions would not hold good. External strains due to expansion and contraction are set up in the piping material only when the piping is rigidly connected, thus offering more or less resistance to the movement of the pipes, or the lengthening or shortening of the pipes as they expand and contract. The above examples serve to give some idea of the enormous strains thrown on the pipe, joints, valves and fittings in a steam main where no provision is made to take up or relieve the expansion and contraction. If the line is anchored improperly, either the anchors will give, or the pipe will spring sideways, thus straining the valves, fittings and pipe joints in the line, sufficiently in many cases, to cause excessive leakage, crack the flanges, or strain the valve bodies and distort the valve seats, causing leakage past the gate or disk.

In building a brick wall where a steam pipe passes through the wall, the bricklayers occasionally build the pipe in rigidly, thus making no allowance for expansion or contraction. The writer has seen cases where steam pipes built into a 12-inch brick wall in this manner have caused the wall to crack and bulge very badly. Where a steam pipe passes through a wall or floor, a sleeve or pipe thimble as they are called, should be built into the wall and should be large enough in diameter to permit drawing the pipe, flanges and all, through the thimble in case it becomes necessary at any time to remove a section of the pipe.

Fig. 40 will serve to illustrate a very rigid piping connection between duplicate steam mains, and the following example will give an idea of the severe strains the piping is subjected to when one main is shut down and the other main is kept alive to supply the engines. As an example, suppose two 8-inch wrought iron steam mains *A* and *C* (Fig. 40), are tied together by branch mains *E* and *F* through valves *B* and *D*, as shown in the end view. Ordinarily steam is kept on both mains, in which case expansion and contraction is nearly uniform in each main. In case of an accident occurring to either main it would then be shut down, and the other main kept in service while making repairs to the disabled section of the piping system. Assume for example that both mains, *A* and *C* (Fig. 40), were installed at a temperature of 60 degrees Fahrenheit and dimensions *H* and *G* at this temperature were found to be 90 feet. If, after erection, saturated steam at 190 pounds gage pressure (190 + 15 = 205 pounds absolute) was turned into steam main *A* only, valves *D* being closed, and steam main *C* being cold (60 degrees F.) as no steam is admitted to same, what effect would this have on the piping system?

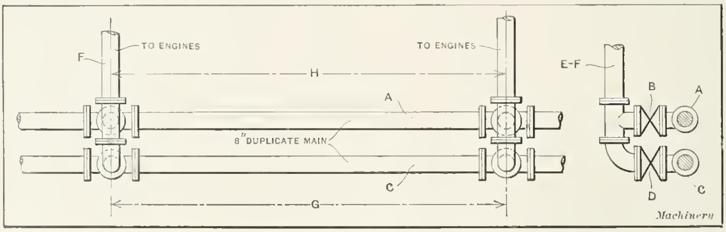

Fig. 40. Installation arranged with Duplicate Mains over Boilers

First let us find the elongation of steam main *A* between points *E* and *F* due to expansion in that section of the piping system. From Formula 1 we have: $e = LCT$ and by the above conditions we have $L = 90$ feet $= 90 \times 12 = 1080$ inches, and the coefficient of expansion $C = 0.000007$ for wrought iron (See Table 1). In order to compute the rise in temperature T, we find by aid of the steam tables that the temperature of saturated steam at 190 pounds gage pressure, or 205 pounds absolute pressure, equals 384 degrees Fahrenheit. Subtracting from this the initial temperature of the pipe (60 degrees F.) we have: $384 - 60 = 324$ degrees, equals temperature rise T.

Substituting these values in Formula 1, we have: $e = 1080 \times 0.000007 \times 324 = 2.45$ inches or $2\frac{1}{2}$ inches approximately, the elongation of steam main *A*. Adding the original length (dimension *H*) we have 90 feet $2\frac{1}{2}$ inches between points *E* and *F* if steam main *A* was free to expand. Dimension *G*, steam main *C*, is 90 feet 0 inches, however, as the pipe has not been heated and in order that steam main *A* be allowed to expand freely it would be necessary to lengthen steam main *C* $2\frac{1}{2}$ inches. Steam main *C* and the rigid piping connections at *E* and *F* would quite naturally resist the expansion or elongation of main *A*, thus throwing severe strains on the pipe joints and the valves *B* and *D*.

TABLE IV. AREA OF METAL IN STEAM PIPES*

Size of Pipe, Inches	Area of Metal in a Cross Section of Pipe in Square Inches = A			Size of Pipe, Inches	Area of Metal in a Cross Section of Pipe in Square Inches = A		
	Standard Pipe	Extra Heavy Pipe	Double Extra Heavy Pipe		Standard Pipe	Extra Heavy Pipe	Double Extra Heavy Pipe
1	0.4939	0.6388	1.076	4½	3.688	5.180	9.569
1¼	0.6685	0.8815	1.534	5	4.300	6.112	11.340
1½	0.7995	1.068	1.885	6	5.581	8.405	15.640
2	1.075	1.477	2.656	7	6.926	11.190	18.560
2½	1.704	2.254	4.028	8	8.399	12.760	21.300
3	2.228	3.016	5.466	9	9.974	14.330	......
3½	2.680	3.678	6.721	10	11.91	16.100	......
4	3.174	4.407	8.101	12	14.58	19.25	......

Machinery

* Condensed from National Tube Co 's Catalogue

From Formula 6 we have: $P = CTAE$. Assuming steam mains *A* and *C* to be of 8-inch standard weight wrought iron pipe, we find from Table IV the area of metal in a cross-section of the pipe to be 8.399 square inches $= A$.

C from Table 1 $= 0.000007$.

$T = 324$ degrees.

$E = 25{,}000{,}000$ for wrought iron.

Substituting these values in Formula 6 we have: $P = 0.000007 \times 324 \times 8.4 \times 25{,}000{,}000 = 476{,}280$ pounds, the thrust exerted by steam main *A* when expanding. This means that the total tensile strain on the metal of the 8-inch pipe *C* equals 476,280 pounds, and as the area of the metal in the pipe equals 8.4 square inches, the stress per square inch would be $476{,}280 \div 8.4 = 56{,}700$ pounds per square inch. If steam were turned into both mains and then one of them shut down and allowed to cool to its initial temperature (60 degrees F.) the result would be practically the same, due to the contraction of the pipe when cooling. It is doubtful if the above stresses would actually be encountered in a case of this kind in practice as the steam main *A* being in compression lengthwise would bow or spring out of shape sideways due to its length before any such stresses would be realized. The above examples give, however, a general idea of the stresses likely to be encountered in work of this kind. The above example does not take into account the tension on the metal of steam main *A* due to the steam pressure of 190 pounds per square inch acting against the ends of the pipe tending to stretch it. The internal area of an 8-inch standard weight steam pipe is approximately 50 square inches. Therefore $50 \times 190 = 9500$ pounds total, or $9500 \div 8.4 = 1131$ pounds per square inch tension on the metal of steam pipe *A* due to the steam pressure tending to stretch the pipe. As this stress is all resisted by the metal of pipe *A* it does not enter into the previous calculation.

Rigid piping connections between two steam mains, such as shown in Fig. 40 should never be employed. The writer assumed this condition merely to illustrate the above example.

THE VETTER STEEL TYPE MAKING MACHINE

A RECENT DEVELOPMENT IN MACHINERY FOR MAKING STEEL TYPE FOR TYPEWRITERS

BY CHESTER L. LUCAS*

Since the advent of the typewriter the problem of making steel type has been a very important one. Several different processes have been followed during the past thirty years, all of which are based on the principle of forcing the metal of the type blank into a hardened steel matrix. A general idea of typewriter type may be obtained from Fig. 1, which illustrates at *A* blanks from which the type are made, showing the slot by which the type is secured to the type bar; at *B* type just as it leaves the matrix, with the displaced metal left untrimmed; and at *C* completed type with this fin of extra metal sheared off. The primitive method of typewriter type-making was that of using a drop-hammer, mashing the blanks straight down into the matrices by a direct blow. Although the type blanks were prepared in different ways in order to make the metal flow more easily, this method was given up years ago as being impracticable because the surface of the type could not be readily brought up sharp.

Another of the earlier methods used by prominent typewriter manufacturers was the rolling process whereby the type blanks were mounted about the circumference of a large heavy roll indicated in the diagram at *A* in Fig. 2. This rolling method operated similarly to a printer's proving press, and as the matrices were clamped upon the bed of the apparatus the type blanks were forced into them when the roll was passed over the bed under pressure. Although this method is in use today in some shops, it has serious disadvantages, trouble frequently arising from the "creeping" of the metal in the type blanks. In addition, it is difficult to line the dies up properly for the work.

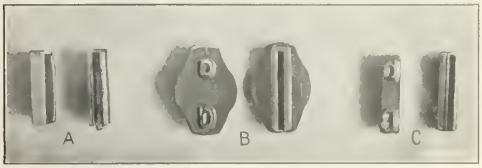

Fig. 1. Evolution of a Steel Typewriter Type. A, The Slotted Blank; B, The Kneaded Type; C, The Trimmed Type

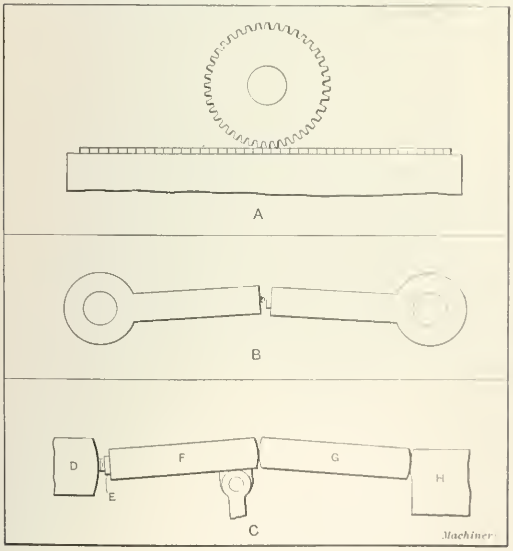

Fig. 2. Diagrams illustrating Different Type-making Methods

Until recently the most generally used machine for typewriter type-making was the Mallonee machine. This is a hand-operated machine which incorporates the kneading or knuckling movement which has been so successful in type-making. By referring to Fig. 2 at *B* the principle upon which the Mallonee machine operates will be seen. Two arms or levers are pivoted upon shafts at opposite ends of the machine, and in the end face of one of these arms the matrix is held, while in the corresponding end face of the other arm the blank is held. Now, by kneading these two arms of the machine together the metal of the type blank is caused to fill the impression in the matrix. The capacity of this machine is 1700 type per day. Good type is obtained from this style of machine, but its disadvantage lies in the fact that a great amount of friction is developed on account of the arms being under pressure while they are undergoing the kneading process; it will be seen that the friction in the arm bearings upon the shafts must be great. Also the fact that the machine is hand operated greatly limits the production.

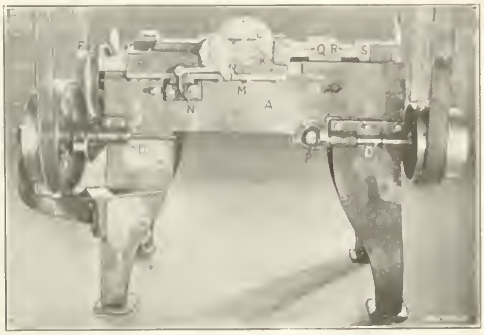

Fig. 3. Vettor Steel Type Making Machine

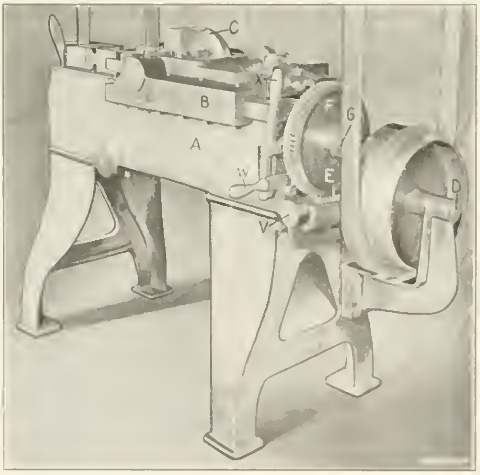

Fig. 4. Rear View of Vettor Steel Type Making Machine

The Vetter Machine

One of the latest and most improved of type-making machines and a machine which has been adopted in several of the leading typewriter factories is the Vetter machine illustrated in Figs. 3 and 4. This machine is the invention of R. C. Vetter, Syracuse, N. Y., and is made by the Acme Tool & Die Co., also of Syracuse. The machine embodies the kneading principle, but its chief advantages are that the frictional losses are largely overcome and in addition the machine is semi-automatic in its operation. The illustration at *C* in Fig. 2 shows the principle upon which the mechanism operates. The type blanks are held in a four-position turret,

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[*] Associate Editor of MACHINERY.

a section of which is indicated at *D*. The matrix *E* is held in the end of arm *F* which is one of the kneading members. The other kneading member *G* bears against the frame of the machine at *H*. By reciprocating member *G*, arm *F* is caused to rock, thereby working the face of the matrix against the type blanks which are held in the turret. It will be observed that there are no shafts to cause friction, the entire kneading pressure being taken upon the carbon contact faces between the members *F* and *G* and *G* and *H*. This, in brief, explains the operating principle of the mechanism, but there are some interesting details of the machine which it will be profitable to consider.

Upon the top of frame *A* of the machine as illustrated in Figs. 3, 4 and 5, is mounted a carriage *B* which supports the turret *C*. The carriage and turret have a reciprocating movement, causing the carriage to make a stroke of 2½ inches and return every six seconds. The carriage is operated through power from the driving shaft *D* and thence to worm *E* and wormwheel *F*. Located within the machine on shaft *G*, upon which wormwheel *F* is located, is a barrel cam *H*, more clearly shown in the line illustration Fig. 5. The carriage is guided in its reciprocating movement by means of a stud *I*; this stud extends all the way through the carriage and its lower end engages the cam groove in the barrel cam *H*. In order to obtain a dwell at the time the kneading takes place this groove is cut straight, of course, allowing the carriage to remain stationary at the end of the stroke during the four seconds' space of time required for kneading the type into the matrices. On the outer end of this cam shaft is located a smaller cam *J* which operates an indexing pin, serving to hold the turret stationary while the type is being kneaded. The location of the driving shaft, worm, wormwheel, carriage and turret may be clearly seen by referring to the rear view of the machine shown in Fig. 4.

The indexing of the turret is effected through a gear *K* on the end of the turret shaft which is operated by another gear *L* on the carriage proper. Gear *L* is, in turn, actuated by a ratchet wheel pinned to the side of the gear and caused to turn through contact with a pawl *M*. This mechanism is all mounted on the side of the carriage and through a lever connection with bracket *N* which is bolted to the frame of the machine, the ratchet wheel, and consequently the turret, is caused to index during the return stroke of the carriage. This mechanism has been omitted in Fig. 5, but is clearly shown in Fig. 3. The cycle of the carriage movements is completed in six seconds—one second for advancing, four seconds in the position for kneading and one second for returning.

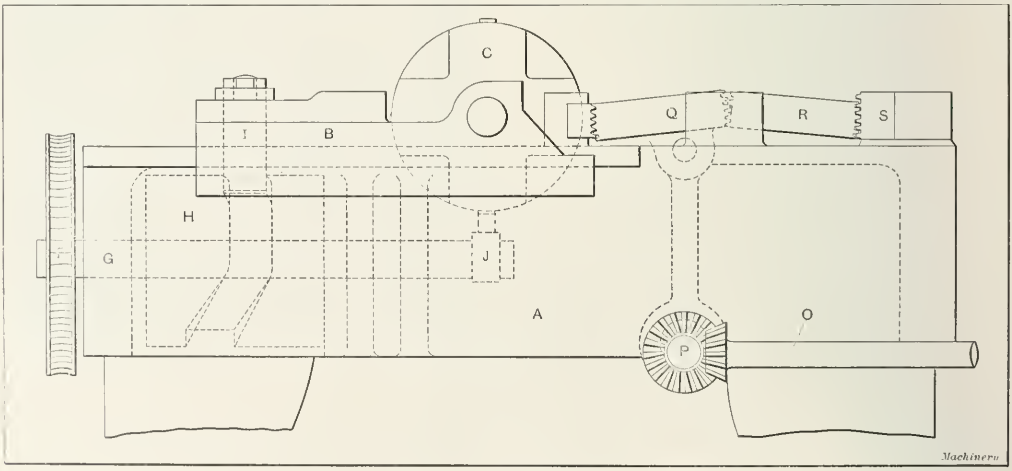

Fig. 5. Side Elevation, showing Principal Features of Machine

The Kneading Movement

The Vetter machine consists essentially of two distinct mechanisms, combined in their action. At one end of the machine the carriage is operated and the turret indexes, while at the opposite end the kneading movement is secured. Power for the kneading operation is brought to the machine at driving shaft *O* and is transmitted to cross-shaft *P* through bevel gearing, and by means of an eccentric upon this shaft a rocking motion is imparted to knuckling section *Q*. The other knuckling section is indicated at *R*, and by referring to Figs. 3 and 6 it will be seen that these sections are rectangular in shape. As has been before stated, the important feature of this mechanism is the fact that it is operated with a minimum amount of friction. The pressure involved in the kneading operation is taken upon the cylindrical faces between sections *Q* and *R* and section *R* and end stop *S* on the framework of the machine. In no instance is there any resemblance of a shaft bearing, the contact points in each of the two cases being practically of no width. The reciprocating movement takes place about an imaginary fulcrum point located exactly at the point of kneading. This may be more clearly observed by noticing in Fig. 6 that the fulcrum point would come in a line with the left-hand faces of the stops *S*. As the matrices are held by means of set-screws in member *Q* so that their faces are in this line, it will be seen that there is absolutely no vertical movement of the matrices during the kneading. The gear teeth which may be noticed at each of the joints of this mechanism are simply for the purpose of keeping the members in line. The gears do not receive any of the kneading pressure, as the teeth are far enough out of engagement so that there is practically no contact, although the pitch line is in line with the bearing points of the members. When the turret has advanced to the kneading position the carriage upon which the turret is located is not quite at its extreme forward position, but during the dwell it is advanced very slightly to take up the distance lost by the receding of the stock in kneading.

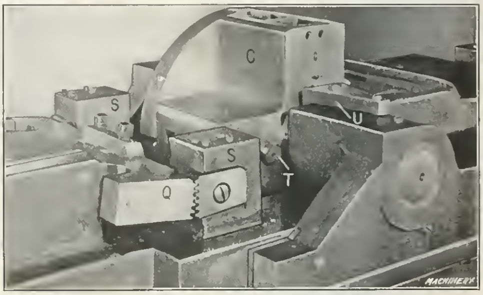

Fig. 6. Close Range View at the Kneading Point

Provision is made for holding two blanks at each of the turret stations as indicated in the section of the turret shown in Fig. 7. Decided advantage is secured on this machine by being able to knead the characters upon blanks after the slots have been milled. In the past it has been one of the difficult features of type-making to mill the slot correctly in the finished piece of type, because, on account of its tapered sides, it was almost impossible to center the milling cut with the raised letters upon the face of the type. This is an important matter because in action an uneven slot means a crooked type. On the Vetter machine the slots are milled in the blanks first.

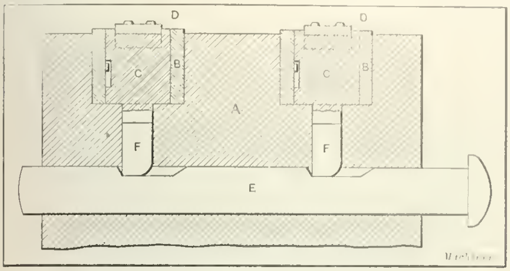

Fig. 7. Section of Turret showing Type Ejecting Mechanism

Referring to Fig. 7, the body of the turret is indicated at *A* and into this member are set the type holders *B*. Within the type holders are fitted two tongues *C*, each the exact thickness of the milled slot in the type blank. The type blanks are fitted over these tongues at the loading position and they are kneaded leaving them in the condition shown at *D*. After the type has been kneaded, side pressure from a cam plate is exerted against the head of bolt *E*, which through a stud *F* causes the tongues to rise and eject the type, allowing it to drop into a pan. In Fig. 6 the end of the tongue-operating bolt may be seen at *T* and plate *U* is used for returning the bolt to its original position.

From Fig. 4 it will be seen that the machine may be stopped or started at will by the engagement or disengagement of the worm gear *V*, engaged by handle *W* and disengaged by lever *X*. Two type having a total of four letters are completed in six seconds or twenty type per minute, and the only attention that the machine requires is the locating of the type blanks in the turret. The surplus metal which extends from the face of the type in a fin is afterward removed by shearing.

* * *

A modest success is better than a gigantic failure.

BUTTON BACK BLANKING AND PIERCING DIE

BY WALTER J OLDROYD[*]

A cross-sectional view of an interesting design of punch and die which is used for blanking and piercing metal backs used on trouser buttons is shown in Fig. 1. No. 19 Birmingham gage (0.042 inch thick) ribbon stock is used for making these button backs and the metal is not of a particularly good quality. Fig. 2 shows an enlarged view of one of the finished button backs, and Fig. 3 illustrates the location of the holes in a piece of scrap metal, from which it will be seen that the method of blanking requires very little stock to be wasted.

Referring to the cross-sectional view through the punch and die, *A* is the punch block in which three blanking punches *B* are set in the positions indicated by the cross-sectioned holes in Fig. 3. These punches are held in place by set-screws and are equipped with spring plungers *C* for ejecting the work from the die. The blanking die-holder *D* is screwed to the cast-iron shoe *E*; this holder is made of machine steel and has three tool steel blanking dies *F*, which have a three-degree taper on the outside. *G* is the stripper plate for the dies. The ribbon stock is fed through the die between the guides *H*, and as the ram of the press descends the lever *I*, which is operated by a cam on the ram, moves from the position illustrated until the center line of the lever is in the position shown at I_2. The lever *I* moves the slide *K* through link *J*; and the slide *K* has a transfer slide *L* secured to it, in which there are three holes for transferring the blanks to the piercing punch and die. Before the work is blanked out the transfer slide has reached its extreme left-hand position, and after the blanking operation is completed the spring plungers *C* push the blanks down into the holes in the transfer slide. When the ram starts upon its return stroke the transfer slide moves to the right and delivers the blanks to the piercing die. The transfer slide *L* is held to the cast-iron slide *K* by means of the spring *M*; this spring will allow the transfer slide to remain stationary, regardless of the movement of the slide *K*, so that the mechanism will not be wrecked in event of any obstruction being met.

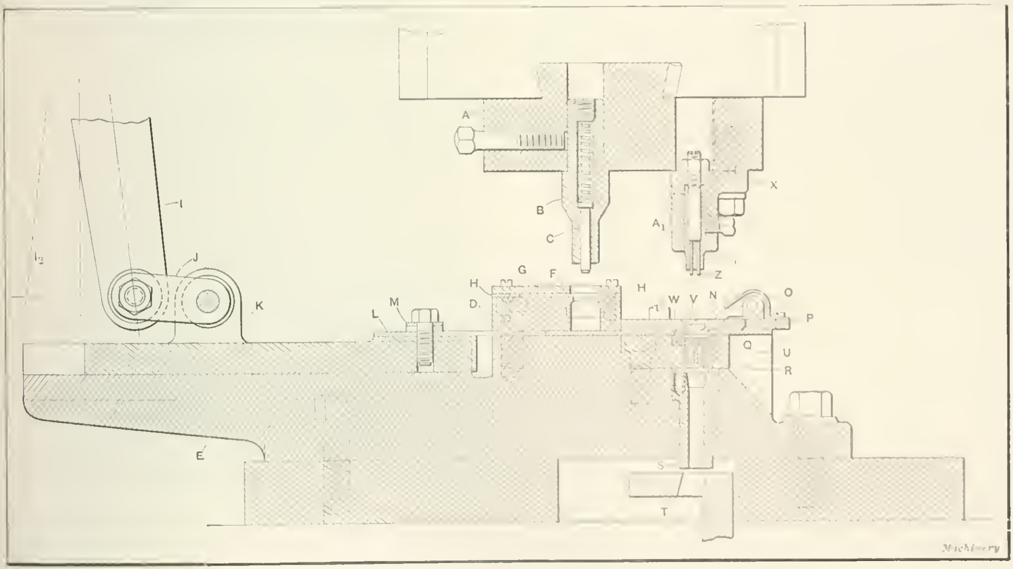

Fig. 1. Cross-sectional View of Button Back Blanking and Piercing Punch and Die

After the blanks are transferred to the piercing punches they are pushed out of the holes in the transfer slide by means of fingers *N* which act on each blank; these fingers are held down by the tension of springs *O*. Referring to this part of the illustration it will be seen that *P* is the punch stripper plate and Q one of the piercing dies. These three piercing dies have a three-degree taper on the sides and are forced into the machine steel die block R. After the blanks have been delivered to the piercing die the ram descends and pierces the four holes, the scrap dropping down through the knock-out tube S. When the slide starts on its return stroke the knock-out T lifts the tube S, which, in turn, forces up the three pins U. These three pins raise the die stripper V so that the blanks are on the same level as the bottom of the transfer slide, and when the latter comes forward with a fresh supply of blanks it pushes the pierced blanks off onto the side of the press. The height to which the stripper V can be raised is limited by the stop W screwed onto the die block. The knock-out tube S is returned to its original position by the tension of the small coiled spring which is carried in a socket at its upper end, and the stripper V is returned by the tension of the springs O acting on fingers N.

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[*] Address, 46 Walnut Ave., Waterbury, Conn.

The construction of the piercing punch is worthy of more than passing consideration. The steel castings X for the punch-holders are carried in stock, for these castings constitute the punch-holders used for producing a large variety of work. The punch-holders X carry the tool steel pins Y, which are not hardened. These pins are drilled to receive the four drill rod piercing punches Z; the upper ends of these drill rod punches are slightly upset to prevent them dropping out of Y. A hardened tool steel plug A_1, is held in place on top of the four drill rod punches Z by means of the case-hardened set-screw and check-nut. In event of one of the piercing punches breaking, it is merely necessary to cut off a piece of the drill rod, upset it on one end, then harden it and place it in position in Y. Just enough pressure is put on the set-screw to hold the drill rod punches Z in place, but not enough to push Y out of place.

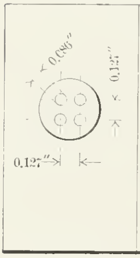

Fig. 2. Finished Button Back

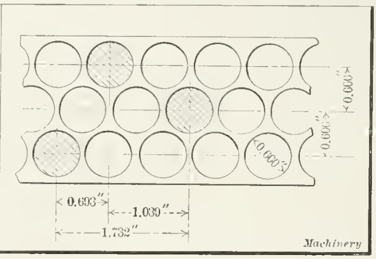

Fig. 3. Ribbon Stock showing Arrangement of Punches

The factory in which this punch and die is used manufactures a large variety of button blanks which are supplied to outside firms in addition to being used by the manufacturer. In many cases it is possible to use the same set of tools for several different styles of button backs, as a slight difference in the outside diameter of the blank will not waste enough stock to justify the expense involved in producing a new set of tools for this particular class of work.

* * *

A somewhat novel arrangement has been made between two German machine tool builders. According to the *Mechanical World*, the Maschinenfabrik Augsburg-Nürnberg and the Ludwig Loewe & Co. Aktien-Gesellschaft have agreed to interchange apprentices, and have made an arrangement by means of which an apprentice, after having completed the period of his training in one shop and expressing a desire for a change, will be taken over by the other concern. While absent, he is supposed to write at stated intervals about his work, and thus keep in touch with his first employer. It is assumed that the apprentice will eventually return to the firm that began his training and that the experience gained elsewhere will make him more valuable than if he had remained in one place.

* * *

As a binder for a cement to stand high heat (1475 degrees F.), use sodium silicate (water glass) diluted with rain-water until a specific gravity of 20 degrees on the Baumé hydrometer is obtained. Sand or quartz may be used in the cement to give the proper consistency.

BENJAMIN LAWRENCE AND COST-KEEPING

Benjamin Lawrence started a machine shop in a thriving Connecticut town fifty or sixty miles out of New York, in the early seventies. Benjamin was young; he worked hard and his shop grew. As his first success came long before the motor car, he had a chance to keep his earnings, and by and by he found himself in possession of a fine profit-producing plant. Benjamin was a man of the old school. There were not many systems in his shop, and those that he had were not very rigidly adhered to. He had a kind of cost system of his own, which consisted largely in comparing bank balances from year to year; and as these balances continued to add ciphers at the right end, he did not worry much about card-index systems.

But as Benjamin grew old, he concluded that it was time to retire. Younger hands were to grip the helm. He sold out, and those who bought his plant had no cause to complain. Judging by the profits of previous years the investment should net twelve per cent. Of course some things about the shop were old-fashioned, but the buyers were men with modern ways who knew how to change for the better. They were experts on systems and methods, and had the time of their lives changing over the old shop to fit their ideal. They became so expert that they could tell the price of a wing-nut to a tenth of a mill, and their chief cost-keeper could keep himself in luxury and comfort—in his mind—on the interest of savings that were to result. The men worked as by clock-work. A minute-and-a-half for this and seventeen seconds for that; if a man lost three minutes looking too long at the drawing before starting to work on a new piece, it was pretty sure to show up on the time-keeper's record and in the cost data.

When the system had been all worked out fine, the new owners felt a pardonable pride in their achievement, and they could not sleep well nights until Benjamin had been down to the shop to see the improvement. The old man did not say much, but there are those who claim they saw him shake his head. He was too old to appreciate these modern improvements!

A year went by, but there was no twelve per cent profit. Another year passed and the result was no better. Then the new owners began to worry. Why could they not do what old man Lawrence had done? Why were their profits less than his when they produced so much more economically?

Finally Benjamin was called into consultation. The old gentleman had followed the events in his shop quite closely. He went over everything again; he looked into this and into that, inspected systems and rate cards, and time records and cost diagrams, and finally when convinced that he had found the cause of the trouble he smiled broadly and said: "Well, you see it's just like this with an old-fashioned fool like myself; when he makes a dollar he never thinks of spending seventy-five cents of it to find out *how* he made it!"

* * *

THE SUPPLY OF EMERY

The world's supply of emery comes from some of the Greek Islands, principally Naxos, and from Asia Minor near Smyrna. Emery to the value of \$250,000 is imported annually into the United States. During the past year, some American manufacturers have had difficulty on account of delays in emery shipments, due partly to the disturbed conditions in the Balkans and partly to a strike for higher wages among the workers engaged in obtaining the emery. A bill regulating the emery trade was recently passed by the Greek chamber. This bill provides that the minimum selling price of ordinary Naxos emery is to be \$12.54 per metric ton (2205 pounds), and emery of the highest grade must not be sold for less than \$21.23 per metric ton. The grading of the mineral will be under governmental control.

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To solder steel to cast iron, first copperize the cast iron surface with vitriol. It is necessary that the cast-iron surface be thoroughly cleaned and polished before the vitriol is put onto it. After having applied the vitriol, allow the surface to dry thoroughly and then solder the steel to the copperized surface the same as in ordinary soldering.

MANUFACTURING GREAVES-KLUSMAN ENGINE LATHES

SOME TOOLS AND METHODS EMPLOYED IN MAKING GEAR-BOXES, APRONS AND OTHER PARTS

BY DOUGLAS T. HAMILTON*

Some of the most interesting tools and methods used in producing the engine lathe manufactured by Greaves, Klusman & Co., Cincinnati, Ohio, are illustrated and described in the following. In Fig. 1 are shown the tools and jig used in drilling, boring, reaming and facing the quick-change gear-box, shown removed from the jig at *A*. Twenty tools, not counting the numerous bushings, are used in machining this casting, which is placed in the jig after it comes from the planer and milling machine and finished complete without being removed. The casting is located in the jig by a tongue, which is also used as a locating point when this unit is assembled on the finished bed of the lathe. The box for the tumbler shaft is milled before the jig machining operations, and this surface is used as a locating point for endwise location in the jig.

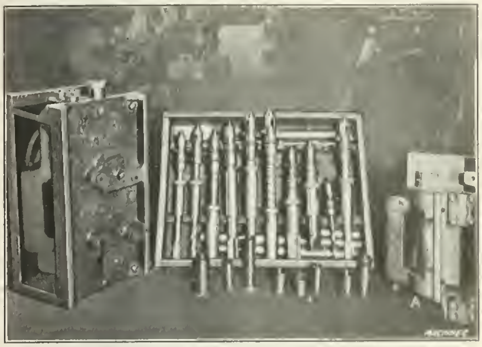

Fig. 1. Jig and Tools used in machining Quick-change Gear-box for Greaves-Klusman Engine Lathes

Briefly stated, the machining operations performed on this quick-change gear-box in the jig consist in drilling, boring, reaming and facing the following holes: Tumbler shaft holes—one in each end; cone shaft holes—one in each end; feed rod holes—one in each end; front shifter lever holes and lead-screw gear eccentric hole, the latter being drilled and tapped. In addition to these operations four clamp bolt holes are drilled, as well as eight holes for the caps for the cone-gear shaft bearings; also four of the bosses are faced with counterbores. Putting the work through without removing it from the jig until all of the machining operations are completed goes a long way toward insuring interchangeability of product.

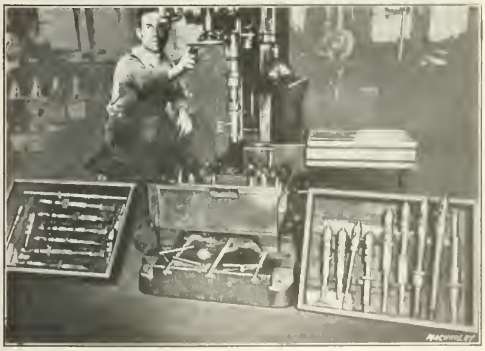

Fig. 2. Jig and Tools used for machining Double-plate Lathe Aprons

Jig and Tools for Machining Lathe Aprons

The jig and tools used for machining the double-plate apron are shown in Figs. 2 and 3. Fig. 2 shows the jig in place on the base of the radial drilling machine, where all the operations are accomplished, and Fig. 3 shows a view of the interior of the jig—the top plate being removed—and also the apron and back plate which are machined in it. Twenty-five separate tools are used for machining these castings complete. The back plate, which is shown at *C* in Fig. 3, is drilled, reamed and faced at the same time that the apron is being machined. The apron is located in the jig *B* from all four corners on corresponding finished surfaces in the jig. It is located from the end by the bosses, and is clamped in place by four screws directly in line with the bosses *a* in the jig, these being machined on the under side to act as locating points.

After the apron *A* is clamped in the jig, the back plate *C* is next put in place. This is located on the apron by a groove cut in its surface which fits a corresponding tongue on the apron. When the back plate has been properly located, the removable plate *D* is put in place and properly located by two No. 4 Morse taper sleeves *b*, which fit into corresponding taper holes in the bosses *a*. The top plate is held in position by four bolts *c*, two of which pass up through the tapered sleeves *b*. Three clamping screws in the removable plate *D* are used to hold the back plate tightly against the apron *A*.

Some idea of the kind of work performed in the jig shown in Figs. 2 and 3, may be obtained from a brief outline of the operations accomplished. Five holes are drilled in the top edge of the apron, four of these being used for bolting it to the carriage, and the fifth hole for the chasing dial indicator. The operations performed from the end of the apron are: Boring and reaming the holes in each end for the feed-rod bearing; performing the same operations on the holes for the double bevel pinion, and boring and reaming the hole for the lead-screw. On the rear side of the apron, the following operations are performed through the removable plate *D*: Drill six holes for bolting the back plate to the apron; drill and ream one dowel pin hole; drill, ream and bore, rack pinion hole, first stud hole, lateral friction hole, and cross friction shaft hole. From the front of the apron the following operations are performed: Drill, bore and ream first stud hole and rack pinion hole; and bore, face and counterbore lateral friction hole, and cross-feed friction hole. In addition to this, the following holes are bored and reamed: Bevel gear stud hole; bevel pinion shifter shaft hole; three locating holes for shifter lever, for locating the double bevel pinions in the three positions—right or left pinion in contact and pinions in the neutral position. The hole for the half-nut cam is also drilled and reamed in the jig shown in Figs. 2 and 3, and in fact both the apron and back plate are machined complete without being removed.

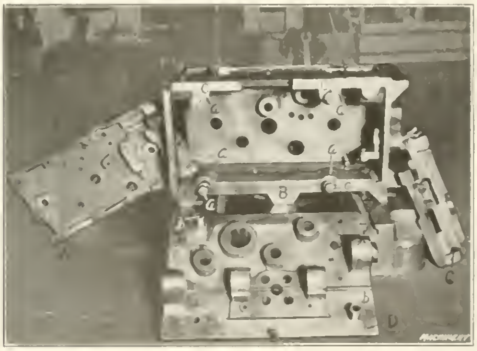

Fig. 3. Closer View of Apron Jig shown in Fig. 2, with Work Removed

A Counterboring Tool

The tool used in counterboring the holes for the friction cross-feed and lateral-feed shafts is worthy of special mention. This tool is shown at *E* in the spindle of the machine in Fig. 2, and in detail in Fig. 4. It consists principally of a shank *A*, which is threaded for the reception of the counterbore *B*, and two locking collars *C*. The shank is made from low-grade tool steel and is left soft, and a hardened and ground bushing *D*, which is held in place by a screw and washer, as shown, acts as a pilot. The body of the holder is made a good running fit in the cast-iron bushing *E*, and is separated from the locking washers by a feeler *F*, which is ⅛ inch thick.

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In use, the shank of this tool fits in a quick-removing socket in the spindle of the radial drilling machine, and as the spindle of the machine is brought down, the bushing is made to enter the desired hole in the jig, being prevented from rotating by the pin *G*. The locking washers *C* are adjusted so that when the counterbore has penetrated to the proper distance in the work, they come in contact with the feeler *F*, which of course is resting on top of the bushing *D*. This makes it practically impossible for the counterbore to penetrate beyond the proper depth, and provides a quick and accurate means of determining when the correct depth is reached. With the aid of this feeler it is a simple matter to counterbore a hole to within 0.0005 inch of the depth required, the feeler being practically as sensitive as an ordinary micrometer.

Cast-iron Jig Bushings

All the slip or removable jig bushings used by Greaves, Klusman & Co. in the manufacture of their engine lathes are made from a good grade of gray cast iron, in preference to tool or machine steel. It is claimed that the cast-iron bushing gives satisfactory results, and, what is still more important to the manufacturer, its first cost is considerably less than that of a tool-steel bushing. Drill bushings made from either machine or tool steel have to be hardened, not only to prolong their life, but to prevent the drill or tool used from seizing in them. The hardening of the bushing distorts it to a greater or less extent, thus making it necessary to grind it inside and out (especially when of the "slip" type) and where additional refinement is desired the hole in the bushing is sometimes lapped.

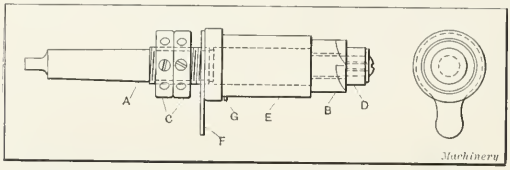

Fig. 4. Counterboring Tool designed for boring to Correct Depth

Contrast with this the cost of making a cast-iron bushing. This can be completed in less than one-fifth the time, and the material not only costs much less but it is also more easily worked. The bushings need not be hardened, and in fact can be practically completed in the lathe. When a good smooth surface is desired, this can be easily and quickly obtained by lapping, although a reamed hole is good enough for all practical purposes. Another point which adds greatly to the decreased cost incident to the use of cast-iron bushings is the fact that the tool shanks can be made from a low grade of tool steel and need not be hardened or ground. This is impossible with a hardened tool-steel bushing, especially if the tool is used for working cast iron and is operated at a high speed without being properly lubricated and well taken care of.

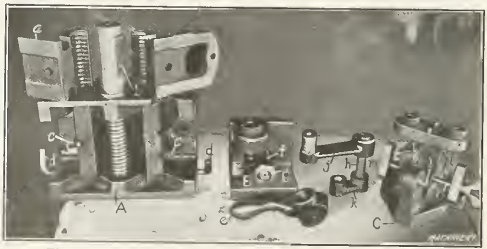

Fig. 5. Group of Jigs used for drilling Lathe Apron Parts

It is a well-known fact that a soft steel shaft running in a cast-iron bushing makes an excellent bearing for normal periphery velocities, so that as far as a bearing is concerned, the cast-iron bushing fills all requirements. By making the tool shank from low-grade tool steel and the cutting portions from inserted pieces of high-speed steel, a very cheap tool of maximum cutting capacity and long life will be produced. It is also possible to renew it when worn below size at a very small cost. To provide means for lubricating the tool shanks when working in the cast-iron bushing, the shanks of all tools are made with spiral oil grooves, as is clearly indicated in Figs. 1 and 2.

A tool-steel jig bushing, properly hardened and ground, will last for years, but this is of little or no advantage to a manufacturer who is continually on the lookout for improvements, which of course necessitates making new jigs and fixtures to handle the improved parts. The jigs in many cases can be used again by making slight additions or alterations, but this is not generally the case with the bushings, which must be annealed, machined, hardened and ground if it is desired to use them again. The cost of doing this hardly warrants using the old bushings; consequently, they either go into the scrap heap or are relegated to the store of out-of-date equipment. This is not the case with cast-iron bushings, as it is a simple matter, in many cases, to work them in at a very little expense. Another point which has not been mentioned is the fact that if proper care is exercised a cast-iron bushing will usually last as long as the particular model of the machine on which it is used. Consequently it also fills the bill in this respect. The writer was shown cast-iron bushings which have been in use for over a year that were practically as good as when they were first made—and just as accurate as to size.

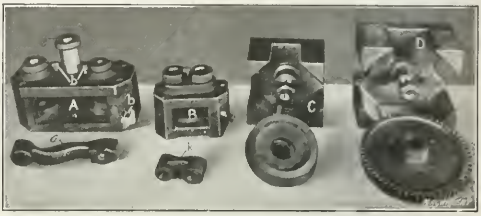

Fig. 6. Another Group of Jigs for Apron Parts

Drill Jigs for Machining Apron Parts

Some of the principal jigs used in machining a few of the apron parts are shown in Figs. 5 and 6. At *A* in Fig. 5 is shown the jig used for drilling the cam pin holes in the half-nut *a*. The jig consists primarily of a cast-iron box into which is fitted a plug gage *b* which has the same pitch and shape of thread that is cut on the lead-screw of the lathe. The two parts *a* of the half-nuts are located sideways in the jig by a machined groove, and are held tight up against the plug gage *b* and the machined base of the jig by set-screws *c*; these are held in swinging straps, which are retained in place by the bent pins *d*. By locating the half-nut in this manner when drilling, it is possible to get the holes in the proper position with respect to the center of the lead-screw and the grooves in the cam which is used for opening and closing the half-nut.

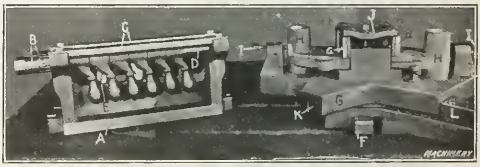

Fig. 7. Two Types of Milling Fixtures for Apron Parts

At *B* in Fig. 5 is shown the jig for drilling the clamp screw hole in the lever *e*, which is used for operating the half-nut opening and closing cam. The lever *e* is located from the hole on the stud *f* of the jig, and is clamped by a quick-removing nut *g*. This nut has only one full thread and the hole is filed oblong in shape on both sides, removing the thread entirely from opposite sides of the hole. This gives the nut a sort of cam action, making it possible to either loosen or tighten it by giving it about ¾ or a full turn, without reducing its effectiveness as a clamping device.

The type of jig used for drilling the half-nut locking link is shown at *A* in Fig. 6. This consists of a cast-iron box having two bosses cast integral, which are machined and act as locating points for the link *a*. The work is located endwise from the boss, and is held in place by the three screws *b*, two of these holding the work down on the machined bosses in the jig. A 5/16-inch hole is drilled completely through the small end of the link, whereas the other end is drilled and reamed with a 19/32-inch drill and ⅝-inch reamer, respectively—two slip bushings *c* being used.

At *C* in Fig. 5 is shown the jig used for locating and drilling the pin holes in the link and handle for the apron feed reverse. The stud *h* is first placed in the hole *i* of the jig, then the handle *j* and link *k* are put on the stud, being located in the proper relative positions by pins *l*, against which the bosses of the handle and link rest. The three members are held rigidly in position while the pin holes are being drilled, by the heel clamps *m*, which are drawn together by the wing nut *n*, working on the screw *o*. The jig used for drilling the double bevel pinion shifting link *k*, Fig. 6, is shown at *B*, and as will be seen is similar in design to the one shown at *A* in the same illustration.

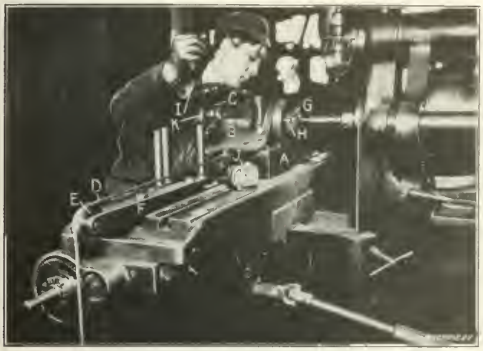

Fig. 8. Fixture for milling Half-nut Operating Cam Grooves

All the gears used in the aprons of Greaves-Klusman engine lathes are made from steel forgings, and in order to have the friction gear work efficiently it is necessary to furnish it with a cast-iron boss. This is accomplished by making the friction from a separate disk of cast iron, and then fastening this to the drop-forged friction gear by four ⅜-inch cap-screws. The type of drill jigs used for this purpose are shown at *C* and *D*, respectively, in Fig. 6. The jigs are of plain open construction, furnished with studs by which the work is located and held, quick-acting nuts of the type shown at *g* in Fig. 5, being used for clamping. The three bushing holes are laid out in each jig so that the parts drilled in them are interchangeable.

Milling Fixtures for Apron Parts

A gang type of milling fixture which is used for splitting twelve lead-screw half-nut operating handles, is shown to the left in Fig. 7. One of the handles which has been split in this fixture is more clearly shown at *e* in Fig. 5. The fixture *A* is made from an iron casting having two uprights which carry the arbors *B* that hold the work, and also the guide strips *C* for the slitting saws. The two arbors which are made to fit the hole in the handles are screwed into the bracket or upright at the right, and to provide for the curve of the handles, washers *D* are placed between the last handle and the bracket. The handles are located in the proper position for slitting by a web *E* against which the turned portions of the handles bear. In use, this fixture is held in the ordinary way on the table of the milling machine, and two slitting cutters are held on the cutter arbor, so that both rows of handles are completed at the same time. The guides *C* afford means of setting the slitting saws quickly in the proper positions.

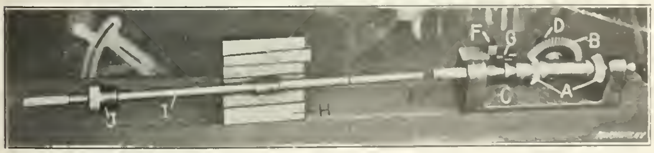

Fig. 9. Fixture used in testing Alignment of Cross-slide Screw and Gage for testing Apron Shifter Gears

To the right of the illustration Fig. 7 is shown another milling fixture which differs considerably from that just described. This fixture is used for milling feed gear driving shaft brackets, and is built to hold two castings at a time. It consists principally of two castings *F* and *G*, the former being held to the milling machine table in the usual manner, while the top casting is pinned by a stud to the base *F*, but is free to be swung around when the spring-operated locating plunger, held in box *L*, is withdrawn. The brackets *H* which are to be milled on the faces *a* and *b* are held on machined seats provided on the center portion of the top member of the fixture, and are also located from the bosses as indicated. The castings are held up against the machined seats of the fixture by set-screws *I*, and are clamped by a bridge strap *J*. As the faces to be machined are located at right angles to each other, the fixture is provided with locating slots *K* (one of which is shown) so that the top member can be swung around through 180 degrees. The machining is done by two straddle milling cutters, held the correct distance apart by spacing washers.

The type of fixture used for milling the two grooves in the half-nut cams, is shown in place on the milling machine table in Fig. 8. This consists of a cast-iron base *A*, held to the milling machine table, in which the casting *B* carrying the rotating head slides. The movement of the casting *B* is controlled by a cam on the rotating head *C*, which is kept in contact with a roller by the wire rope *D* and a suspended weight. In order to make the movement of the head as sensitive as possible to the action of the cam, and also to lift the rope from the table, the wire rope is made to run over a roller *E* held in the bracket *F*, which is bolted to the table.

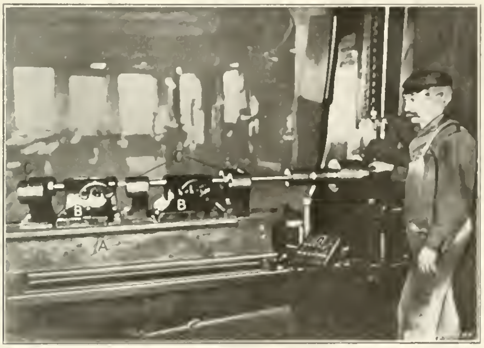

Fig. 10. Boring Tailstock Spindle Holes in a Horizontal Boring Machine

The work *G* is held in a draw-in collet and is located in the proper position by a pin *H* in the front plate of the head. A stop is held on the milling machine table, so that the work can be brought into the proper relation with the end milling cutter, and there is also a stop provided to govern the distance that the cutter penetrates into the work. The head is rotated by the operator by means of the handle *I*, which operates a worm meshing with a worm-wheel held on the rotating head. After the first cam groove is cut, the table of the milling machine is withdrawn from the cutter, and the head indexed ½ turn (180 degrees) thus bringing the work into position for milling the second groove. Stops on the rotating head locate it in the two positions for cutting the grooves. One of these finished cams is shown at *J* lying on the table.

Gage for Apron Shifter Gears

To the right of Fig. 9 is shown a fixture which is used in testing the running contact between the double bevel pinions *A* and the bevel gear *B*. The fixture *C* consists of a casting provided with three vertical bosses. The rear boss *D* contains a stud on which the bevel gear *B* is held, whereas the two end bosses are drilled and reamed for the reception of the stud *E* on which the double pinion sleeve is held, the two pinions being made integral with the sleeve. The left-hand boss is extended around to the rear of the fixture, and is slotted to fit the two gage blocks *F* and *G*, which fit into the groove in the double pinion sleeve when the latter is shifted along the stud to bring the two pinions alternately in mesh with the bevel gear. By this means it is possible to test the running contact of the bevel pinions with the gear and in this way insure interchangeability of product. It might be mentioned here that masters of both gears and bevel pinions are provided, so that as the teeth in the bevel pinions or gear are cut, they can be tested with the masters.

Fixture for Testing Alignment of Carriage Cross-feed Screw

Another testing fixture which greatly assists in obtaining interchangeable lathe parts is that for the carriage cross-feed screw shown to the left in Fig. 9. This comprises a casting *H*, which is made to fit the dovetail projection on the top of the carriage; it is furnished with an adjustable gib and carries a rod *I* of the same diameter as the cross-feed screw. Rod *I* carries on its outer end a nut *J*, which, when the fixture is put in position, takes the place of the cross-feed screw nut. The other end of the rod is used as an indicator for determining the correct alignment of the cross-feed screw bearings. This fixture is also used for testing the alignment of the sliding block of the taper turning attachment with the cross-slide.

Fixture for Boring Tailstocks

In boring the hole in the tailstock for the spindle, two castings are held at one time on a 6-foot lathe bed, as indicated in Fig. 10. The lathe bed *A* is clamped to the bed of a Fosdick floor-type horizontal boring machine, and the tailstocks *B* are held in the same manner as when in place on the completed lathe. Three steel bushed bearings *C* are provided for guiding the boring bar. Three cuts are taken—two roughing and one finishing—the cutters all being of the correct diameter and held in place by cone-head screws. This same fixture is used for boring out the head, the center bracket being removed for this purpose, and only one casting is machined at a time.

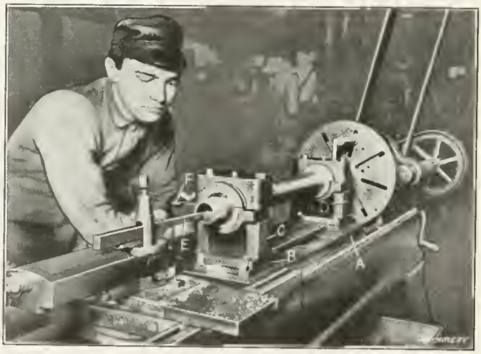

Fig. 11. Boring the Taper Hole in the Nose of the Lathe Spindle

Boring Taper Hole in Nose of Spindle

The fixture used for boring the taper hole in the nose of the lathe spindle is shown in Fig. 11, and as can be seen is used on a regular engine lathe. It consists of a bottom plate *A* which rests on the vees of the lathe, and a top adjustable member *B* to which the two brackets *C* and *D* are held. The lathe spindle to be bored is held in babbitted bearings by caps which have to be removed to insert the spindle. The top part of the fixture is set to the correct taper angle, allowing the boring tool to travel in a straight path parallel with the axis of the lathe centers. The boring tool *E* is held in the tool-post of the tool-slide, and its cutting edge is set to the correct height—directly on the center—by a hardened tool setting block *F*, which is held on a projecting arm of the front bracket. The hole is bored almost to the exact size, only sufficient stock being left to take a light finishing cut with a taper reamer. The work is rotated by a stud, held in the faceplate of the lathe, which comes in contact with a pin attached to the lathe spindle being bored.

STEEL WORKS AND ROLLING MILLS, 1909

Statistics for the steel works and rolling mill industry in the United States for 1909 are presented in detail in a bulletin issued by the Bureau of the Census, Department of Commerce.

Steel works and rolling mills constitute one of the largest industries in the country, the total value of products for 1909 being $985,722,534. The number of establishments was 446, and the number of persons engaged in the industry was 260,762 of whom 240,076 were wage earners, the amount paid in wages being $163,200,758.

The total number of establishments, including forges and bloomeries has not varied greatly, the increase for the forty years since 1869 being only 5.7 per cent. In the case of value of products, however, the amount for 1909 was over seven times that for 1869 and the average value of products per establishment shows a progressive increase with each census —from $325,991 in 1869 to $2,210,140 in 1909. The rate of increase in value of products for the successive decades has been quite uniform, ranging from a minimum increase of 50.6 per cent for the decade 1869-1879 to a maximum of 79.3 per cent from 1889 to 1899. The increase in value of products from 1899 to 1909 is perhaps partly attributable to advance in prices.

The steel-works and rolling-mill industry is concentrated largely in the Middle Atlantic and East North Central states, and in the Panhandle of West Virginia. Of the 446 establishments in 1909, 362, or 81.2 per cent, were located in seven contiguous states—New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, and Illinois. The value of products in these seven states amounted to $897,365,567, or 91 per cent of the total for the United States.

The steel-works and rolling-mill industry comprises three classes of establishments: (1) Those equipped both with furnaces for making steel and with hot rolls for rolling it; (2) those equipped with steel furnaces but not with hot rolls; and (3) those equipped with hot rolls but not with steel furnaces. Most of the largest establishments belong to the first group. All steel plants operated in conjunction with blast furnaces are equipped also with rolling departments. On the other hand, no establishments of the second group have blast furnaces, but all buy pig iron and scrap for steel making. Establishments of the third group include those purchasing their material in the form of ingots, blooms, slabs, or other shapes, pig iron for puddling furnaces, and also the few independent bloomeries.

In the country as a whole combined steel works and rolling mills produced 61.6 per cent of the aggregate value of products in 1909; steel works without rolling mills, only 4.7 per cent; and rolling mills without steel works, 33.8 per cent. These percentages, however, give a somewhat exaggerated idea of the importance of the latter class of mills, because the value of their product consists in considerable part of the value of the crude steel purchased by them from plants of the first two groups. Pennsylvania in 1909 contributed over half (50.7 per cent) of the total value of products; Ohio, about one-fifth (20.1 per cent); Illinois, 8.8 per cent; New York, 4 per cent; and Indiana, 3.9 per cent.

The average number of persons engaged in the industry in 1909 was 260,762, of whom 240,076, or 92.1 per cent, were wage earners; 4286, or 1.6 per cent, proprietors and officials; and 16,400, or 6.3 per cent, clerks. Individual proprietors and firm members were few in number, the industry being mainly controlled by corporations. Of the total number of wage earners in 1909, 34.2 per cent were in establishments where the prevailing hours were 60 per week, or 10 hours a day for six days in the week, while 34.4 per cent were in establishments where the prevailing hours were over 60 per week, and 21.8 per cent where they were 72 per week and over. The eight-hour day is not found to any large extent, only 9.3 per cent of the wage earners being employed in establishments where the prevailing hours were less than 54 per week. The proportion in establishments in which the prevailing hours of labor were 72 or more per week was especially high in Illinois, Wisconsin, and Indiana.

The tendency toward concentration in large establishments is very marked in the steel industry. There is no other industry in which so many plants of great size are found. In 1909, 41.7 per cent of the establishments reported products valued at $1,000,000 or more each, as compared with 31.6 per cent in 1904. This group of establishments in 1909 included 23, and in 1904, 15 with products in excess of $10,000,000 in value. The value of the output of the establishments with products valued at $1,000,000 or over formed 91 per cent of the total for all establishments in 1909, as compared with 84.6 per cent in 1904, and that of the establishments with products valued at $10,000,000 or over constituted 43.2 per cent of the total in 1909, as compared with 36.6 per cent in 1904.

In the distribution of the 19,276,237 tons of finished rolled products and forgings made by steel works and rolling mills in 1909 among the principal producing states, Pennsylvania produced 51.4 per cent of the total output of these products in 1909, as compared with 54.3 per cent in 1904. Ohio increased its proportion of the output from 13 per cent in the earlier to 16.1 per cent in the later year. Indiana and Illinois showed higher percentages of the total output in 1909 than in 1904; but those of New York and West Virginia were about the same.

There has been during each decade a marked increase both in the absolute and relative amount of open-hearth steel produced. Basic open-hearth steel constituted 1.3 per cent of the total steel production in 1889, as against 56.2 per cent in 1909. Bessemer steel, on the other hand, although the output increased 153.8 per cent during this period, constituted only 39 per cent of the total production in 1909, as compared with 86.6 per cent in 1889.

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BROACHING A LONG KEYWAY

The J. N. Lapointe Co., New London, Conn., recently fitted out one of its broaching machines for cutting a 1-inch keyway in a cast-iron sleeve 40 inches long. The hole in the sleeve is 6 inches diameter and as the sleeve was not chambered, the keyway had to be cut in solid metal the full length. The principal difficulty in broaching such long work is to provide for discharge of the chips. The accumulation of chips in such long cuts is greater than can be taken care of in the spaces between the teeth when the broach is made in the customary manner. It was necessary to make the cutter bar with staggered teeth or in other words with teeth having a shearing cut. This arrangement of the teeth diverts the chips to the sides, and two recesses were provided on both sides of the cutter bar in the work bushing to receive the chips.

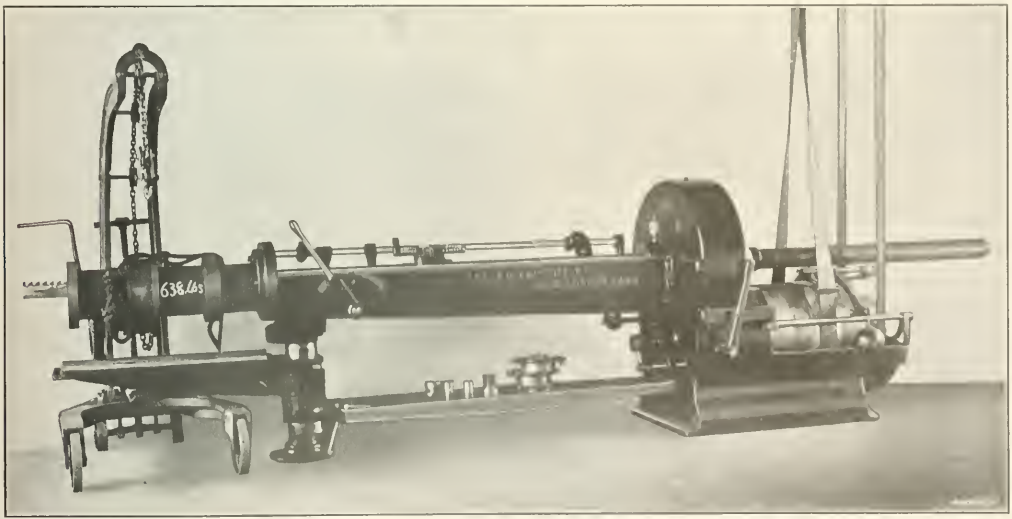

Fig. 1. J. N. Lapointe Co.'s Broaching Machine broaching 1-inch Keyway, 40 inches long, in Three Cuts in Ten Minutes

The weight of the sleeve shown in Figs. 1 and 2 is 638 pounds. It was necessary to handle it by means of the portable shop crane shown. The crane suspended the work and held it in place during the operation, one end of the piece being slipped onto the work bushing which is bolted to the nose of the machine.

The cutter bar does its work in three operations, that is three passes of the cutter through the work cuts the keyway to full depth. A blocking key is provided for raising the cutter bar one-third the depth of the keyway after each cut. The cutter bar is so arranged that it does not require adjustment or raising for each operation; provision is made in the pull bushing connecting with the bar so that it slides up and down at each operation, thus enabling the work to be done rapidly and conveniently. This fact is indicated by the time required for cutting the keyway to the full depth, the time being ten minutes to set the work on the machine, cut the keyway and remove the work. The time required by the manufacturer ordering the equipment who had been cutting keyways in similar pieces on a planer, was two and one-half to three hours, and the alignment of the planed keyways was defective as compared with that obtained by broaching.

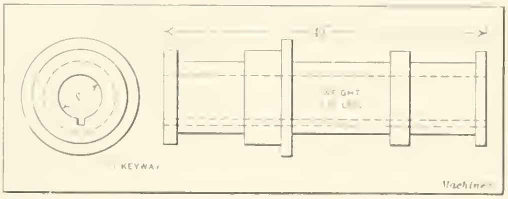

Fig. 2. Work Piece weighing 638 Pounds containing 1-inch Keyway in 6-inch Hole 40 inches long

* * *

ADVERTISING IN STREET CARS

An effective method of utilizing advertising space is being employed to some extent in street cars, the principle being to keep the advertising cards in motion. Instead of being mounted in stationary racks as is usual, the cards on each side of the car are mounted on an endless belt. This belt is traversed by a small motor at the rate of about six feet per minute. Thus about twice as many advertising cards can be shown as when displayed in the usual way. Besides showing a greater amount of advertising matter, the scheme has the additional advantage, which is probably of still greater importance, of keeping the advertisements in motion and thus attracting far greater attention than if they were held stationary.

* * *

Amber-mica fuses at a temperature of about 2500 degrees F. However, mica will fuse readily at any temperature above 1450 degrees F., if certain elements of which mica is composed are in contact with it at this temperature. Such elements are silica, alumina, felspar, etc.

THE MACHINING OF ALUMINUM AND WHITE METALS

BY KURT DEINHARDT*

Some time ago, a manufacturer complained that great difficulty was met with in the working of various white metals, and that there was nothing in the mechanical literature on this subject. The following article, therefore, has been prepared in order to give the most important points on the subject, based on experiments during past years. Besides the well-known bearing metals, there is a long series of white metals which, according to the main constituents, may be considered as aluminum, tin, lead or zinc alloys.

Without considering punched or pressed articles which are not worked upon with cutting tools, there are numerous objects which previously were made from brass or bronze, but which are now, on account of the improved appearance, the reduction in weight, or other properties, made from aluminum alloys or other white metals. Aluminum not alloyed with other metals is also used for a great many machine parts and devices. Commercially pure cast aluminum has a tensile strength of about 14,000 pounds per square inch, which is too low for many purposes. In order to increase the strength, aluminum is, therefore, alloyed with other metals. So-called aluminum-bronze is an alloy of copper with from 5 to 11 per cent aluminum, which increases the tensile strength of the copper from 28,000 pounds per square inch to from 85,000 to 110,000 pounds per square inch. Aluminum-bronze is light yellow and not as heavy as ordinary bronze. It shrinks in casting about twice as much as bronze containing tin. The casting is, therefore, often porous, and the increased strength rather imaginary. The casting of aluminum-bronze is a difficult matter and requires especial skill in order to insure success. Alloys containing aluminum as a base and a small addition of other metals are, therefore, of greater value. The alloy with magnesium—magnalium— is especially well-known. Magnalium containing from 3 to 10 per cent magnesium has two and a half times the tensile strength of aluminum and is at the same time lighter; it is therefore especially useful in the building of aerial craft. The addition of magnesium makes the metal firm and less tough, so that it can be more easily worked with cutting tools. If the magnesium content is too great, the metal becomes too brittle and is useless.

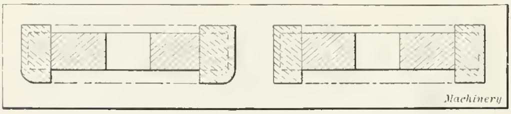

Fig. 1. Rounded Corners are objectionable in Cutters for Aluminum
Fig. 2. The Sharp-cornered Cutter gives Best Results

The main difficulty met with in the working of aluminum and aluminum alloys is the carrying off of the chips. These become so firmly imbedded between the teeth of milling cutters, counterbores and similar tools that they cannot be removed with a brush. The only way in which to avoid this difficulty is to use the right kind of cutting lubricant. Oil cannot be used, but soapy water gives good results, although not a shiny surface. The best cutting lubricant is kerosene, which gives a mirror finish to the work when the cutting tool is properly ground. The cutting edges of the tools must have sharp corners. Rounded corners, as shown in Fig. 1, are objectionable, and all milling should be done by cutters shaped as in Fig. 2.

For milling flat surfaces, it is preferable to use end mills rather than cylindrical cutters. The mills will cut best if a high cutting speed is used with a moderate feed. The depth and width of the cut is of less importance. A cutting speed of 325 feet per minute can be considered as practicable and from 2½ to 4 cubic inches of metal may be removed per minute, in aluminum.

Rolled Britannia metal is composed of from 90 to 93 per cent of tin, from 4 to 8 per cent of antimony, and from 1 to 2.5 per cent of copper. Cast Britannia metal consists of 80 to 85 per cent of tin, 9 to 17 per cent of antimony, 1 to 3 per cent of copper, and from 0 to 3 per cent of zinc. Cast Britannia metal is less tough than the rolled metal, and is more easily worked by cutting tools. Cast metal can be worked without a cutting lubricant, which is not possible with the rolled metal. With the same cutting speed as is used for aluminum, from 1.25 to 1.5 cubic inch of metal may be removed per minute. The adding of antimony makes this metal more brittle, but also more easy to machine.

The Prussian State Railways use the following composition for white-metal bearings: Tin 83 per cent; antimony, 11 per cent; copper, 6 per cent. The Austrian Northwest Railway uses: Tin, 82 per cent; antimony, 12 per cent; copper, 6 per cent. Several English railways use from 73 to 77 per cent of tin; from 15 to 19 per cent of antimony, and from 7 to 9 per cent of copper.

The lead alloys are similar to the tin alloys with regard to their machining. The addition of antimony makes the metal less tough and, therefore, more easy to work. Stuffing-boxes for locomotive cylinders are made of an alloy consisting of 80 per cent of lead, 8 per cent of antimony, and 12 per cent tin. Pure lead is very difficult to work, and a very small feed should be used. The width of the cut can be of fair proportions, so that from 1.75 to 2 cubic inches of metal may be removed per minute.

Zinc is most commonly used for cast objects which are to be plated with copper or nickel. Zinc is also used in bearing metals because it is cheaper than tin and stands wear better than lead. This bearing metal is composed of from 60 to 80 per cent of zinc, from 10 to 35 per cent of tin, 5 per cent of copper, and a small percentage of antimony. Zinc alloys can be easily machined dry. They have the disadvantage that the castings are somewhat porous, which causes trouble in the plating.

It may be generally remarked that it is impossible, when working white metals, to take full advantage of the efficiency of the modern machines or cutting tools, and that an increase of the antimony or magnesium content makes an alloy of the metals mentioned more easily machined.

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* * *

CHAIN DRIVE FOR MACHINE TOOLS

Tests were recently carried out by Messrs. Hans Renold, Ltd., of Manchester, England, to determine the value of chain drive on gear cutting machines, and reported in *Engineering*. Two No. 6 Brown & Sharpe automatic gear cutting machines, one driven by belting and the other by a Renold high-speed chain, were used. The belted machine was arranged exactly as supplied by the makers and the other machine was altered to permit the use of chain drive. Both machines were employed in cutting silent chain sprockets of 1¾ inch pitch, the cutting speed being 75 feet per minute. The results were as follows: It was found that with the belt-driven machine, the maximum feed practicable was 3¼ inches per minute, while with the chain-driven machine, the maximum feed could be raised to 5¼ inches per minute. The weight removed per minute was 1.66 pound in the case of the belt-driven machine and 2.68 pounds in the case of the chain-driven gear cutter. This increase of 60 per cent in output involved an increase of only 10 per cent in the power necessary for the chain-driven machine. In a second series of tests, both machines were run to give the same output; the feed of the belt-driven machine being 3¼ inches per minute, while that of the chain-driven was reduced to the same figure. In this case the chain-driven machine required 7.1 horsepower, while the belt-driven machine required 8.3 horsepower. Mr. Renold further claims that he has found by experience that the milling cutters will last longer and require less frequent grindings when the belt drive is replaced by a silent chain, this being due, no doubt, to the fact that the vibrations due to the slipping of the belt are minimized by the use of the chain.

* * *

On December 31, 1912, the records of the International Aeronautical Federation showed that there were 966 certified aviators in France, 376 in Great Britain, 335 in Germany and 193 in the United States. There were also 23 certified airship pilots in Germany, 22 in France, 11 in Great Britain and 3 in the United States.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A MOLDING DIE FOR FIBER INSULATIONS

The punch and die illustrated in Fig. 1 is used to form the knurled thumb-nuts or "binding post caps," as they are familiarly called, which are used to connect wires to electrical apparatus. Fig. 2 shows the two blanks used for this purpose and the finished nut. Referring to this illustration, *A* is a metal core which is threaded on the inside to screw onto the binding post. *B* is a section cut from a fiber tube, which is molded over the metal core by the action of the punch and die, the finished product being shown at *C* in the illustration. The metal core is provided to prevent the screw from wearing, while the fiber shell protects the operator from electrical shock. The fiber shell is corrugated on the outside and pressed onto the inner metal shell at one stroke of the punch press.

The molding die consists of a body which forms the main part of the mold, a steel plate which is corrugated to produce the corrugations on the nut, and a punch which is corrugated in such a way that it fits into the plate. The body of the die is fitted with a stripper, which also constitutes the bottom of the mold, and the punch has a spring pilot pin that locates the work in the die.

The blanks are produced as follows: The steel core is made on a screw machine where it is tapped, knurled on the outside and cut off to the proper length. The fiber insulation is bought in the form of tubes, from which the blanks are cut off to the proper length, making an allowance for compression and shortening, due to the pressure used to force it to "flow." To operate the die, a steel core is placed in the slight recess in the face of the die stripper. A fiber blank is dropped over the core, on which it fits loosely. As the punch descends, the spring pilot brings the steel core into its proper place. The corrugations on the punch enter those on the die, and as the pressure on the fiber increases, it flows or forms itself into the knurling on the steel core, at the same time filling the vertical corrugations on the plate which molds the insulation to the required shape. The fiber also flows over the top of the core until it fills all the space not occupied by the pilot pin. The end of the punch is slightly cupped so as to form a rounding top on the nut. As the punch leaves the die, the stripper forces the nut out ready for the operation to be repeated.

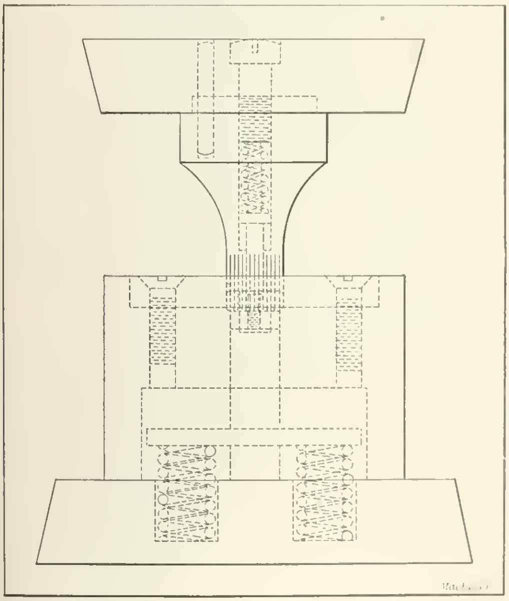


Fig. 1. Punch and Die for molding Fiber Insulations

This die is both simple and efficient. The steel plate which is set into the top of the mold was made in this way so that in case a careless workman should not set the die right in the press, the whole die would not be ruined but only the punch and plate. The corrugations were cut with a broach, the shape of which exactly corresponded to that of the punch. It was necessary to corrugate the punch because the pressure is so great that the fiber would flow upward in each corrugation leaving a thread on each point. This is overcome by filling the corrugations on the punch. This punch press method proves very satisfactory since it is quick, clean and dependable. The former method of molding these nuts from a paste composition is greatly excelled by this process, since perfect work is the general rule, which was an exception in the other case.

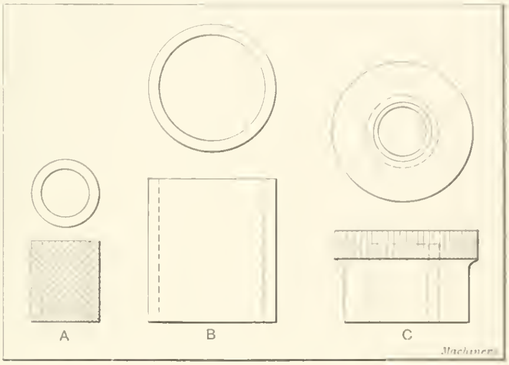


Fig. 2. Blanks and Finished Binding Post made from them in the Molding Die

Beverly, Mass. EVERETT CHIPMAN

SETTING DIAMONDS

In the article by C. L. L. in the July issue of MACHINERY on setting diamonds, it is stated that the use of molten spelter is the usual method of fixing the diamond in place in the end of the rod or tool. Is it? In my contact with grinding operations during ten years past, I have never noticed this to be a particularly common method.

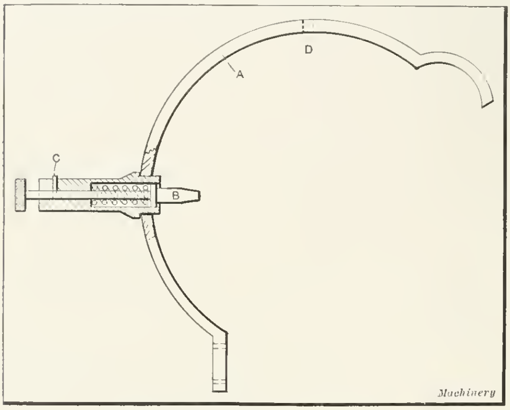
In our shop we use hundreds of diamonds, and also retail many diamond tools. Those that we sell are mounted in soft steel, the metal being peened carefully around the stone. Those that we use ourselves are mounted in copper rods, and we believe this to be the best method, as it is easy to peen the copper around the stone without liability of breaking the stone. The only reason we use the steel instead of copper in filling customers' orders is because they like the looks of the steel better.

The rods in which we mount these diamonds are made of soft machinery steel. We take the diamond and ascertain its approximate diameter at its thickest part by passing it through a drill gage. We then drill a hole in the end of the rod just a little deeper than the length of the stone to be set and of the same diameter as the greatest thickness of the diamond. We then peen the metal carefully around the stone, this being done with the metal cold. The peening is done with a small flat headed chisel or set. If this is done carefully there is no liability of breaking the diamond. When through peening, the diamond is covered entirely by the metal and we then touch the end of the rod slightly to the face of a grinding wheel, removing just enough metal so that but a fraction of the surface of the diamond is exposed.

I can see no necessity of using molten spelter in fixing diamonds in place. GRINDING WHEEL MANUFACTURER

DIVIDING ATTACHMENT FOR A LATHE

The dividing attachment for a lathe shown in the accompanying illustration was designed by the writer for locating quartered keyways in shafting, pulleys, etc. This attachment is screwed into a tapped hole at the front of the gear-guard *A* and the pin *B* enters the space between the gear teeth. A stop-pin *C* limits the amount that pin *B* is forced out, and disengages it when not in use. This stop-pin should not reach the bottom of the slot when the pin is in engagement with the gear, as it is required to have the pin wedged between the teeth to index accurately. A sight hole *D* is drilled at the top of the gear-guard, and in locating quartered work the mechanic turns the lathe by hand, counting the teeth as they pass under the sight hole. The writer uses this attachment on an 80-tooth gear so that he counts 20 teeth in indexing through 90 degrees. This arrangement could be used for indexing any number of spaces that can be evenly divided into the number of teeth on the gear. In cases where the attachment is constantly used for a given operation, it would probably be a good idea to mark the teeth in some way so that the possibility of making a mistake in counting would be eliminated.

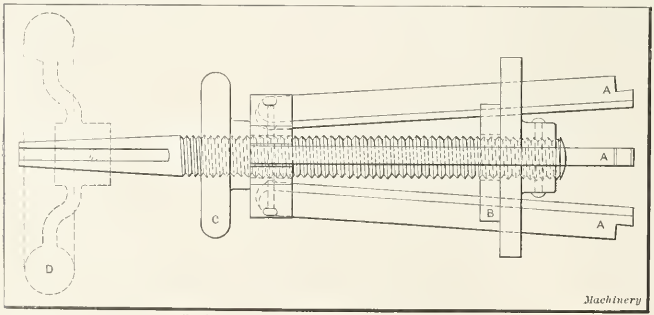


Dividing Attachment for Use on a Lathe

Denver, Col. STANLEY EDWARDS

DEVICE FOR GRINDING HALF BALL JOINTS

The general arrangement of a device for grinding half ball joints is shown in the accompanying illustration. This is a very convenient tool for use in connection with an air motor for grinding hemispherical surfaces, and is particularly adaptable for use in railroad shops. The ends of the arms *A* are made to suit the particular class of work for which the tool is intended and they receive either the grinding element or the piece which is to be ground, as the case may be.



Device used for grinding Half Ball Joints

For the benefit of those who are not familiar with operations of this kind, it may be mentioned that these joints consist of two hemispherical surfaces, one piece being of brass and the other of cast iron. The cast-iron piece is finished to the required shape, and the brass part is roughed out and then finished by rotating it against the cast-iron surface which it is to fit, a grinding mixture of oil and emery being used.

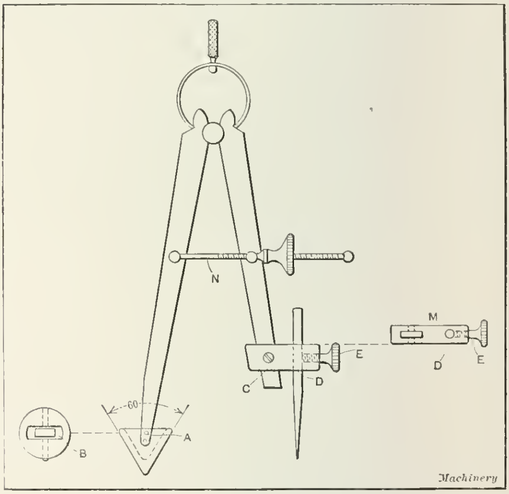
The ends of levers *A* may be used to carry either the grinding element or the part to be ground. The part *B* is used to provide a rapid adjustment of the arms *A*, this adjustment being completed by turning the handwheel *C*, to secure the required grip for the arms. The light dotted lines indicate an ordinary handwheel of the type used on valves. This handwheel provides for operating the tool by hand, but where an air motor is available this wheel may easily be removed and replaced by power drive. The method used in some shops for grinding joints of this kind is exceedingly crude and the application of the present tool affords a means of greatly reducing the cost of production.

LEROY SMITH

Olean, N. Y.

COMPASS FOR MACHINE WORK

Mechanics often wish to locate points, draw circles, etc., after they have drilled 60-degree centers for turning. This cannot be done accurately with an ordinary compass, and as a result the tool shown in the accompanying illustration was designed. About one inch was cut off from the leg of a pair of dividers and the end rounded, after which the hole *A* was drilled. A piece of round steel about ½ inch in diameter was next turned to a 60-degree taper, and a slot *B* cut in the center of this piece to receive the end of the leg without binding. A hole was then drilled through the tapered piece and a small screw used to secure it to the leg of the dividers through the hole *A*.



Pair of Dividers adapted for use as a Compass for Machine Work

A piece of metal *M* about 1¼ inch by ¼ inch by ½ inch in size was then prepared. This piece was slotted ⅛ inch from the end, the slot being cut at an angle of about 15 degrees to receive the leg *C* of the dividers. A transverse hole was then drilled and tapped through this slot, and the block fastened to the dividers by means of a screw shown at *C*. A hole *D*, ⅛ inch in diameter, was next drilled through the opposite end of the block at a distance of about ¼ inch from the end. A hole *E* was drilled in from the end of the block and tapped to receive a set-screw. A piece of pointed steel ⅛ inch in diameter and about 2 inches in length was inserted in the hole *D*. The point can thus be secured in any desired position by means of the set-screw. The other settings of the dividers are obtained in the usual way.

With the aid of this tool, it is possible to draw circles no matter how large the hole is in which the fixed leg is located. If it is desired to use the tool in other than 60-degree holes, a suitable taper center could be made for this purpose. The same tool could also be used on more than one taper by making a set of centers to meet the requirements of all such classes of work.

Storrs, Conn. C. M. Penning

MARKING ECCENTRIC PISTON RINGS

While passing through the factory some time ago, I noticed a mechanic working at his bench on which there was a surface plate with several hundred eccentric piston rings piled up beside it. As I watched him, he picked up a ring, set it carefully up on the plate before him, as shown in Fig. 1, and after trying several times, succeeded in balancing it with the thin side down. He then scribed a line on the ring at the point *A*. Reaching for another ring he repeated the process, and as I was somewhat curious, I asked him what he was doing. He answered that he was marking the thinnest part of the rings so that they could be afterward split at this point.

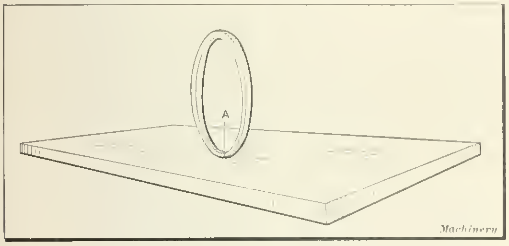


Fig. 1. Old Method of marking Point at which Rings are split

This naturally struck me as a somewhat crude process and upon looking up the man's rate, I found that he was getting 30 cents an hour and that he frequently spent from two to three hours a day (depending upon the ring production) in making these little marks on the rings. Obviously this was an expensive operation.

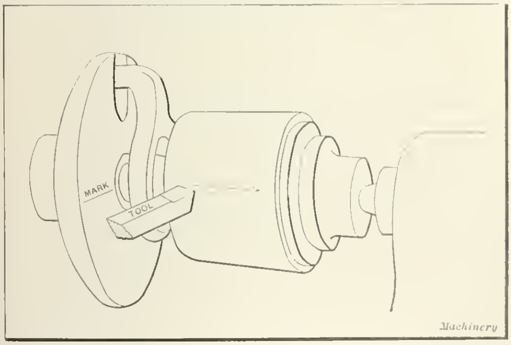


Fig. 2. Improved Method of turning and marking Twenty Rings at One Setting

In order to improve this method I looked up the operation of turning these rings and found that they were put on an arbor with an expanding split bushing (the arbor being eccentric), and turned on an ordinary engine lathe. See Fig. 2. The rings were made in a shell containing material enough for twenty rings, the shell being cut up after it was turned to the required shape. After determining the high point on the eccentric arbor, I made a scratch mark on the faceplate of the lathe at that point. Then, after the rings had been turned and the lathe stopped, and before removing the arbor from the lathe centers, I took hold of the belt and pulled it around by hand until the scratch mark was in line with the cutting edge of the tool. Setting the tool lightly up against the ring shell, I simply ran the carriage along, dragging the tool, and thus marked all the twenty rings at once.

Bridgeport, Conn. Albert A. Dowd

MANUFACTURING COMMUTATOR NUTS ON THE TURRET LATHE

Of the various methods used for the manufacture of shallow nuts of large diameter, the following has been found most economical in labor and material. An example of the nuts under consideration is illustrated at *F* in Fig. 1. These nuts are turned on the periphery, bored, chamfered, threaded to gage, and faced true on one side. They are ordered in lots of fifty pieces. The nuts are manufactured from mild steel of a diameter suitable for the work in hand, the stock being cut from the bar in lengths which are approximately equal to twice the diameter. A No. 3-A Warner & Swasey turret lathe is used and the stock is held in the fifteen-inch scroll chuck. A plan view showing the stock in position, together with chuck, saddle turret and tools, is shown in Fig. 1.

After the stock has been chucked as shown in the illustration, turning tool *B* is revolved into position and the stock reduced to the outside diameter of the required nut by two cuts. These cuts are taken along the stock as far as the chuck jaws will permit. Boring tool *A* is next fed into the stock face, cutting a groove *D* whose external diameter is suitable for reboring to the tapping size, the depth of the groove being made equal to the thickness of the nut plus one-quarter of an inch. This depth is shown at *E*. After boring tool *A* has been withdrawn, the parting tool *C*, which is $\frac{1}{8}$ inch thick, is brought into position and fed into the work to cut off the ring. In a similar manner, boring and cutting off operations are conducted along the stock until the chuck jaws interfere. After the rings are cut off and removed they are piled up ready for the next operation. The stock remaining in the lathe must now be reversed in the chuck, as shown in Fig. 2, the large diameter turned to size, and the rings bored and parted, as in the previous operation. Fig. 2 shows the stock after the first ring has been removed and the second ring cut off. Ring No. 3 may now be cut off by the boring tool, after which the center core of the stock may

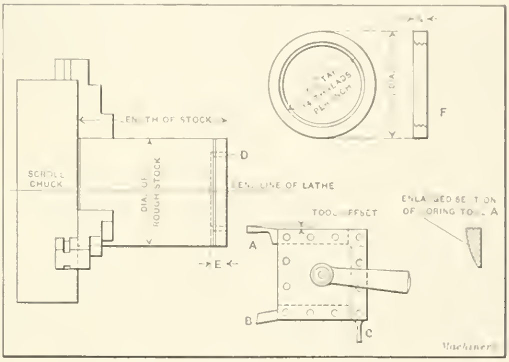


Fig. 1. Tooling of Turret Lathe for machining the Blanks

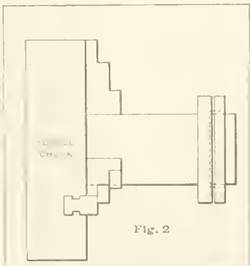


Fig. 2

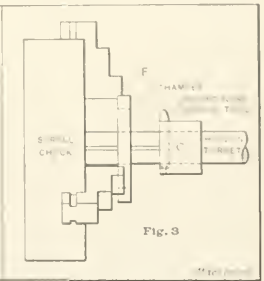


Fig. 3

Fig. 2. Bar reversed in Chuck Fig. 3. Tooling for boring Nut Blanks

be removed. This core will be used for nuts of a smaller outside diameter.

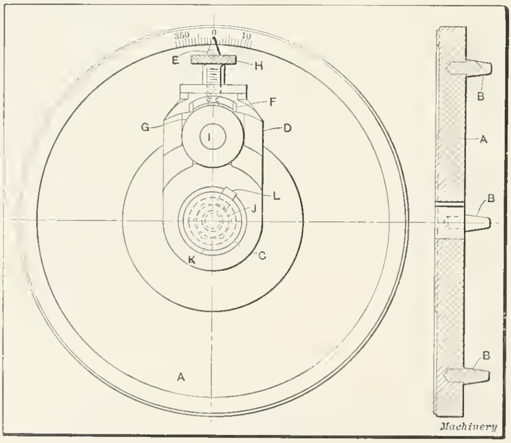
The rings are now ready for boring to the tapping size, facing, chamfering and tapping. These operations are carried out as follows: The ring is held in the chuck jaws, which have been counterbored as shown at *F* in Fig. 3. It is then simultaneously bored, faced, chamfered and filed, this latter operation being necessary in order to remove the sharp burrs from the outer edge of the ring. Boring is performed by the round nosed tool shown in the boring head on the 2-inch arbor which is held in the turret and guided in the lathe mandrel. Facing and chamfering are carried out by tool *B* shown in Fig. 1. The turret is now run back and indexed to bring the collapsible tap into line. This tap (not shown in the illustration) is held in the turret and fed into the work by hand while the work revolves at a slow speed. After the tap is well advanced in its cut, the speed is increased and it runs through the nut at an increased rate. The tap is now collapsed by hand and the tap and turret are run back rapidly. All cutting is carried on under a stream of cutting compound.

By following the above methods, the following advantages are secured. First: there is small expense in preparing the stock, the only machining necessary in this connection being to cut off. Second: forging is entirely eliminated. Third: the cores may be used for smaller nuts, and in this way the waste of material is reduced to a minimum. Finally, the machining operations are simple, rapid and partly simultaneous.

Wilkinsburg, Pa. T. Pilkington

GAGE FOR TESTING OIL ENGINE CAMS

The gage illustrated herewith is used for testing the accuracy of cams used for opening and closing the valves of oil engines. These cams are ground to size after being casehardened, but in order to be certain that they are of the exact form that is required to open and close the valves at the required points, the gage shown in the accompanying illustration was designed. It consists of a plate *A* which is supported by four legs *B*. A stud *C* is held in place at the center of the plate by means of the nut *J* and washer *K*, the stud being prevented from turning by means of a small key. The edge of the plate *A* is graduated from zero to 360 degrees, and as the arm *D* is rotated about the stud *C*, the pointer *E* at the end of this arm swings over the graduated scale. The roller *G* is mounted upon the pin *I* and the latter can be adjusted along the slide *F* by means of the knurled screw *H*. In using the gage, the cam to be tested is mounted upon the stud *C*; the bore of the cam is of such a size that it is a slip-fit on the stud *C* and the cam is held stationary in the position which it would occupy on the cam shaft of the engine by means of the key *L*. The roller *G* is now brought into contact with the face of the cam and as the body *D* is revolved, the pointer *E* swings over the graduated scale and shows the exact position of the points of inlet and exhaust. If there is any error in the location of this point on the cam its exact amount is determined by the scale on the gage. M. W. W.

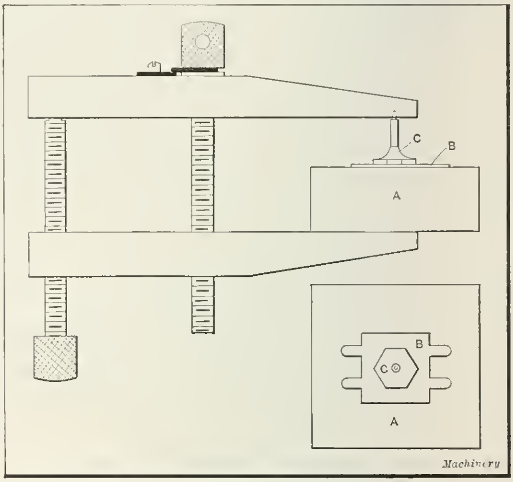


Gage for testing Location of Inlet and Exhaust Points on Oil Engine Cams

ATTACHMENT FOR PARALLEL CLAMPS

An attachment which the writer has found very handy in connection with the use of parallel clamps on die work is shown in the accompanying illustration. Here it will be seen that a die block *A* has a templet *B* secured to it. *C* is the attachment referred to and serves the purpose of providing the required clearance for scribing all the way round the templet. The part *C* is made from a cap-screw which is machined to the shape shown in the illustration and then casehardened. The jaw of the clamp on which the attachment is to be used is annealed and has a hole drilled in it to receive the pointed end of *C* which is 1/64 inch smaller than the hole in the clamp into which it fits. The size of the attachment will, of course, be governed by the class of work for which it is intended.

Detroit, Mich. J. F. Tholl



Parallel Clamp Attachment for laying out Die Work

MAKING SMALL ECCENTRICS IN A LATHE

Most machine shops are called upon to handle jobs requiring eccentric turning in a lathe, and the writer was much interested in reading Mr. Donald A. Hampson's description of a simple and inexpensive method of handling operations of this kind, which will be found satisfactory for small quantities of work. An objectionable feature of the usual methods of handling such operations lies in the fact that it is necessary to go to the expense of building special tools even where quantities as small as 100 pieces are to be produced. It is evident that where very accurate work is required, a method which requires chucking a piece twice will introduce an error considerably greater than would be the case where the better known method of using a movable toolpost operated by an eccentric ring on the spindle nose is used. This is not intended to be a criticism of Mr. Hampson's article, as he made it clear that a limit of tolerance of 0.007 inch was allowed on the work produced by his method.

Some shops only consider the item of first tool cost and make use of the movable cross-slide method. In such shops a supply of rings having eccentricities of the various dimensions which are required are carried in stock. An important advantage of Mr. Hampson's method is the saving which would be effected by being able to use ½-inch stock, whereas, by the cross-slide method it would be necessary to make the piece from stock 13/16 inch in diameter. This additional cost of stock could only be justified in cases where exceptional accuracy is required.

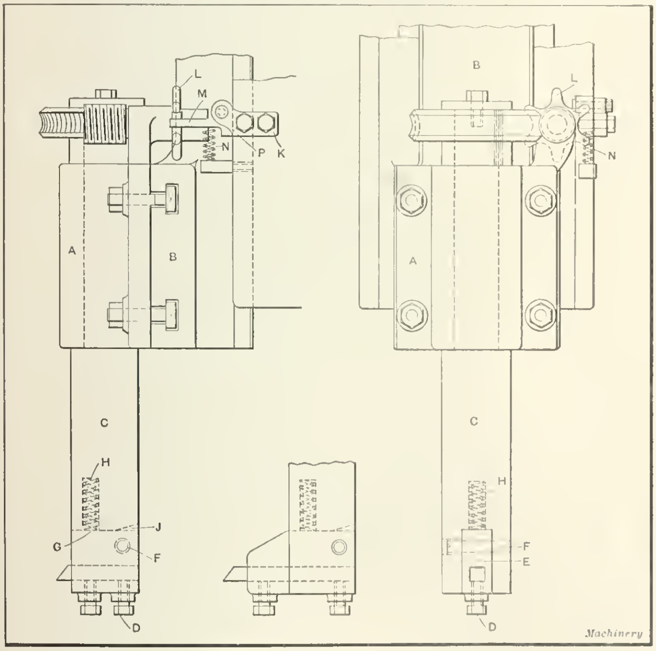
The writer has seen parts of the kind described in Mr. Hampson's article manufactured with fairly good results in a drill press, but, of course, such a method requires two operations and also the expense of building a jig. A variety of such work has been successfully handled in a turret lathe by removing the liner or gib and offsetting the turret carriage the required amount to produce the desired eccentricity. A high-speed drilling attachment was made use of to drive a hollow mill for use in turning the stem while the head of the work was formed by a cross-slide tool. In this case the work was made of brass and the amount of eccentricity was quite small.

Karl Kline

ROTARY TOOL-HOLDER FOR A SLOTTING MACHINE

The illustration shows a simple form of automatic tool-holder which adapts a slotting machine for slotting out circles or parts of circles. This tool-holder will be seen to consist of a bracket *A* which is bolted to the ram *B* of the slotting machine, the bolts used for this purpose being secured in the T-grooves provided for fastening an ordinary tool-holder to the ram. The bar *C* passes through bracket *A* and this bar carries the tool-holder at its lower end. A worm and worm-wheel which transmit the circular movement to the bar are carried at its upper end. The two screws *D* fasten the tool to the tool-holder *E* which has a pin *F* passing through it, screwed into bar *C*. When the ram descends, the tool-holder *E* is pressed against the lower face of the bar at *G* and forces the spring *H* into the hole in the bar. After the working stroke has been completed and the ram starts to ascend, the pressure is released and spring *H* forces the tool-holder to swivel on the pin *F* until it is stopped by the inclined surface *J* at the lower end of the bar. This clears the tool from the work and serves the double purpose of preventing the work from being damaged and increasing the life of the tool.

The tappet catch *M* is fastened to the main casting of the slotting machine. When the ram descends, carrying the tool-holder with it, and just before the cutter starts work, the star-wheel *L* on the end of the worm-shaft engages with the tappet catch *M* and is turned through part of a revolution, thus rotating the tool and cutting out a circle or part of a circle as may be desired. The tappet consists of two pieces, a bracket *K* fastened to the frame of the machine, and the hinged piece *M*. As the ram ascends, the hinged tappet is swiveled out of the way when the star-wheel strikes it, but on the downward stroke, just before the cutting begins, the star-wheel engages the tappet *M*, which has been pulled back into position by the spring *N*. The tappet is now held by contact against the surface *P*, so that the star-wheel is turned and transmits the circular movement to the tool through the worm and worm-wheel.



Tool for slotting Circles or Parts of Circles

The bar shown in the illustration has a tool-holder of the same diameter as bar *C*, and only comparatively small circles can be cut by this tool. A detailed view of the lower end of a bar is shown, however, equipped with a larger sized tool-holder, and with this tool larger sized circles can be slotted. For circles of smaller diameter, smaller sized bars could be used, having the top part of the proper size to fit the bracket *A* and the worm-wheel. If long bars are used to enable the tool-holder to machine deep holes, they could probably be steadied by bracing them from the ram of the machine.

W. R. O.

KNURLED NUTS

The letter on knurled nuts by Mr. Felix Heberlein, published in the April issue of Machinery, reveals a condition in machine building which is of more importance than the first consideration of the subject would lead one to believe. It will be noticed that wherever it is possible to use a standard nut for making adjustments on machines, a hexagon nut is used, but in other places where a special stud or threaded part is made use of, the nut will be knurled instead of being milled to provide for the use of a wrench. This is particularly the case when such a nut is used entirely for purposes of adjustment and is not depended upon for clamping a part in place. The reason for this is that knurling is a much cheaper operation than milling the flats for a wrench. It should be remembered, however, that these knurled parts are not as easily adjusted after the machine has been in use for some time, on account of the tendency for the knurling to become gummed up with dirt and grit. In some cases, a hole is drilled through a knurled nut to provide for the use of a nail or wire to turn it when the fingers are not strong enough for this purpose, and this provision should always be made on the better classes of machinery. Sometimes the adjusting nuts are both milled and knurled so that either a wrench or the fingers can be used to turn them.

In many cases, the designer does not intend a wrench to be used because the parts are tightened too firmly by such a method. On such parts as drill jigs or milling fixtures, the use of a wrench would require too much time for making adjustments. Knurled nuts are hard on the operator's hands and many drill jigs and other tools have the nuts wrapped with tape after they have been in use a short time. For this reason, cast-iron knobs provided with finger holds are superior for use in tool work.

Flange

GIVING THE SHOP MAN A CHANCE

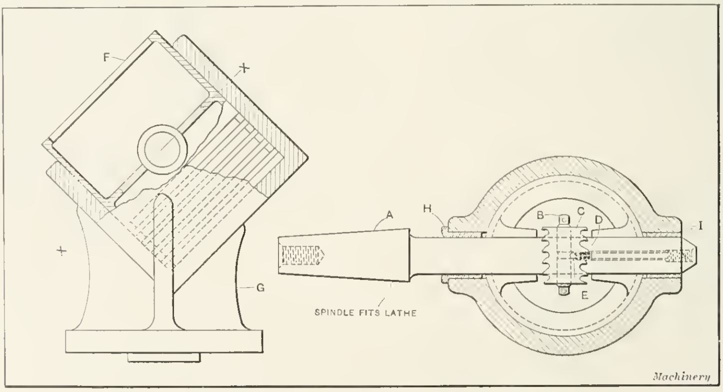
A great many articles have been published in the technical papers dealing with the manual training and trade schools which are maintained in conjunction with manufacturing establishments. Manufacturers' associations have devoted large sums of money for the purpose of educating the future generation of mechanics, foremen, etc., but they seem to have overlooked the possibility of doing something for the present generation. If it is a good investment to devote time and money to training young men to become competent mechanics, why not do something for the present employes of the shops who learned their trade before the technical schools had been placed in operation? Although such men are admitted to free evening trade schools in the larger cities, a man with a family cannot devote four nights a week to attending school. Furthermore, these classes are largely attended by students to whom it is necessary to explain matters with which the older mechanics are thoroughly conversant.

It appears to the writer that one solution of this difficulty would be to establish a small library of technical books in the factory and provide a reading room for the use of all classes of employes. The men could use this room during the noon hour and possibly for an hour after quitting time. It seems that the provision of books and technical magazines in such a room would offer an opportunity for those men who are interested in their trade to keep in touch with up-to-date methods. Such a library could also be used as a reference room by the various departments.

Newark, N. J. George W. Jager

FIXTURE FOR FACING PISTON BEARINGS

The illustration shows a fixture for facing the bearings of automobile pistons. This job is generally handled on a drill press, but the use of the fixture illustrated herewith enables twice as much work to be turned out in a given time by handling this operation on a lathe. The base of the fixture *G* is fitted to the seat of the compound rest and held in place by the rest bolts. A chamber is bored out in the fixture to receive the piston which is about 0.005 inch larger than the piston diameter, so that the work will drop into place easily. The bushings *H* and *I* are ground to the same size as the hole in the piston, and the arbor *A* is 0.002 inch under size. The cutter *C* should be an easy fit on the arbor. This cutter is held by the pin *B* which fits in a hole drilled through the center of the arbor. This hole is a little over size and the pin is held in place by means of the spring *D* and ball *E*.



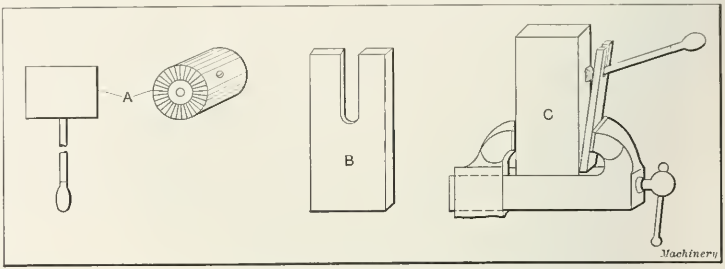
Fixture used for facing Piston Bearings in a Lathe

In using the fixture a stop is placed on the lathe bed at the forward end of the carriage and a second movable stop is placed at the tailstock end. These stops are set to check the feed of the work to the cutter *C* when the two bearings on the piston have been machined the required distance. After these stops have been properly set, it is merely necessary to move the carriage forward and back; by so doing the cutter is brought up against the faces of the two bearings and machines them. The pin which holds the spring *D* and ball *E* against the pin *B* is then drawn back. This allows the pin *B* to drop out and the work can then be withdrawn from the arbor ready to have a fresh casting mounted in the fixture.

Buffalo, N. Y. A. W. Massecar

A CHERRYING OPERATION

In most of the articles describing methods used to produce dies and similar tools, it is assumed that the workman has the proper machines at his command for performing the various operations, as it would obviously be impracticable to consider the equipment of each separate shop. However, an "all around" mechanic should be versatile and ingenious enough to get out a special job at times, even when he has not, as often happens, the proper machine tools at his command.



Tools used in performing an Emergency Cherrying Operation

The following describes a "cherrying" operation on a drop-forging die which the writer recently performed by hand. It was required to sink a number of impressions, half cylindrical in shape, and approximately 15/16 inch in diameter by 1 inch long, into the face of a drop-forging die block. This is a difficult impression to "sink," although it can easily be done by means of a special fixture on a milling machine. In this instance, however, there was no milling machine available, nor was it desired to spend very much money on special tools. A tool-steel cutter *A* was turned to size in a lathe, and the teeth were formed by moving the lathe carriage back and forth by hand. A piece long enough to make several of these cutters can be made in this way, and the cutters can then be cut from the bar to the length desired. The teeth on the ends of the cutters were made with a cold-chisel. A ⅜-inch hole was drilled part way through the middle of the cutter, to provide a place for inserting a handle of drill rod by means of which the cutter is rotated. The cutter was then hardened and drawn to a light straw color.

The piece *B* was then made of ½ by 2-inch tool steel. This was used to press the cutter against the work, the handle projecting through the slot in one end of the piece. After drilling and chipping out the greater part of the stock, the cutter was inserted as shown at *C* and the impression filed by revolving the "circular file" back and forth by means of the handle, the pressure on the cutter being regulated by tightening the vise. While this may seem a rather crude way to those who are fully equipped for this kind of work, it was rapid and efficient and produced the desired result with a very small outlay for equipment.

Henry J. Beck

Troy, Ohio.

BENDING DIES FOR CAR FORGINGS

The following methods are employed in a railroad forge shop for bending certain forgings which are used on passenger and freight cars. Fig. 1 shows an equalizer *A* which is used on passenger cars; it is made from a square billet of steel forged to the shape shown at *B* on a pair of flat dies. The bending is done by means of the pair of dies *C* which weigh about two tons. There are two pairs of bending surfaces, one for each end of the equalizer; the full and dotted lines show the equalizer in position between these bending surfaces. The tapered surface at *D* is for tapering the body of the forging. The flat surface of the die is provided for flattening the equalizer between the blows which are applied in the forming and bending operations. The work is all done under a 4000-pound steam hammer. The bearing surfaces *E* on the equalizer are machined after the forging operation is completed and the equalizer is then ready to be assembled on the car truck.

The forging shown at *A* in Fig. 2 is known as a suspension spring and the tools *B*, *C* and *D* are used for forming it to the required shape. The eye end of this forging is slotted on a punch press and the small hole is then punched at the opposite end. The tools *B* and *C* are used for the two operations involved in forming the eye, these tools being mounted on a bulldozer. The opposite end of the spring is bent to the required form by hand. In performing this operation, the end of the work is placed in the slot and held in position by the pin *P* which fits into the hole that was punched in this end of the stock; the work is then bent to shape around the form *D*. A flattener and small sledge are used to forge the spring to shape around the form.

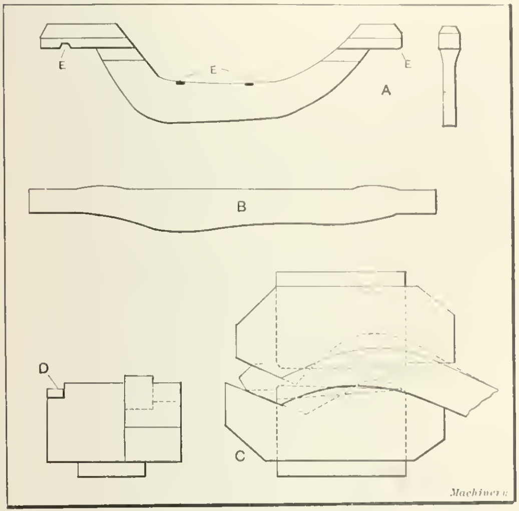


Fig. 1. Equalizer Forging and Bending Die used for forming

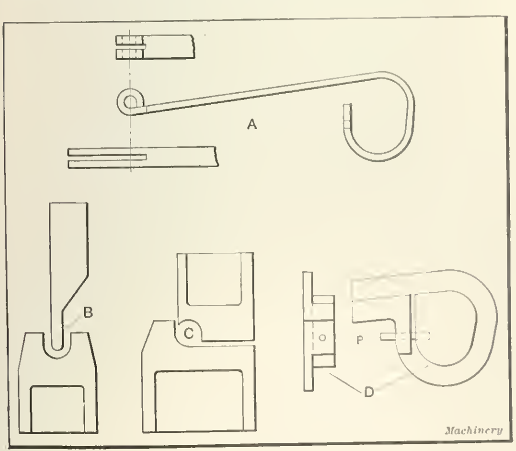


Fig. 2. Suspension Spring and Tools used for bending Ends

Fig. 3 shows a special design of freight car step *A* and the tools *C* and *D* which are used to form these steps on a bulldozer. The holes are first punched in the stock and the two bends *V* are produced by means of the tool *C*; the tool *D* is then used to produce the two bends *W*, a U-fork being placed over the stock and its ends inserted in the hole *H* in order to keep the work from drawing in either direction. The ends of the step are then twisted at *T*, the step being placed edgewise between the two pins on a large faceplate and a U-fork used for twisting the work to the desired shape. A single heat suffices for all of these forming operations.

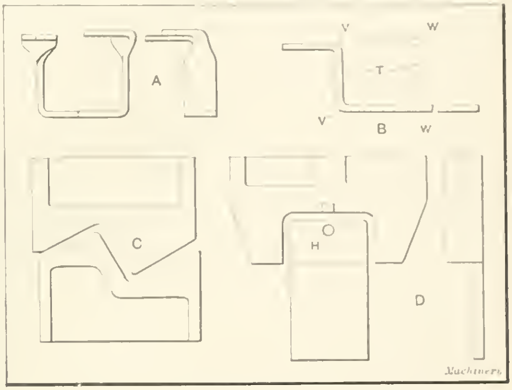


Fig. 3. Freight Car Step and Dies used in forging to Shape

Fig. 4 shows another form of freight car step *A* which is formed by means of the tools *B* and *C*. In making these steps, the ends of the stock are first heated and twisted on a faceplate; the plates *D*, one on the die below the stock and one on the other die above it, keep the flat stock from buckling. After the ends have been twisted and bent by tools *B*, the forging is heated at the center and the round bend and angles *a* are formed by tool *C*. The slant of the step is provided for by having the working surfaces of the dies at the required angle with the sides. The plates *E* keep the stock in position during the bending operation and a pin which passes through the hole in the center of the step keeps the stock from drawing in either direction. S. E. M.

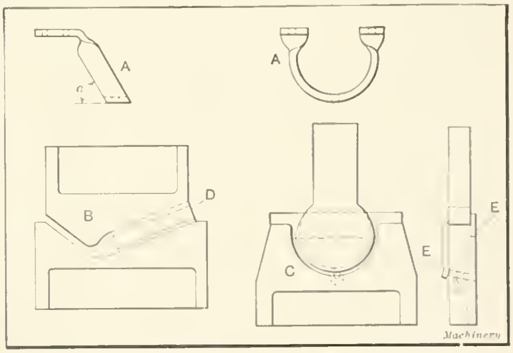
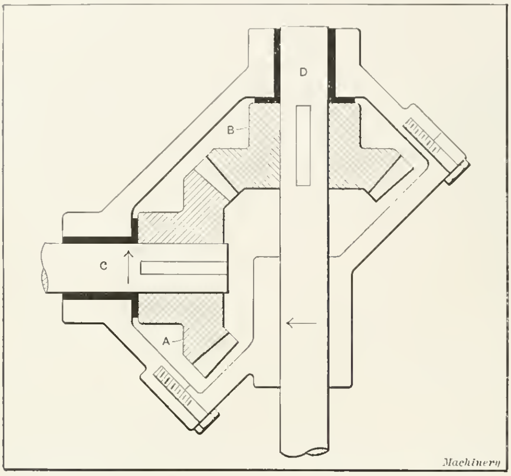


Fig. 4. Another Form of Car Step and Method of forming

BEVEL-GEAR DRIVE FOR SHAFTS RUNNING IN THE SAME DIRECTION

The bevel-gear drive described in the June issue of MACHINERY by Mr. Francis W. Clough seems to be an ingenious piece of mechanism, but I fail to see the necessity for the third gear. If Mr Clough had arranged his drive as shown in the accompanying illustration the shafts *C* and *D* would rotate exactly as shown in the illustration accompanying his article. The gears *A* and *B* shown in the accompanying illustration are miter gears and may be obtained from stock in various sizes, while the angle of the pitch cone of Mr. Clough's gears *A* and *B* is slightly less than 45 degrees and two gears of this kind could not be obtained from stock without buying two other gears that would be useless.

Furthermore, I cannot agree with Mr. Clough when he says "A valuable feature of this drive is the possibility of locating one horizontal shaft above or below another. Thus the advantage of a skew bevel gear can be obtained by means of this combination." If by this Mr. Clough means that he can use bevel gears of the usual type where skew bevel gears would ordinarily be called for I think he is mistaken; as in his design the center line of the stud *G* must intersect the center lines of both of the shafts *C* and *D* and it would be impossible to fulfill this condition if the shafts *C* and *D* were in different planes.

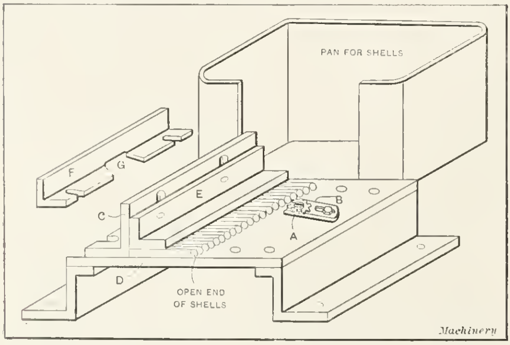


Bevel-gear Drive where Both Shafts run in the Same Direction

Brooklyn, N. Y. WALTER GRIBBEN

FEED MECHANISM FOR DRAWING BRASS SHELLS

In order to economically feed brass shells that are to be operated upon by a punch and die, we are making use of a gravity-feed arrangement somewhat similar to the one described in the May issue of MACHINERY under the title "A Punch and Die for Forming Electric Terminals." The only trouble that we have had with this device has been due to letting a shell go down the chute with the closed end toward the punch instead of the open end. In such a case, the shell buckles, which almost invariably results in breaking the punch. This involves a loss of time to stop the machine and replace the broken punch, in addition to the actual cost of the punch.



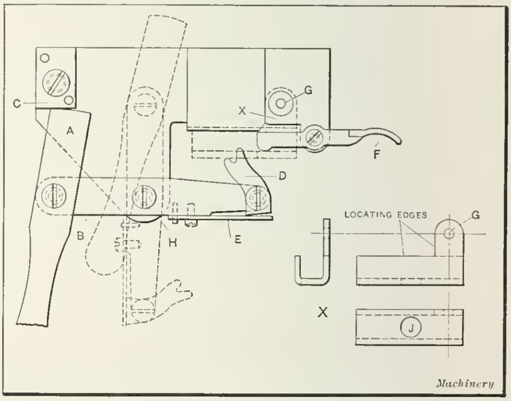
Mechanism used to feed Brass Shells to a Drawing Press

The accompanying illustration shows an attachment which we have applied to this feed mechanism to make it absolutely "fool proof." It will be seen that a small toothed disk *A* is mounted on a stud carried by the part *B* mounted on the body of the feed mechanism. As the shells pass down the chute, the teeth on the disk enter into their open ends, the disk revolving to allow the shells to pass. If a shell is put into the chute with the closed end out, the tooth of the disk which comes into contact with it is not given sufficient clearance to enable the disk to revolve. Consequently, the shell cannot pass down the chute and result in damage to the punch and die.

This arrangement is simple in construction and operates efficiently. Referring again to the illustration, it will be seen that adjustment is provided to adapt the feed mechanism for different diameters and lengths of shells. The bracket *C* is fastened to the body *D* by means of two 3/8-inch cap-screws. The guide *E* can be raised or lowered to accommodate shells of various diameters; this guide prevents the shells from rolling over one another. The guide *F* is illustrated separately in order to show the construction of this part. It is held to the body by means of two 3/8-inch cap-screws, and the slot *G* provides ample room for the toothed disk to engage with the shells as they slide down the chute. In order to obtain the best results, the distance between centers of the teeth of the disk *A* should be the same as the distance between the centers of adjacent shells. It will be seen that a pan is provided in which a supply of shells is held ready to be fed into the chute. G. H. T.

QUICK-ACTION CLAMPING DEVICE

A binding device of novel design that is applicable for use on a variety of dies and jigs, if modified to suit the requirements of different cases, is shown holding the sheet-metal part *X* which is also shown in detail. This piece is secured to the die to have the small hole *G* pierced in it. It will be seen from the illustration that the lever *B* has a cam *A* at one end and a finger *D* at the other. This lever swings about the center *H*, and is shown by dotted lines swung away from the die to allow the work to be removed. After swinging the clamping device out of the way, the work is kicked off the die by the ejector *F*. A new piece of work is next placed in position and the operator pulls the cam lever *A* over to bring the cam into engagement with block *C*; he then pushes the lever to the right to clamp the work in position. The flat spring *E* presses against the finger *D* and throws it forward on its center so that when it first engages the work, the shorter extension gradually slides toward the left until the longer extension comes into contact with the edge of the hole *J*. The work is moved to the left in this manner until the lug in which the hole is being pierced engages with the shoulder on the die and further action of the lever pushes the work firmly against the side of the die. In this position, the work is located ready to be punched. The arrangement of the levers is such that ample pressure can be secured to hold the work in position on the die.



Quick-action Binding Device for Dies and Jigs

Hartford, Conn. S. VICTOR BROOK

SPEED RATIOS OF AUTOMOBILE PLANETARY GEARS

In replying to the inquiry of G. M. G. concerning speed ratios of planetary gears in the February issue, I submit a solution which is simple and does not require the use of any complicated mathematical formulas. Taking the different gears in the same order, and using the same letters of reference mentioned by G. M. G., I will commence by clutching the drum *G* to prevent it from moving. As long as the drum remains stationary, the gears *D*, *C*, *B* and *A* take the form of a simple train, the speed ratio of which is:

$$\frac{20}{25}\times\frac{15}{30}=\frac{2}{5}$$

or, to state it more simply, wheel *D* makes 5 revolutions while wheel *A* makes 2 revolutions.

When the clutch *J* is engaged it is obvious that the whole piece of mechanism becomes locked to shaft *K*, owing to the wheel *D* being keyed to *K*, and wheel *F* being caused to rotate at the same speed as *K* by the action of clutch *J*. This results in the whole mechanism revolving in the same direction and at the same speed as the driving shaft *K*.

By clutching the drum *H*, the wheel *F* becomes fixed and the drum *G* which carries the planetary gears must revolve either in one direction or the other. Looking at the apparatus from the clutch end, let us assume that drum *G* makes one revolution in a clockwise direction, and that the wheel *F* remains stationary. It is now necessary to find the speed and direction of rotation of the wheel *D*. We will proceed in the following manner. Throwing clutch *J* out of action, imagine the whole apparatus to make one revolution in a clockwise direction, where it will be clear that each wheel has made one complete revolution about the common axis *K*. Tabulate these revolutions as shown in Table I—calling movement in a clockwise direction positive and in a counter-clockwise direction negative. Now wheel *F* should not rotate, being a fixed wheel, and as we have given it a clockwise revolution we must correct this by keeping drum *G* fixed and revolve wheel *F* one revolution in a counter-clockwise direction. This will impart motion to wheels *E*, *C*, and *D*, as tabulated in the second line of Table I. We have now fulfilled the conditions of the first half of gear *G*, making one revolution in the clockwise direction and *F* remaining fixed. The effect on the other wheels is obtained by taking the algebraic sum of the corresponding columns in Table I, where we find that wheel *D* makes 18/17 revolution in the counter-clockwise direction and one revolution in the clockwise direction.

TABLE I

F	E	C	D	G
+ 1	+ 1	+ 1	+ 1	+ 1
− 1	$-\frac{28}{17}$	$+\frac{28}{17}$	$-\frac{28}{17}\times\frac{25}{20}=-\frac{35}{17}$	0
0	$+\frac{45}{17}$	$+\frac{45}{17}$	$-\frac{18}{17}$	+ 1

Machinery

Having found the rotation of wheel *D* in relation to drum *G*, we can determine the revolutions made by wheel *A*, relative to *D*, in the same time that drum *G* makes one revolution. Proceeding as before, imagine the whole arrangement to make one revolution in the clockwise direction and tabulate the results as shown in Table II. Now in this case, wheel *D* makes 18/17 revolution in the counter-clockwise direction, while drum *G* makes one revolution in the clockwise direction, and to attain this motion in relation to *D* we must keep drum *G* fixed and revolve wheel *D* 35/17 revolution in the counter-clockwise direction. Therefore, by giving this motion to wheel *D*, it will cause wheels *C*, *B* and *A* to revolve as tabulated in the second line of Table II. The effect on the other wheels is obtained in the same manner as previously explained, and we find that wheel *A* makes 3/17 revolution in the clockwise direction while wheel *D* makes 18/17 revolution in the counter-clockwise direction, the ratio being 18:3. In other words, wheel *A* makes one revolution while wheel *D* makes six revolutions in the opposite direction. Hence, the three ratios obtainable are:

TABLE II

D	C	B	A	G
+ 1	+ 1	+ 1	+ 1	+ 1
$-\frac{35}{17}$	$+\frac{35}{17}\times\frac{20}{25}=+\frac{28}{17}$	$+\frac{35}{17}\times\frac{20}{25}=+\frac{28}{17}$	$-\frac{28}{17}\times\frac{15}{30}=-\frac{14}{17}$	0
$-\frac{18}{17}$	$+\frac{45}{17}$	$+\frac{45}{17}$	$+\frac{3}{17}$	+ 1

Machinery

First case 1 : 0.4 or 5 : 2
Second case 1 : 1 or 1 : 1
Third case 1 : 0.166 or 6 : 1

H. A. P.

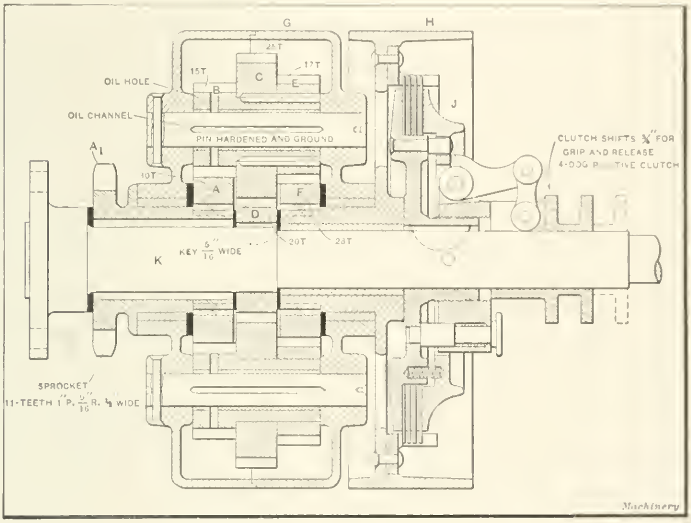

G
H
25T
17T
15T
C
E
B
J
OIL HOLE
OIL CHANNEL
PIN HARDENED AND GROUND
CLUTCH SHIFTS ⅜" FOR GRIP AND RELEASE 4-DOG POSITIVE CLUTCH
A
30T
F
D
20T
28T
KEY 5/16" WIDE
K
SPROCKET 11-TEETH 1" P. 9/16" R. ¾ WIDE
Machinery

Diagram showing Automobile Planetary Gear

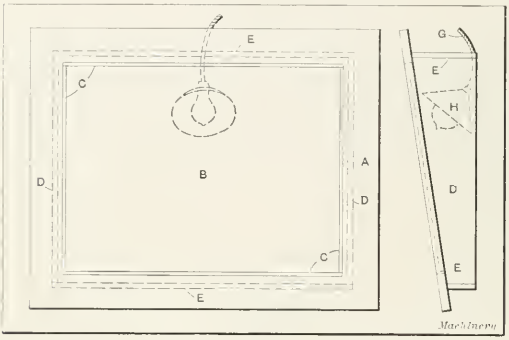
[Correct solutions of this problem were also obtained from Mr. Otto M. Hoch, 69 Kirkland Road, Rochester, N. Y., and from Mr. M. Owen, 20 Railway Road, Manchester, England.—EDITOR.]

SHADOWLESS DRAWING BOARD

The accompanying illustration shows a small shadowless drawing board which may be used for a number of purposes in the drafting-room. Such a board is inexpensive to make and will take the place of boards of this kind that are sold in the market at a price which is usually prohibitive for small drafting-rooms.

Referring to the illustration, the construction of this drawing board may be briefly outlined as follows: The frame is made of soft wood and fits around a square piece of ordinary glass *B*. This glass is held flush with the surface of the board *A* by means of small wooden strips *C*. The side and end boards *D* and *E* are made of soft wood, a notch being provided at the center of the back board *E* for the lamp cord *G* to pass through. By placing a tungsten lamp with a reflector *H* under the board, a very good light may be obtained through the glass, and this illumination may be made still better by placing a sheet of white paper on the table under the board. The dimensions may be made suitable for the class of work which is to be handled and the design may be further improved by using more than one lamp.

The writer has found a board of this kind useful for numerous purposes, among which the following may be mentioned: Reverse drawings may be conveniently made for parts which are to be made right- and left-hand but similar in other respects. This is done by simply turning the drawing for the left-hand part over and tracing a drawing for the right-hand part from the reverse side of the paper. This practice saves a great deal of time which would otherwise be required to make separate drawings for the right- and left-hand parts. Another use for this board has been found in making tracings of drawings on heavy paper where it is impossible to see the lines in the ordinary way. Tracing from blueprints to bristol board can also be handled on a drawing board of this kind. Other uses will be found for the board when it is installed in the drafting-room.

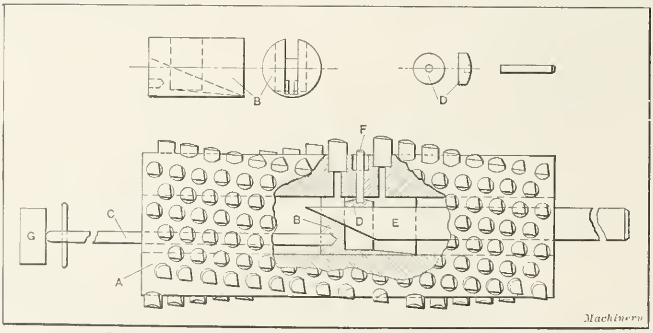


Plan and End View of Shadowless Drawing Board

R. A. C.

DRIFT FOR DRIVING WORN TEETH OUT OF A CUTTER

Shops that use the type of inserted-tooth milling cutter shown in the illustration will find the use of a drift for driving out worn teeth the means of making a considerable saving in the cost of their tools. In most cases, it is customary to throw away these cutters after the teeth have become worn, but the use of this drift enables the old teeth to be driven out and new ones to be inserted in their place. Referring to the illustration, the design of this drift may be briefly outlined as follows: The body of the milling cutter is shown at *A*, and the cylindrical piece *B* is a sliding fit in the bore of the cutter. This piece *B* is moved in the bore of the cutter by means of the handle *C*. The cylindrical guide plug *D* fits in the hole in the piece *B*. This guide plug is raised by the drift *E* which enters the slot in *B* and forces the ejector pin *F* up into the hole in the body *A* of the cutter. By this means, the ejector pin is brought against the bottom of the tooth of the cutter and drives it out, so that a new one can be inserted.



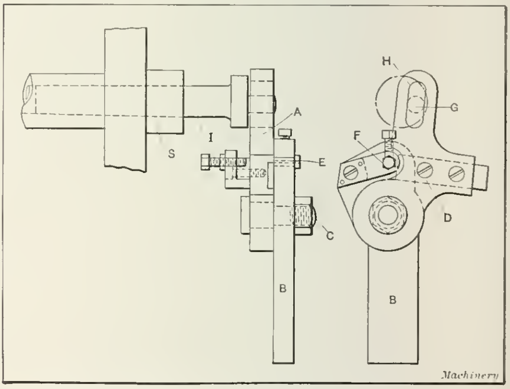
Drift used for driving Worn Teeth out of an Inserted-tooth Cutter

It will be seen that the end of the handle *C* is backed up by a support *G* when the drift is in use. This prevents any lateral movement that would result in shearing off the ejector pin *F*. Referring to the detail of part *B*, it will be seen that there is a narrow slot in the bottom of the slot which receives the drift *E*. This narrow slot receives a smaller key which enters the point of the ejector pin in the hole beneath the cutter. The handle *C* and this key are manipulated by hand until the pin has been entered into a hole; the key is then forced into the slot and the taper drives the pin up until it comes into contact with the bottom of the cutter. As the pin *F* is a tight fit in the hole, it will remain in this position. The key is then withdrawn and the drift *E* driven in to force the worn cutter out of the body. A new cutter can then be inserted in its place. The use of two keys is only required where the wall of the cutter is thick, making a considerable vertical movement of the ejector pin necessary.

Lansing, Mich. August Korbus

PIN CUTTING FIXTURE

Small pins and rivets of either brass or soft steel are not economically produced on an automatic screw machine when the required diameter is obtained from the bar. A more economical method consists of cutting off blanks to the required length, and in a plant where large quantities of soft steel pins are used the fixture shown in the accompanying illustration was designed for this purpose. It is not necessary to cut off the blanks with great accuracy, as they are subsequently finished to the required length after being assembled in position.



Bench Lathe Fixture for cutting Brass or Soft Steel Pins or Rivets

Referring to the illustration it will be seen that the method is one of "chopping off" the blanks from the bar stock, this being accomplished by the swinging arm *A* which is pivoted to the holder *B* by means of the shoulder stud *C*. The cutting tool *D* is carried on the arm *A*, and it will be seen from the illustration that this cutter passes over the inside end of the guide bushing *E* through which the rod is fed against the adjustable stop *F*. A reciprocating action is imparted to the swinging arm *A* by means of the eccentric pin *G* which operates in the elongated slot *H* in the center *I*. The drive is obtained from the lathe or milling machine spindle *S*.

In use, this fixture was set up on a speed lathe and operated by a boy who was able to produce 6000 pins per hour at an hourly rate of only twenty cents for labor. Those readers of Machinery who have a similar problem to handle can rest assured of the convenience, efficiency and economy of this method.

Hartford, Conn. Charles F. Scribner

FIXTURE FOR MILLING BINDER BUSHINGS

Fig. 2 shows a binder bushing on which it was required to mill the arc *A* and the fixture shown in Figs. 1 and 4 was designed for this purpose. These bushings were first turned and drilled on a turret lathe and were then cut off to such a length that the pieces were 3/16 inch longer than two finished bushings. After completing these operations five of the bushing blanks are mounted in the fixture, where they are securely held by the clamp *H* which is secured by means of the screw *K*. The fixture is mounted on the milling machine table so that the center of the stud *D* is in line with the center of the slitting cutter *F*. The table is then locked transversely, as no cross movement is necessary. The upper part of the fixture *C* is pivoted on the stud *D* which is carried by the base *B* of the fixture. Two operations are performed on this fixture; the first consists of milling the arc *A* on ten bushings, and the second of slitting the five blanks mounted in the fixture so that they form ten complete bushings. In performing these two operations, it is necessary to swing the fixture through an angle of 90 degrees, so that the work can be brought into position under the slitting cutter *F* after the milling cutter *G* has completed its work. The taper spring pin *E* is used to locate the work in the required position for either operation.

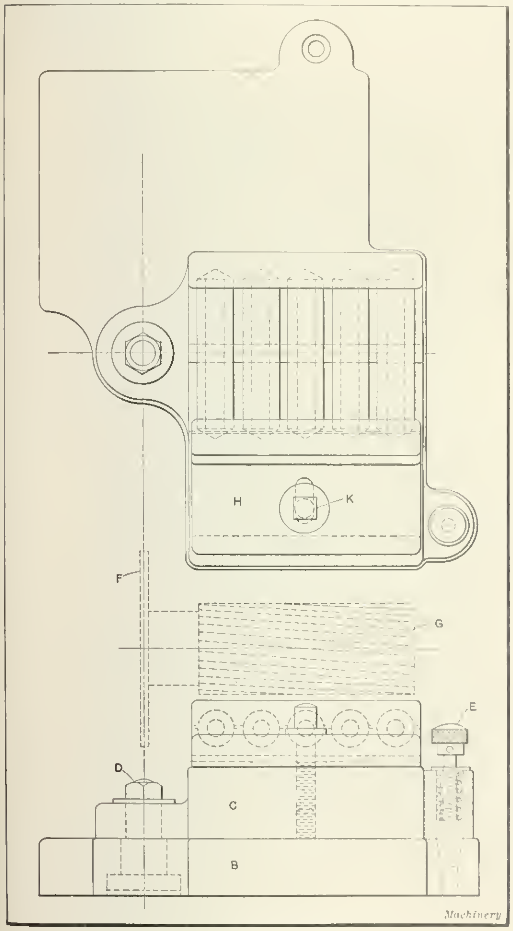


Fig. 1. Fixture set in Position for milling the Arc A in Ten Bushings

Fig. 1 shows the fixture set up for milling the arc *A*. A stop located in the vertical T-slot of the machine prevents the work from being fed too far in against the cutter, thus gaging the depth to which the arc *A* is milled. The work is centered under the cutter by means of a stop shown in detail in Fig. 3; this stop is located in the small T-slot on the side of the table. The stop is adjusted so that the cutter will be exactly in the center of the bushing when the swinging arm *M* engages the swivel block *N* of the miller. After the arc has been milled the arm *M* is lifted out of the way, as shown at the right-hand side in Fig. 3, so that the table is free to move in either direction. The fixture is then swung through an angle of 90 degrees and re-locates the work under the slitting cutter *F*. The work is then fed up against this cutter and the five pieces clamped in the fixture are cut apart so that ten complete bushings are produced. L. J.

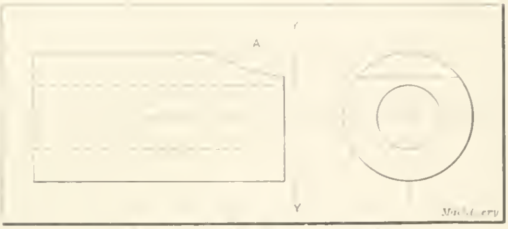


Fig. 2. Binder Bushing with Arc A to be milled and to be cut off on Line Y-Y

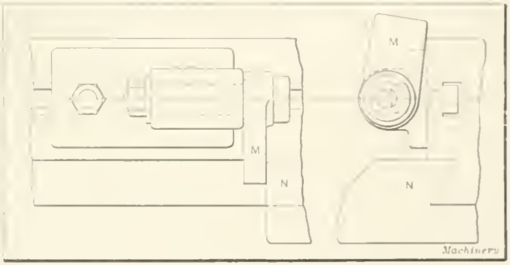


Fig. 3. Stop for locating Work under the Center of the Milling Cutter G

COLORING BRASS IRIDESCENT COLORS

Brass on copper can be given an iridescent color somewhat similar to that produced on steel when the temper is drawn by immersing the articles in a bath. To prepare the solution, dissolve 3 parts of soda hyposulphite and 1 part lead acetate in 48 parts of water. Plunge the pieces into this solution and let them remain for some time. Remove the parts frequently to see when the desired depth of color is reached; then rinse off in water and dry. Unless care is taken in dipping the parts it is a difficult matter to secure the same color on a large part that is obtained on a smaller one. D. T. H.

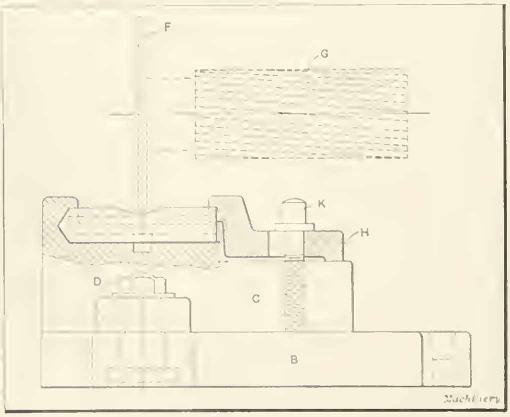
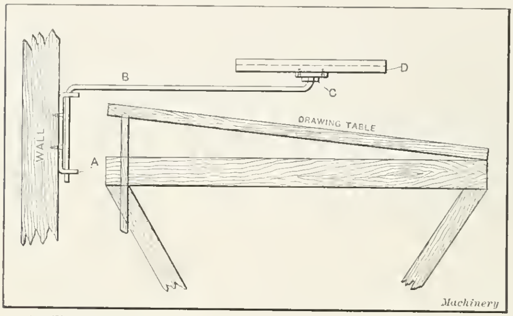


Fig. 4. Fixture set for slitting the Bushings along the Line Y-Y

SWINGING TABLE FOR THE DRAFTING-ROOM

The illustration shows a small swinging table for holding drawing instruments, ink and other small tools. The use of a table of this kind will be found particularly convenient in a drafting-room, as it keeps the tools close at hand and still avoids having them littered over the drawing board. It will be seen from the illustration that the table is supported by an arm *B* which swings in a bracket *A*; this enables the table to be swung to any convenient position. If the drawing table is not situated close to a wall, the bracket *A* can be secured to the back of the drawing table.



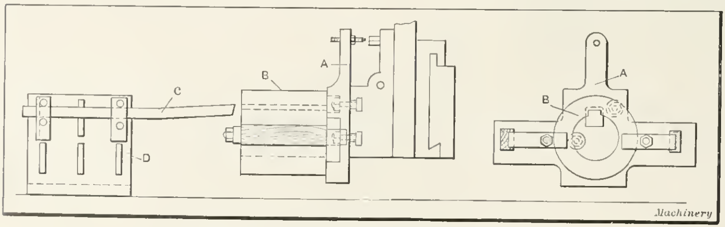
Auxiliary Table for holding Instruments and Ink in the Drafting-room

The construction may be briefly explained as follows: The bracket *A* is made of a piece of 1- by ⅜-inch flat steel which is turned up at the ends and drilled to receive the swinging arm *B*. Holes are also drilled in this bracket to receive the screws which secure it to the wall. The arm *B* is made of a piece of 11/16-inch round stock, which is turned down at one end to fit into the bracket *A* and up at the other end to enter the socket *C*. The length of the arm can be varied to suit the conditions in the drafting-room. The socket *C*, which can be made of either hard wood or iron, is screwed in position on the bottom of the table *D*. This socket has a hole drilled in it to receive the upturned end of the arm *B*. The table *D* can be conveniently made of a piece of ½-inch board, sawed out to 12 or 14 inches in diameter and surrounded by a thin strip 1 inch in width to prevent the tools from being knocked off. The entire device can be made very easily, and it will be found a great convenience in the drafting-room.

R. A. C.

KEYSEATING PULLEYS ON A PLANER

In a shop where I worked for some time we had a small planer, but no slotting machine, and so keyseats in pulleys and bushings were cut by hand. Consequently, I looked through MACHINERY and other magazines for a suitable attachment to put on the planer to adapt it for cutting keyseats, but all the devices I came across had the fault of not giving the tool relief on the back stroke. Finally a job came forward which required a keyseat 1 inch wide by ½ inch deep to be cut through cast-iron bushings five inches long. After some study I devised and made the attachment shown in the accompanying illustration. A cast-iron plate *A*, shaped somewhat as shown and planed on both sides, was bolted to the clapper box. There were slots (not shown) in the two side wings for bolts. A bushing *B* is shown in position ready to have the keyseat cut. The tool *C* was bolted to the side of an angle-plate *D* secured to the table of the planer. The set-screw shown on top is to prevent too much swing if the tool should catch on the sides during the return stroke. It is, of course, obvious that the range of both the length and diameter of the work that can be handled in this way is limited.

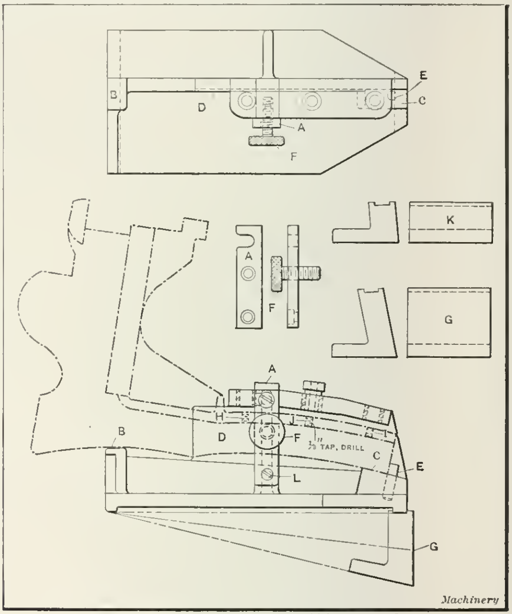


Attachment used for keyseating Pulleys on a Planer

Christchurch, New Zealand. JOHN PEDDIE

JIG FOR DRILLING AND TAPPING HOLES

The accompanying illustration shows an interesting method of drilling holes at different angles in the curved flange of the piece shown mounted in the jig used for this purpose. The piece in which these holes are to be drilled is part of a textile machine, and it was necessary to design a jig which would provide a means of drilling the holes *H*, *I* and *J* at different angles. Referring to the illustration, it will be seen that all these holes run to a common center. The first step in the drilling operations consists of mounting the work in the jig. For this purpose, the swinging clamp *A* is swung down out of the way and the work placed upon the supporting points *B* and *C* of the jig, where it is located by means of the back wall *D* and pin *E*. The clamp *A* is then brought back into position and the work secured in the jig by means of the knurled-headed screw *F*. The hole *H* can now be drilled and tapped through the bushing in the jig. After finishing this drilling operation, the right-hand end of the jig is raised and the auxiliary block *G* is placed under it. This brings the work into the correct position for drilling and tapping the hole *I*, it only being necessary to move the jig on the drill press table to bring the bushing under the spindle. After completing this operation, the block *K* is placed under the jig, and this brings the work into the required position for drilling and tapping hole *J*, the operation being performed as in the preceding cases. Detailed views of the two auxiliary blocks and also of the clamp *A* which is used to secure the work in the jig are shown in the illustration. This method affords a very simple way of performing what looked like a rather difficult drilling operation.



Jig used for drilling Holes at Different Angles

M. F.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

WELDING TOOL-STEEL SEGMENTS TO CAST IRON

J. C. F.—How are tool-steel segments prepared for welding to cast iron? I wish to make some castings with tool steel cutters fixed in them, as in a certain make of pipe die.

A.—The process is simple. The steel requires no preliminary treatment except to remove all rust and scale, and very hot iron should be used. The mold should be so gated that the molten iron flows around and past the steel segments and thus heats them up to the fusing temperature before the mold is filled. Under such conditions the steel and iron readily unite, and cool as one solid mass. This method is employed in making steel-faced jaws for machinists' vises and similar shop equipment.

ETCHING ON BRASS

M. R.—We are having considerable trouble in etching the graduation marks on a brass casting which forms part of an apparatus made by our company. The method we are following is to clean the part with gasoline and cover with an asphaltum coating, having first ground and polished the surface. We mark the lines through the asphaltum coating by means of a special engraving machine and etch with a solution of two parts nitric acid and one part water. The graduations are approximately 1/16 inch apart. Our trouble is that the acid seems to work in under the asphaltum coating on each side of the line, resulting in uneven and too wide graduations. We are not sure we are using the right acid for etching, neither are we sure that the coating we are using is the best. Any information you can give to help us out will be appreciated. We are spoiling a large percentage of the parts, working under present conditions.

A.—The question is submitted to the readers for answer. An article on etching steel as well as brass, giving full directions for coating the work and making the etching solution would be appreciated by many readers.

PROBLEM IN GEOMETRY

Inquirer.—In the problem illustrated in Fig. 1, the dimensions 3.8 and 5.1 inches are known, and also the 23-degree angle. How can the diameter of the circle be found?

A.—In order to show the general solution of this problem, the construction lines shown in Fig. 2 are drawn, and dimensions given in symbols; r is the radius of the circle. Angle α and lengths a and b are given. Then:

$$c = a \div \sin \alpha; \quad d = b \div \sin \alpha; \quad e = a \times \cot \alpha.$$

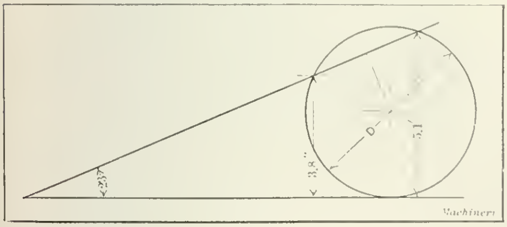


Fig. 1

According to a geometrical proposition, if two lines are drawn to a circle from a point outside of it, so that one of the lines is tangent to the circle and the other line intersects the circle, then the rectangle contained by the total length of the intersecting line and that part of it which is between the outside point and the periphery, equals the square of the tangent; hence:

$$f^2 = cd, \text{ or } f = \sqrt{cd}; \; g = f - e; \; h = a - r; \; r^2 = g^2 + h^2 = g^2 + (a - r)^2$$

$$r = \frac{g^2 + a^2}{2a}$$

In the problem given, $\alpha = 23$ degrees; $a = 3.8$; and $b = 5.1$. Then:

$c = 3.8 \div \sin 23° = 9.7261$ inches.

$d = 5.1 \div \sin 23° = 13.0535$ inches.

$e = 3.8 \times \cot 23° = 8.9528$ inches.

$f = \sqrt{9.7261 \times 13.0535} = 11.2675$ inches.

$g = 11.2675 - 8.9528 = 2.3147$ inches.

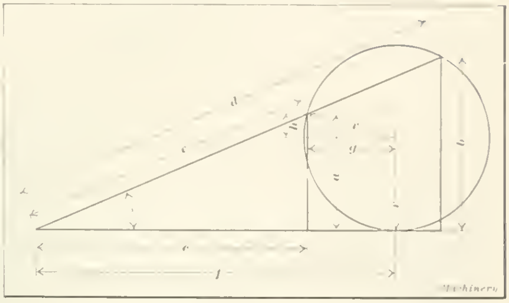


Fig. 2

$$r = \frac{(2.3147)^2 + (3.8)^2}{2 \times 3.8} = 2.605 \text{ inches. Diameter} = 5.210 \text{ inches.}$$

* * *

"OLD-NEW" INVENTIONS

An interesting article in *Industritidningen Norden* calls attention to some of the early inventions that were the forerunners of many of the modern wonders of engineering. As an example may be mentioned the submarine boat. The statement is made that such a vessel was actually built in 1625 and more or less successfully experimented with on the Thames. About 1710, Emanuel Swedenborg, most generally known, perhaps, on account of his religious writings, but who also was one of the most advanced scientists of his age, published a pamphlet in which he described the construction of a vessel which "can with its whole crew dive beneath the surface of the sea wheresoever it pleaseth, and do great harm to the enemy's fleet."

A flying machine which was invented in Vienna in 1809, by a watchmaker, Degan, had a great many details in common with the aeroplane of today. Records state that Degan actually flew with this machine, and that "he did not only rise and fall but actually navigated in the air." Swedenborg, as early as 1716, made up general plans for a flying machine. He was certain that the power problem, which he was unable to solve, would be solved some time in the future. "There are plenty of proofs and examples in nature," said he, "that flights can be done without risks, although some one at the first experiments must pay for his experience and not be too particular about the loss of an arm or a leg."

The fact was recently established by archeologists that the imperial palace in Rome was provided with elevators some two thousand years ago, although it has not been determined exactly how the power was supplied nor how they were operated.

* * *

A great water power development has just been completed at Keokuk, Iowa, on the Mississippi River. A concrete dam nearly 4300 feet long, 53 feet high, 42 feet thick at the base and 29 feet thick at the top impounds a lake 65 miles long and gives a mean head of about 32 feet. The cost of the dam, power house, turbines, electrical machinery, locks, drydock, etc., was about $27,000,000. The power made available is 300,000 H. P., and will be transmitted to nearby cities and towns and to St. Louis, 144 miles distant. The transmission line to St. Louis will be operated at 110,000 volts. The turbine runners are nearly 40 feet diameter and the scroll chambers were molded in concrete instead of being made of metal. The lock has the same width as the Panama Canal (110 feet) and a lift of 40 feet. The gates weigh 5000 tons.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

NORTON PLAIN CYLINDRICAL GRINDING MACHINE

The Norton Grinding Co., Worcester, Mass., has designed and built a heavy cylindrical grinding machine for use in grinding rolls used in rolling sheet steel. The largest rolls which it is expected to grind in the machine are 34 inches in diameter by 18 feet in length, the rolls being supported by massive pillow blocks which hold them by their necks. The machine swings 54 inches in diameter, and when used as a plain cylindrical grinder, it has a capacity of 21 feet between the centers. The machine can be furnished to take any desired length between centers. As will be noted from the illustrations, this machine is equipped especially for grinding heavy rolls, but it can be supplied without this special equipment, then being suitable for grinding plain cylindrical work on centers up to its maximum capacity. The machine is arranged for motor drive only, the equipment being as follows: A 40 H.P. motor mounted on the wheel carriage for the revolution of the grinding wheel and wheel carriage traverse, a 15 H.P. motor mounted on the headstock for work revolution, a 2 H.P. motor on the footstock for traversing the footstock along the ways of the work base, a 2 H.P. motor on the headstock for traversing the headstock along the ways of the work base, and a 2 H.P. vertical motor on the wheel carriage for the pump revolution and traversing the grinding wheel at right angles to the work.

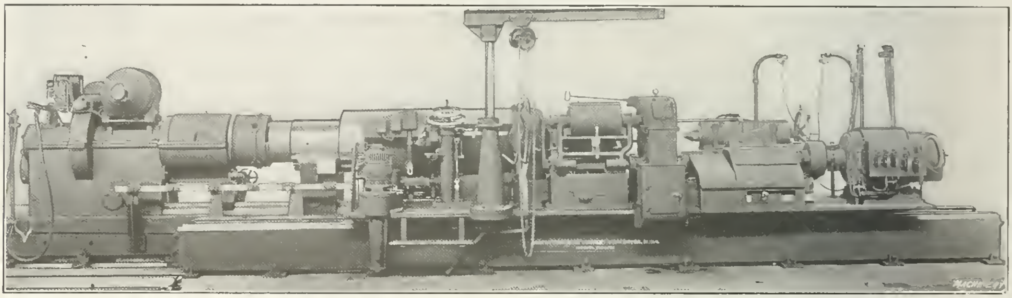


Fig. 1. Front View of Norton Roll Grinding Machine showing Roll in Position for grinding

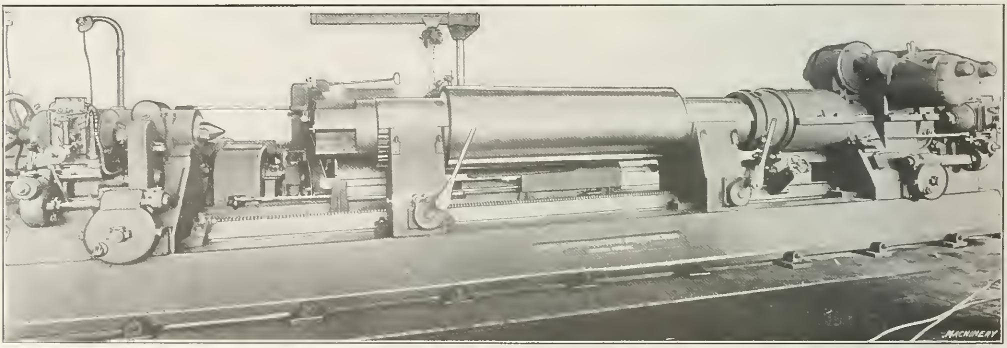


Fig. 2. Rear View of Norton Roll Grinding Machine showing Roll in Position for grinding

Control

This machine is controlled from one position, the operator standing upon the wheel carriage beside the grinding wheel in such a position that he can look directly down between the face of the grinding wheel and the face of the work which is being ground, and see what is taking place at the point of contact between the grinding wheel and roll. Standing in this position, the operator can reach all of the handwheels and levers necessary for starting and stopping the wheel revolution, starting or stopping the roll revolution, reversing the traversing wheel carriage either by hand or by power, moving the wheel carriage for delicate adjustments by hand, moving the wheel to and from the work either by hand or by power, starting or stopping the traverse of the wheel carriage, changing from maximum to minimum speed of the wheel carriage traverse, and controlling the amount of water or lubricant flowing over the wheel and work.

Referring to Figs. 1 and 6, the operator uses the upper handwheel for feeding the grinding wheel to or from the work, one revolution of this handwheel moving the grinding wheel a distance of 0.040 inch, corresponding to 0.080 inch reduction in the diameter of the work. If the grinding wheel is to be moved by power, the upper handwheel is disengaged by moving the lever at the right of the handwheel toward the operator and locking it in this position. This raises the handwheel, disengaging it from the wheel feed mechanism and at the same time releases the wheel traverse lever at the lower left-hand side. Moving the wheel traverse lever to the right or left operates a clutch, resulting in a movement of the grinding wheel either to or from the work. These levers are so constructed that the power traverse cannot be thrown in until the handwheel has been disengaged; nor can the handwheel be engaged until the power traverse levers have been thrown out of engagement. The lever at the upper left-hand side of the handwheels controls the stopping, starting and reversing of the wheel carriage. When automatic traverse of the wheel carriage is desired, this lever is placed in its lowest position. With the lever in the next higher position the wheel carriage can be reversed or stopped by hand. With the lever in its upper position, it engages the lower handwheel with wheel carriage traverse mechanism, permitting movement of the wheel carriage by hand. The changes in speed of work revolution are accomplished at the headstock by means of change gears. Intermediate speed changes for traverse of the wheel carriage are made on the front of this carriage.

Ways and Maintenance of Alignment

As this machine is designed for very large work, it is imperative for the ways in which the wheel carriage travels to be perfectly straight, and to obtain straight ways on this machine the Norton pendulameter is used. This instrument makes sure of the detection of errors as small as 0.001 inch at any point along the ways as related to parallelism and straightness of the ways. The ways are then scraped to master straightedges until the pendulameter registers a perfectly straight line. It will be noted from the illustrations that the machine is provided with supporting wedges which are attached to the base, and the alignment of the ways can be corrected at any time, but the width and length of the bearing of the wheel carriage on the ways of the base are so ample that it is improbable after the machine has once been set up and adjusted for correct alignment, that any error can be detected after many years of use.

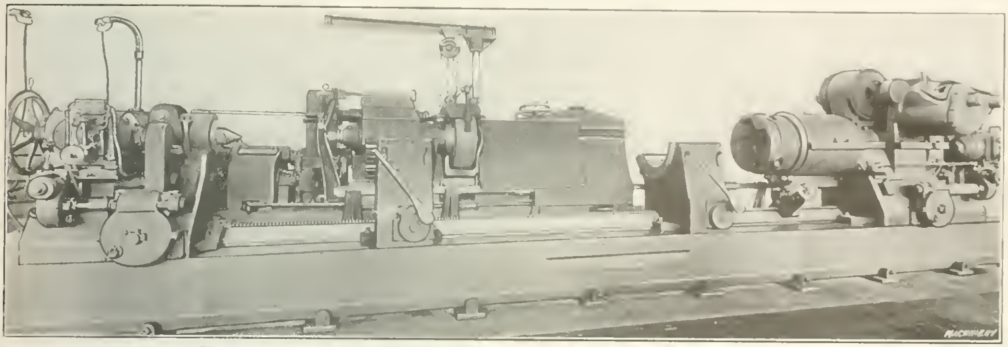


Fig. 3. Rear View of Norton Roll Grinding Machine showing Roll removed from Bearings

Single Wheel Design

Years ago Mr. J. Morton Poole invented the double wheel machine with a swinging frame to secure accurate diameters over the entire length of the roll, because at that time there were no known methods of producing and maintaining straight ways of sufficient accuracy to secure perfectly straight lines or a uniform diameter of roll with a single grinding wheel. The machine here described is designed and constructed in accordance with the experience of recent years, *viz.:* That it is quite practical to produce and maintain ways for a single grinding wheel which will secure absolutely perfect rolls. Incidentally, the advantage of this single wheel is that with the present design it is possible to have the wheel large in diameter, of wide face, and so mounted and provided with a powerful drive that it is possible to grind rolls in a few hours which formerly required a day or more for their grinding. It is also more convenient to place heavy rolls in the machine, or remove them from the machine than when the double wheel machine is used.

Under the old system a roughing cut was unknown. All cuts were practically finishing cuts and hours, in fact days, were spent in the slow process of grinding with small wheels, not exceeding 14 or 15 inches in diameter by 1 or 2 inches in width, and relatively small spindles and frail supports were provided for carrying these wheels. In designing this machine, the two objects in view have been accuracy and large production. The older line of double wheel roll grinding machines have produced accuracy at the expense of time. With the single wheel machine of modern design, advantage can be taken of greater weight and power, securing accuracy and at the same time large production.

Production

The first roll grinding machine of the type described in this article was shipped to a well known steel mill for grinding rolls to be used in the rolling of steel plate. The rolls are of various diameters and lengths, but the largest roll the customer expects to grind on this machine is 34 inches in diameter by 18 feet in length over all, although rolls 54 inches in diameter can be ground if desired. It will be noted by reference to the illustrations, that the machine is equipped with massive pillow blocks and bearings for carrying the rolls upon their necks, the largest of these necks being 24 inches in diameter. During the demonstration of this machine, rolls were ground in from one-fourth to one-half the time previously required for finishing the same rolls in the lathe. As yet there has not been sufficient time in which to definitely establish the conditions under which the machine will give the greatest output, but there is every reason to expect that greater saving will be shown after the machine has been longer in commission.

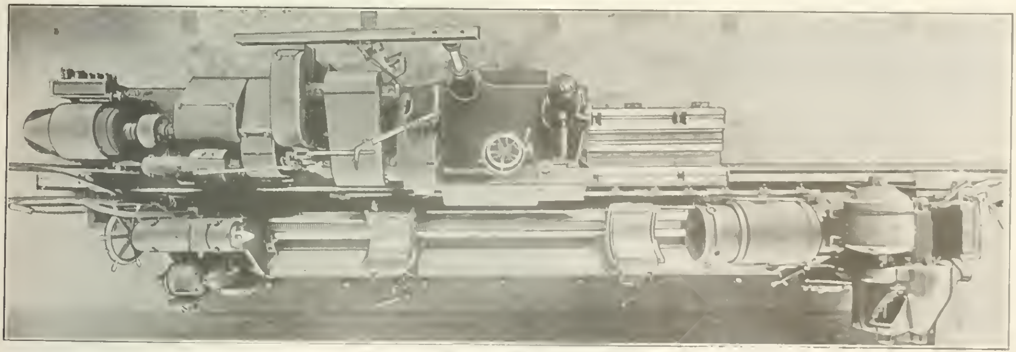


Fig. 4. Plan View of Norton Roll Grinding Machine; Photograph taken from a Traveling Crane

General Description

The original design of Norton plain grinding machines has been departed from in this case, for the reason that the work to be ground is of such size that in order to see the point of contact between the work and the grinding wheel, it is necessary for the operator to have control of the machine on the same side of the work as the wheel is grinding. He does, however, as in the standard machine, have entire control of all of the important functions of the machine while standing in one position, and without reaching over the work. To secure perfectly smooth work, the rolls are revolved through helical gears and a large worm and worm-wheel running in a bath of oil, six speeds of work revolution being provided. The headstock spindle is 12 inches in diameter, the footstock spindle is 10 inches in diameter, and the centers are 6 inches in diameter and are interchangeable.

When grinding rolls carried on their necks, they are revolved by means of a large universal joint, in order to give a steady and uniform rotation of the work, one end of the universal joint being bolted to the faceplate of the headstock spindle. To the other end is bolted a driving sleeve which clamps solidly to the wabbler end of the roll, revolving as a part of the roll. The driving sleeve and universal joint are made of steel castings. When grinding work on centers, the universal joint, the universal joint case and the driving sleeve are removed and a driver is bolted direct to the faceplate on the headstock spindle. The wheel head, with its spindle, wheel guard, wheel sleeve and wheel, weighs over 5000 pounds and rests upon a solid wheel head base mounted on the long, heavy traversing wheel carriage, making it possible to grind the roll rapidly.

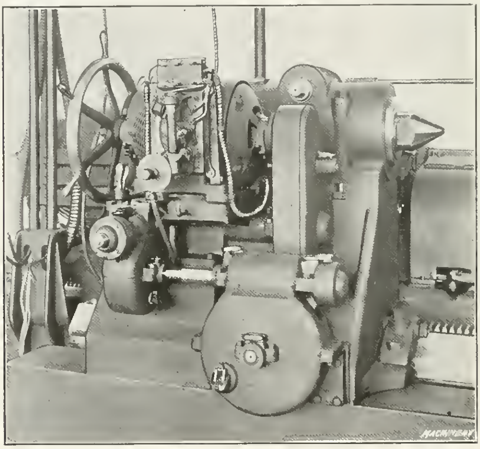


Fig. 5. Detail of Footstock of Norton Roll Grinding Machine

Provision is made for grinding the necks of the rolls, either when carried on the machine centers or when the rolls are revolved upon their necks in specially arranged bearings. Machines can be supplied either with or without the footstock, as the footstock is not necessary for grinding the roll necks, it being entirely practicable to grind rolls both on necks and bodies when carried in these specially arranged bearings. The pillow block bearings for use in grinding the necks are arranged with multiple bronze bearings which are adjustable for the small variation in the size of necks. A pillow block is required for each standard size, and an adjustment takes care of the variation from the standard. Perfectly round necks are produced, no matter whether or not there are centers in the roll. A trammel is provided for adjusting the roll neck bearings to correct diameter before the roll is placed in position for grinding, the design of this trammel being shown in Fig. 7. Fillets on the roll necks can be ground with the same wheel and at the same time as the necks are ground. A forming attachment is also furnished, which is adjustable for any radius for forming the corner of the grinding wheel when fillets are to be ground. A truing device is also furnished for truing the face of the grinding wheel, as shown in Fig. 7. The pump delivers about thirty gallons of lubricant per minute to the wheel and work.

The castings forming parts of this machine contain about 20 per cent steel, giving a very close grain casting possessing good wearing qualities. The wheel spindle is of the best chrome nickel vanadium steel, heat-treated to a hardness which gives it extraordinary wearing qualities. The grinding wheel sleeve is a steel casting, as is also the wheel guard, this guard weighing over 600 pounds. The shafts are made of the best carbon steel and carefully ground to size. The worm and worm-wheel are of material well suited for the purpose, and were made by the Brown & Sharpe Mfg. Co. The helical gears in the headstock are of steel, as are also many of the other gears in the machine, where strength and durability is required. All of the racks are of solid steel, and the pillow blocks for the roll necks are steel castings. The adjusting wedges under these bronze bearings are of high-carbon steel. All bearings, where necessary, are self-oiling. All oil holes are covered with a small iron cap which cannot be easily broken off, but is easily seen by the operator. All oil holes are of ample size. When desired, an attachment can be supplied for this machine, which will permit grinding rolls with either a concave or convex face. The machine as shown in the illustrations is arranged for grinding rolls either straight or with straight tapers, whether or not the rolls are carried on

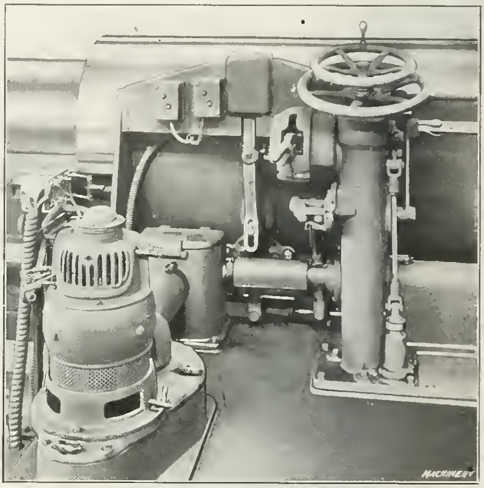


Fig. 6. Detail of Control of Norton Roll Grinding Machine showing Wheels and Levers governing Hand and Power Feed

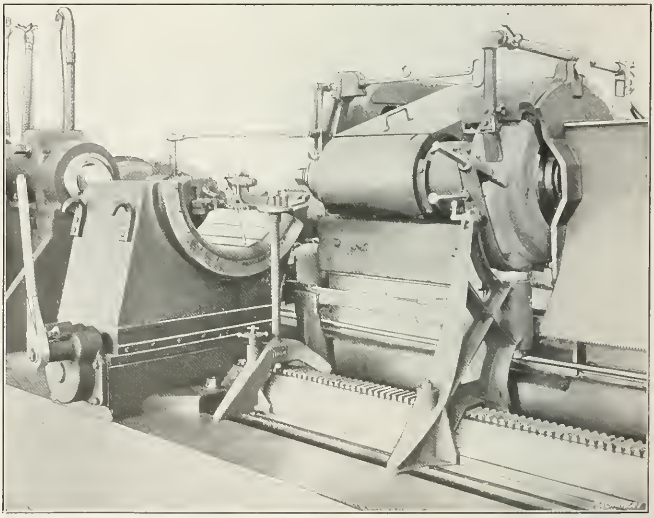


Fig. 7. Journal Rests of Norton Roll Grinding Machine showing Trammel for setting Shoes

centers when being ground. The machine for grinding rolls, as shown in the illustrations, weighs about 100,000 pounds.

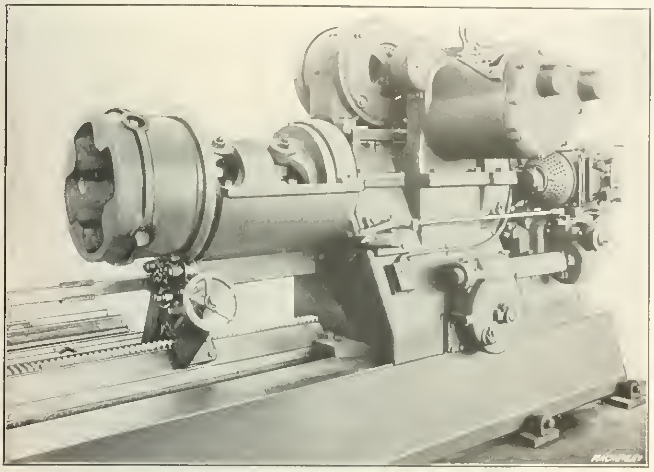
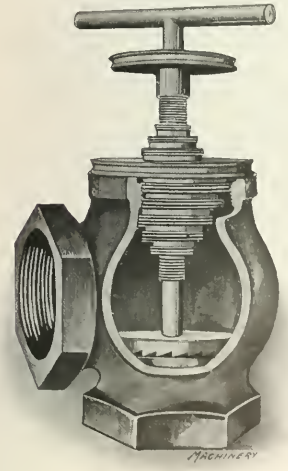


Fig. 8. Detail of Headstock of Norton Roll Grinding Machine showing Universal Joint, Locater and Driving Sleeve

ABBOTT RESEATER FOR THE JENKINS VALVE

The Abbott Hardware Co., 638 Columbus Ave., New York City, has recently brought out the reseating tool shown in the accompanying illustration which is designed for use on the Jenkins type of valve. The tool consists of four essential parts which are: the reseating tool, the spindle upon which the reseating tool is mounted, a sleeve surrounding the spindle, which provides for feeding the tool, and a double-cone of threaded disks which screw into the bonnet opening of the different sizes of valves for which the tool is adapted, as shown in the illustration. In reseating a valve with this tool, the right size of cutter is first mounted on the spindle, after which the threaded disk is screwed into the valve bonnet by means of the knurled wheel provided for this purpose. The cutter is then fed down to the work by operating the upper knurled wheel which rotates a threaded sleeve surrounding the spindle. The cutter is turned by rotating the handle at the end of the spindle. This tool is made for reseating valves ranging from ¼ inch up to 2 inches in size.

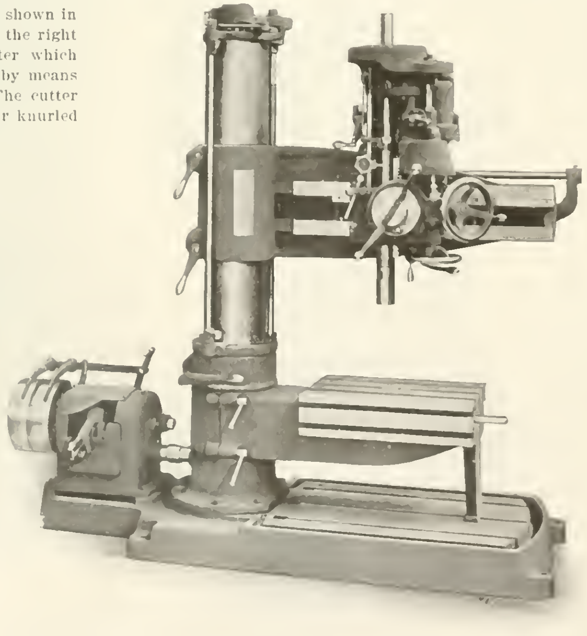


Abbott Reseater for the Jenkins Type of Valve

FOSDICK THREE-FOOT RADIAL DRILL

The three-foot radial drill illustrated herewith is a product of the Fosdick Machine Tool Co., Cincinnati, Ohio. The machine is self-contained and it requires no special foundation. As no countershaft is required, the machine may be placed directly under the lineshaft. The base is a deep triple I-beam section which insures great rigidity. It is provided with extra large T-slots and has an oil channel surrounding it which drains into a large reservoir under the column. The column is of the double tubular type. The fixed inner column is heavily ribbed and extends to the top, where a large ball thrust bearing insures easy swinging of the arm. The arm is rigidly clamped by a convenient form of malleable lever which travels with it and is made adjustable. Means have been provided for taking up wear on the clamping surface of the column.

The arm is of tubular section and is cross and vertically ribbed to give the greatest possible resistance to both torsional and bending strains. The tighteners are provided with adjusting screws to prevent sagging and to provide means for taking up wear. The elevating screw is suspended by a ball thrust bearing, and the arm lowers at twice the elevating speed by means of a handle placed in a convenient position for the operator. Safety trips are provided at both extremes of the movement. The head is moved along the arm by a rack and spiral pinion, and the thrust in either direction is taken by a ball bearing. The back gears on the head give three changes of speed through hardened steel gears and clutches, all of these changes being made while running, by means of a single lever in front of the head. All of the gears are enclosed and placed between the spindle and the friction, thus giving the friction the benefit of the back gear ratio for the heavier classes of work.



Fosdick 3-foot Radial Drill

The tapping reverse frictions are mounted on a sleeve which slides on the arm shaft, the construction being such that grit cannot be drawn into the mechanism, which is enclosed and runs in oil. The adjustment for wear is made from the outside by means of a common screw-driver. The spindle is made of crucible steel and takes the thrust on a special form of ball bearing. The sleeve is provided with a direct reading depth gage and the adjustable automatic trip may be set to the exact depth of the hole in any position. The quick-return friction is instantly adjusted, being operated by a double lever. The feed changes are all made while the machine is running. Only one handle is required and this handle has a direct reading index. The feed-box is placed low down on the head in order to give support to both sides of the worm. The worm-wheel is enclosed and runs in an oil bath, and an "over-take" clutch permits the hand feed to be fed ahead of the power feed without disengaging the latter. The speed-box is of simple construction and positive in action; it has a direct reading index plate for the positions of the lever and all changes are made easily and noiselessly. All shock is avoided by an "over-take" arrangement which keeps the machine running at a reduced speed. A latch pin secures the tumbler and prevents chattering on heavy work.

The lubrication system consists of oil chambers and felt wipers or pipes, as the location requires, and the bearings are made of special phosphor-bronze. The machine is ordinarily equipped for belting direct to the lineshaft, but when desired it may be readily changed over for the application of individual motor drive. A constant speed or three-to-one variable speed motor of any speed may be used. In cases where motor drive is applied, rawhide gearing or a silent chain is used for connecting the motor to the machine.

CLEVELAND POWER PRESS AND PLAIN SHEAR

The open-back inclinable type power press illustrated in Fig. 1 has recently been brought out by the Cleveland Machine & Mfg. Co., Cleveland, Ohio. The inclining device consists of a rack and pinion and worm and worm-wheel, which multiplies the power applied so that one man can easily adjust the press to either the inclined or straight position. The clutch pin is mounted in a steel collar forged solid on the shaft and has a safety latch which automatically locks the pin and makes it impossible to trip the press with the treadle when the shaft is turned down for the purpose of setting dies. The slide is provided with a knock-out bar which is operated by two adjustable plates mounted at the front of the housing on each side of the slide. These plates can be tightened to suit the work in hand, and adjusted to slip under overload which would cause some part to break if the adjustment were positive. The brake band is adjusted under the tension of a spring which automatically compensates for wear and for the expansion due to heat when running the press continually. The crankshaft bearings in the frame and the flywheel are bronze bushed. The principal dimensions of the machine are as follows: Bed area, 27 inches by 18 inches; distance back from center of slide, 9½ inches; distance from bed to slide with stroke and adjustment up, 11 inches; thickness of bolster plate, 2 inches; standard stroke of slide, 2 inches; weight of flywheel, 800 pounds; total weight of machine, 4400 pounds.

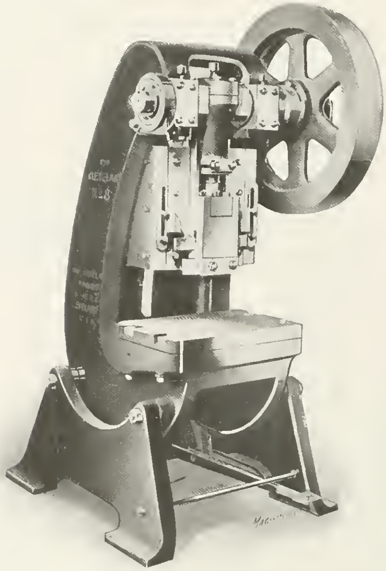


Fig. 1. Cleveland Open-back Inclinable Power Press

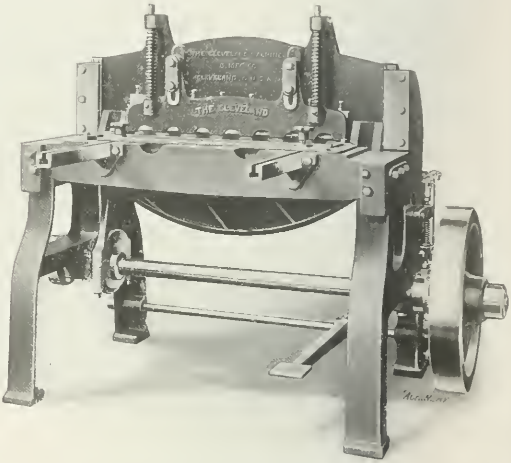
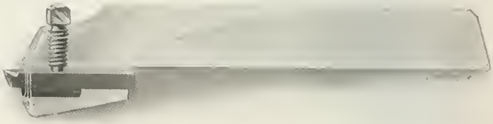


Fig. 2. Cleveland Plain Shear

Fig. 2 shows a plain power shear which has been added to the line of the Cleveland Machine & Mfg. Co. This shear has blades 31 inches in length and the capacity for cutting 18-gage steel, and has been designed to produce accurate work under hard usage. It has the same style of clutch as was described in connection with the power press. The gate has a powerful spring hold-down, and the machine is furnished with a complete set of front, rear and side gages. The total weight is 1250 pounds.

READY SHAPER AND PLANER TOOL

The illustration shows the "Red-E" style K shaper and planer tool, a recent product of the Ready Tool Co., 654 Main St., Bridgeport, Conn. An important feature of this tool-holder is the location of the cutter with reference to the holder and the tool apron. Placing the cutter back of the line of force prevents it from digging into the work and causing chatter. In this respect, the advantages of the goose-neck form of tool are obtained in connection with the increased cutting capacity of high-speed steel. The tool-holder has a piece of tool steel welded into it to form a bearing for the cutter, thus doing away with the tendency for the tool-holder to wear in the tool seat. The tool is made in three sizes adapted for using cutters of square stock 5/16 by 2½ inches, 7/16 by 3 inches and ½ by 3½ inches.



"Red-E" Style K Planer and Shaper Tool

WESTINGHOUSE INDUCTION MOTOR

The new line of type CS squirrel cage induction motors made by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., possesses several noteworthy features of design. Among these may be mentioned the extensive use of pressed steel in the construction, and rotors with cast-on short circuiting rings, and moisture and heat-resisting insulation. The use of pressed steel represents an advance in motor design. It imparts great mechanical strength and is very uniform in structure; hence a motor of given weight can be made with more active material than motors of corresponding capacity built with cast-iron frames. In these motors rolled steel forms the frames of all sizes above twenty horsepower, the end plates of the smaller sizes (which are of the so-called frameless type), and the feet and the slide rails of all sizes. As a result these motors are very compact, a feature that is of great importance in many applications. Above five horsepower the form-wound stator coils are laid out in open slots, and in case of accident, repairs can be readily made.

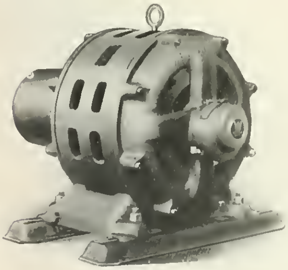


Fig. 1. Westinghouse Type CS Induction Motor

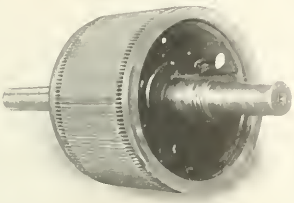


Fig. 2. Rotor of Westinghouse Type CS Motor

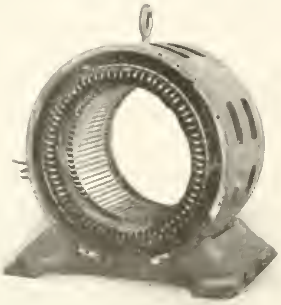


Fig. 3. Stator of Westinghouse Type CS Motor

The rotor construction is especially interesting. In all sizes, the rotor bars are insulated with a special cement which is moisture-resisting and will withstand a high degree of heat and mechanical stress. In motors above fifteen horsepower the bars are connected electrically and mechanically by casting the short circuiting rings around their ends. Hence there is nothing that can burn out, deteriorate under heat, or work loose under vibration. The bearings, the only wearing parts, are made of liberal size. They are protected from dust by a cap on the front end and by felt washers between metal rings on the pulley end. The efficiency and power factor are high, not only at full loads but also at fractional loads. This last feature is of special importance because industrial motors generally run at less than full load. These motors are being built in all commercial sizes from 1 to 200 horsepower.

SPRINGFIELD WET TOOL GRINDER

The illustrations show front and back views of the Brandes wet tool grinder, which was recently placed on the market by the Springfield Mfg. Co., Bridgeport, Conn. This machine combines a number of useful features in its design. The method of mounting the wheel enables a worn wheel to be removed and a new one substituted in its place without the necessity of dismantling the bearings. For this purpose, it is merely necessary to take off the hood and remove the nut from the end of the spindle. The ball bearings are of ample size to fit them for carrying a considerably greater load than they are required to support when used on this machine. They are packed with lubricant which enables them to run for extended periods of time without attention.

The necessity of a pump has been eliminated by the provision of a reservoir which is raised and lowered by means of the handwheel shown in Fig. 1. By raising this reservoir, the water is brought up to the wheel and the amount of water

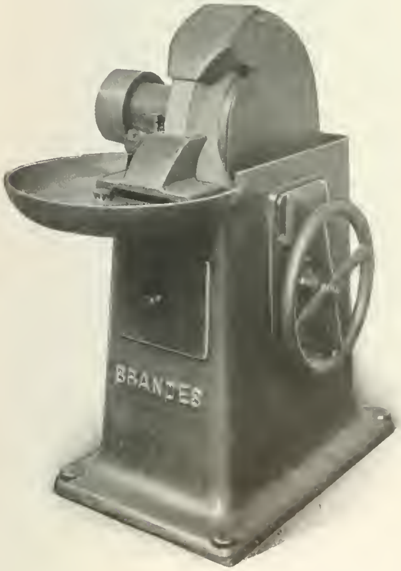


Fig. 1. Front View of Springfield Wet Tool Grinder

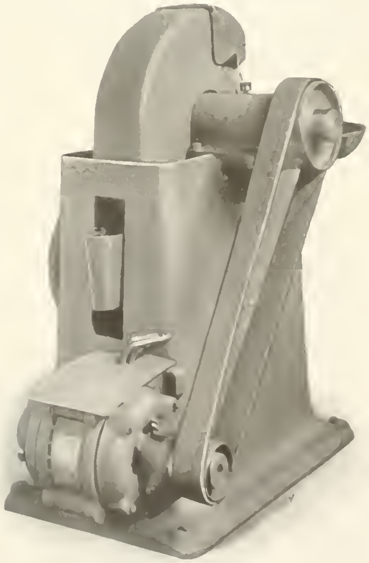


Fig. 2. Rear View of Springfield Wet Tool Grinder

supplied can be regulated by adjusting the height of the reservoir. The reservoir extends out from the base at the back of the machine as shown in Fig. 2, to permit filling it and also to permit of easy observation of the water level. The door shown at the front of the machine in Fig. 1 can be removed, thus providing an opening sufficiently large to enable the reservoir to be withdrawn when necessary. The water apron is exceptionally large for a machine of this size, and this apron, together with the convex surface of the toolrest, effectually prevents the spattering of water on the floor.

Fig. 2 shows the application of individual motor drive to this machine. This construction enables a standard direct-current or alternating-current type of motor to be used, and there is ample distance between the motor and wheel spindle to give the belt a good grip on the pulleys. The machine is designed to operate at a speed of 900 revolutions per minute.

SLEEPER & HARTLEY SPRING COILER

The universal spring coiler shown in the accompanying illustrations is a recent product of Sleeper & Hartley, 98 Beacon St., Worcester, Mass. The machine is known as the No. 1 universal coiler and is automatic in operation.

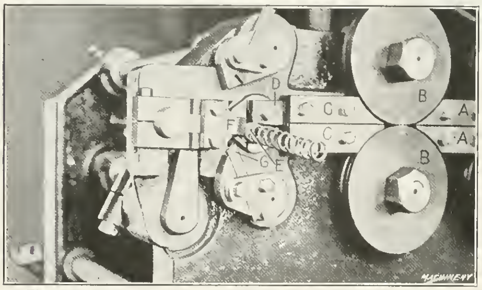


Fig. 1. Operating Mechanism of Sleeper & Hartley Spring Coiler

It takes the wire from the coil, feeds it into the machine, coils it to the required form and cuts off the finished spring. The output varies from 50 to 150 springs per minute, according to the type of spring which is being wound and the size of the wire. The machine will coil right- and left-hand springs, two-diameter springs, conical springs with any degree of taper, and barrel springs with any desired "crowning." It will also taper one or both ends of the spring. Single rings or any desired portion of a single ring may also be formed and cut on this machine. The range of wire which can be handled is from No. 32 to No. 16 gage with a feed of from 0 to 36 inches. Springs varying from 1/8 inch to 1 inch inside diameter can be wound. The range and variety of spring forms which can be produced is indicated in Fig. 5, and it will be of interest to know that an experienced operator is able to change the machine for producing a new form of spring in from ten to twenty minutes.

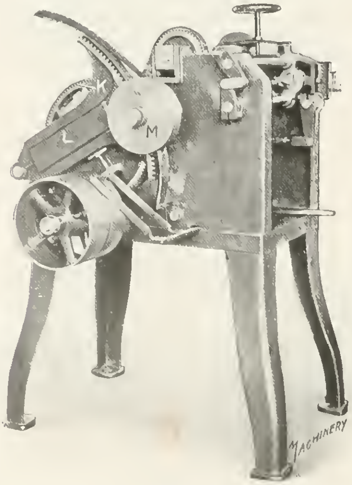


Fig. 2. Mechanism of Sleeper & Hartley Spring Coiler that controls Length of Spring

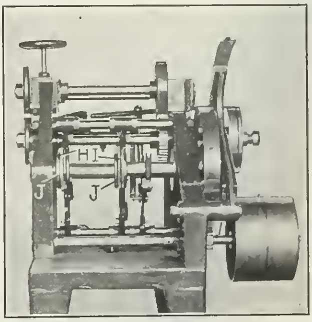


Fig. 3. End View of Machine showing Cams that control Diameter and Pitch of Spring

The operation may be briefly described as follows: The wire enters the machine through the guides *A*, passing between the adjustable feed rolls *B* by means of which it is fed forward through guides *C* under the guide *D* and over the arbor *E*. When the end of the wire strikes the coiling point *F*, it is forced into a curve of the required form for the spring which it is desired to make. The relative positions of the coiling point *F* and the arbor *E* are adjustable, and this relation determines the diameter of the coil that is formed. The complete spring is cut off by the knife *G*. Variations in diameter or pitch are made by means of cams *H* or *I*, Fig. 3, these cams being made in two parts which are adjustable in relation to each other and also on the cam hubs *J* to which they are clamped. Variations in the length of wire are effected by adjusting the position of the crank piece which slides across the gear *K*, Fig. 2. The crank piece is connected with a sliding member in segment *L* by

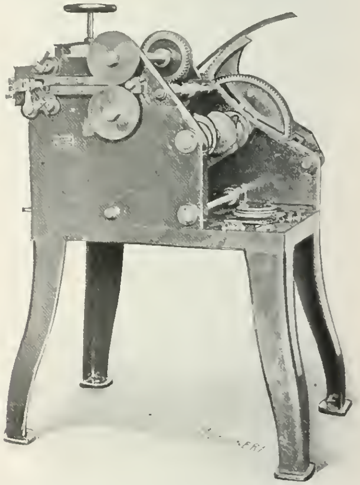


Fig. 4. Feed Mechanism of Spring Coiler shown in Detail in Fig. 1

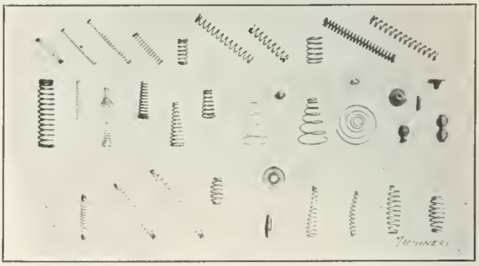


Fig. 5. Different Forms of Springs made on Sleeper & Hartley No. 1 Universal Coiler

means of which the feed rolls are driven. An interesting mechanical feature of this machine is the noiseless ratchet *M* which forms the intermediate driving connection between the segment *L* and the feed rolls *B*.

GEAR GUARD FOR WALCOTT ENGINE LATHES

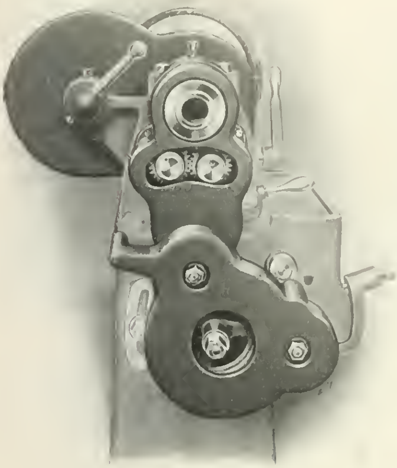


Fig. 1. Method of guarding Change Gears of Walcott Engine Lathes

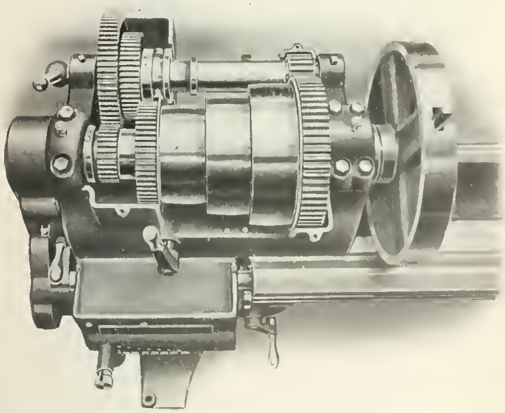


Fig. 2. Gear Guard for Walcott Engine Lathes made Integral with Headstock

The Walcott & Wood Machine Tool Co., Jackson, Mich., has lately applied a new form of gear guard to all sizes of its engine lathes, which were described in the January number of MACHINERY. The lower part of the gear guard is made integral with the headstock casting, and is machined on its top face to fit the removable or top part of the guard. This guard completely encloses the back gears and protects the operator against accidents. The change gears are also guarded, as illustrated in Fig. 1, as are also the reverse gears. These two guards can be easily and quickly removed when necessary.

Another improvement in the Walcott engine lathes is the method of shifting the sliding back gear for changing the speed of the spindle. The sliding gear is operated by the handle at the front in Fig. 2, which through a fork lever that fits in the sleeve, draws this gear over in contact with the larger gear on the cone. This is accomplished after the larger back gear has been thrown out of mesh with the smaller gear on the cone. Walcott engine lathes are now being built with the improvements here described, in 14-, 16-, 18- and 20-inch sizes.

VICTOR BOLT POINTER

The No. 2 nut facing machine built by the Victor Tool Co., Waynesboro, Pa., was illustrated and described in the June issue of MACHINERY. The illustrations presented herewith show a cutter head designed for use on this machine which adapts it for the operation of pointing or rounding bolts. When the nut facing machine is to be used for this operation, the cutter head is screwed onto the spindle of the machine and the bolt to be pointed is carried by a suitable holder on the tool carriage. The bolt is fed up to the cutter head by means of the hand lever which also feeds the facing tool up to the work when the machine is being used for its regular purpose.

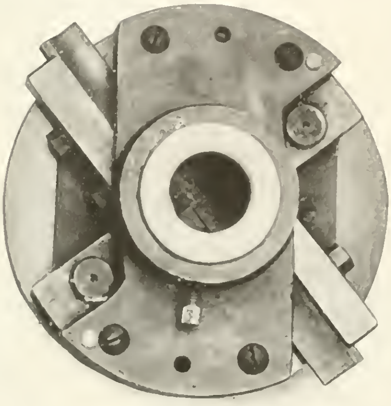


Fig. 1. Bolt Pointer for use on Victor Nut Facing Machine

The cutter head is strongly built and fitted with high-speed steel forming tools or cutters, the front and back view of the cutters being illustrated in Fig. 2. The cutters are 4½ inches in length when new and are ground to a cutting edge on one end. They can be reground until their length has been reduced to 1 inch, thus giving 3½ inches of actual wearing length to each tool. Means of adjustment are provided to enable the position of the cutters to be so regulated that one set will point or round a number of different sizes of bolts, and the design of the adjustment is such that both cutters can be regulated at the same time.

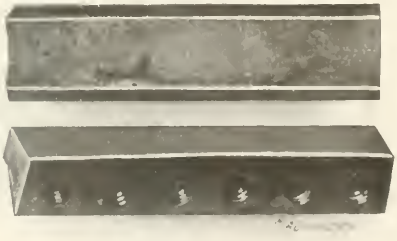


Fig. 2. Cutter used in the Victor Bolt Pointer

The head is fitted with hardened steel bushings for supporting the bolt while it is being pointed. Although this cutter head was especially designed for use on the Victor nut facing machines, it can be attached to any bolt cutter, lathe or any other machine tool on which bolts can be pointed. The tool is of simple construction and does not require a skilled mechanic to operate it.

WESTINGHOUSE UNIVERSAL BLOW TORCH

The gasoline blow torch shown was recently placed on the market by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The design of this torch includes several improvements which adapt it for all conditions of service; hence the application of the term "universal." The burner is made particularly heavy so that it will retain its heat and keep the torch burning in cold or windy weather. The drip cup is made especially deep so that it will start the torch under adverse weather conditions. These features, however, do not detract in any way from the use of the torch for indoor work.

Another improvement is the self-cleaning burner valve. The needle at the end of the valve stem cleans the hole automatically when the valve handle is turned. Consequently, the valve seat need never be injured by picking at the opening in order to clean it. The valve seat is a separate plug which may be replaced when necessary. The handle of the valve is made of fiber and does not get hot nor require a long valve stem for cooling. It will not crack, wear loose, char nor burn. The tank is reinforced with an extra corrugated brass disk which covers the entire inner surface of the tank pot. This insures having the tank keep its proper shape under very rough handling. The pump valve works in a cylindrical guide and insures perfect seating for the valve. It can be taken apart and all parts are made replaceable. The illustrations show the quart size of torch, but this tool is also made in a pint size which is designed along the same general lines as described in the preceding paragraphs.

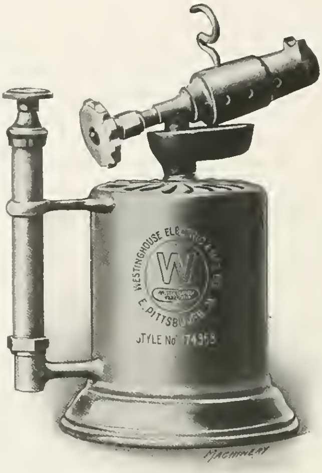


Fig. 1. Westinghouse Universal Blow Torch

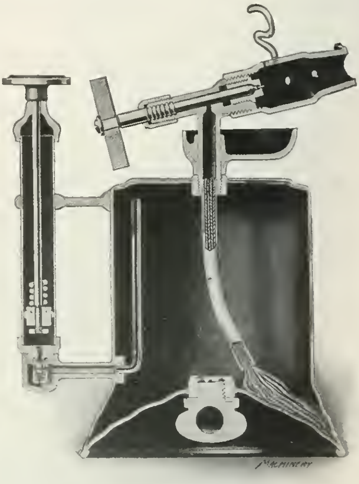


Fig. 2. Cross-sectional View of Blow Torch

SPRINGFIELD DRY GRINDERS

The illustrations show two sizes of a type of dry grinder which has been added to the line of the Springfield Mfg. Co., Bridgeport, Conn. The spindle runs in ball bearings which are carried in boxes especially designed for use on grinding machines. These boxes are made with two felt packing rings on each side of the bearing, and in addition to this protection the end shells fit closely around the shaft thus making it practically impossible for any dirt or grit to find its way into the bearings. The bearings are packed with lubricant, and the machines have been operated continuously in the factory of the manufacturers for a period of three months, at the end of which time it was said to be impossible to detect any wear or perceptible loss of lubricant.

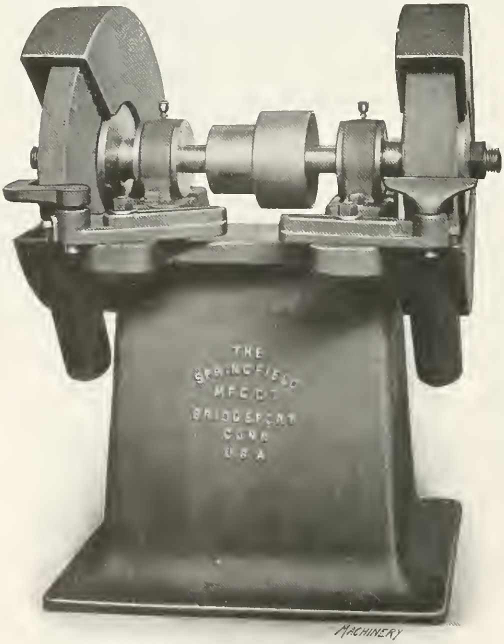


Fig. 1. No. D-B Springfield Dry Grinder

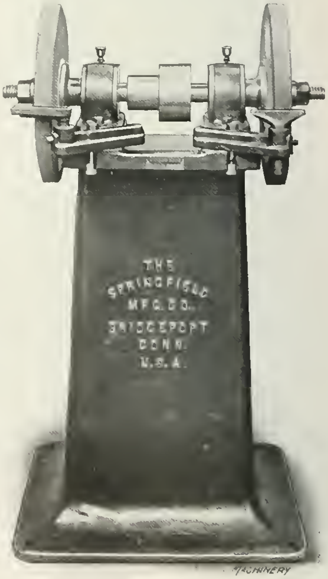


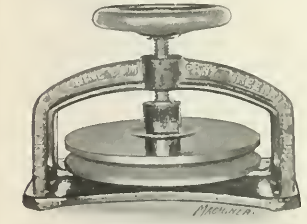
Fig. 2. No. B-B Springfield Dry Grinder

The machines can be furnished with hoods as shown in

Fig. 1. Reference to this illustration will show that the hoods enclose the entire wheel with the exception of the necessary space for grinding. The ends of the hoods can be readily removed to enable wheels to be changed. These hoods are designed for use either with or without an exhaust system. The No. BB machine illustrated in Fig. 2 is designed to carry wheels up to 16 by 2 inches in size; it occupies a floor space of 20 by 27 inches and weighs 625 pounds. The No. DB machine illustrated in Fig. 1 is designed to carry wheels up to 24 by 4 inches in size; it occupies a floor space of 28 by 44½ inches and weighs 1400 pounds.

BICKFORD CEMENTING PRESS

The bench type of disk grinder made by the Bickford Machine Co., Greenfield, Mass., was illustrated and described in the May, 1913, issue of MACHINERY. The cementing press illustrated herewith has been brought out by the company for use in cementing disk wheels for the bench grinder. The design of the press will be readily understood by reference to the illustration. The disk is 10½ inches in diameter and the handwheel 7½ inches in diameter. The screw is ¾ inch in diameter and has an Acme thread, and a ball thrust bearing is provided between the collar on the screw and a shoulder on the disk hub. The screw provides sufficient movement to enable the press to take in two disks at the same time, if necessary.



Bickford Press for cementing Disk Wheels

WENNERSTROM DIVIDING CHUCK

A dividing chuck which incorporates some interesting features in its construction is being manufactured by Wennerstrom Bros., 432 Sinclair Ave., Grand Rapids, Mich. While this chuck is particularly adapted for lathe work it can also be used to good advantage on the milling machine, where it takes the place of the usual dividing head. Its range, however, is much greater than that of the regular dividing head, and when equipped with a base to provide for angular settings the scope of the tool is practically unlimited.

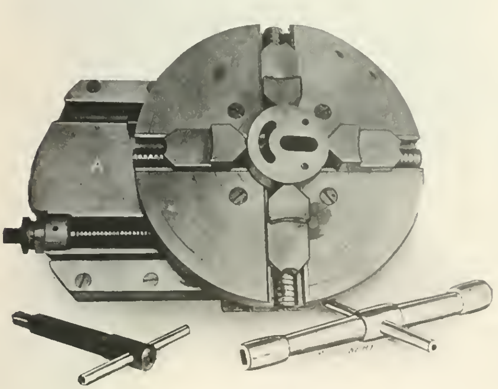


Fig. 1. The Wennerstrom Dividing Chuck for use on the Lathe or Miller

Referring to Fig. 1, the chuck consists of a base *A*, to which a second plate is fastened, the latter being provided with a threaded hole to fit the nose of the lathe spindle. The base-plate *A* is provided with V-grooves in which a carriage *B* slides, which is operated by the micrometer screw C. (Fig. 2.) The carriage is made to fit the rotating member *D* to which the four-jaw chuck *E* is held by four screws as shown in Fig. 1. The lower portion of the rotating member *D* is provided with worm teeth *F* which mesh with worm *G* carried on the dividing screw *H*. That portion of the rotating member *D* which fits in the carriage *B* is turned taper to an angle of 15 degrees, thus making provision for adjusting for any wear which may take place between these two members; this also makes a bearing superior to a straight surface.

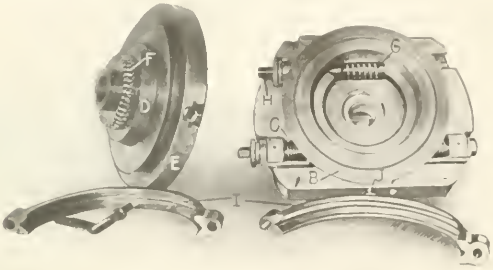


Fig. 2. Parts of the Wennerstrom Dividing Chuck

The top circular portion of the slide *B* and that portion of the rotating member *D* which comes in contact with it are provided with reverse tapered edges, which enables them to be clamped together by means of the split bronze clamping ring *I* shown in Fig. 2. When tightly clamped, this ring secures the two members together and prevents any movement while an operation is being performed on the work held in the chuck. When it is required to use the chuck for producing a circular groove, the screw binding the collar *I* is loosened sufficiently to allow the rotating member *D* to be moved around.

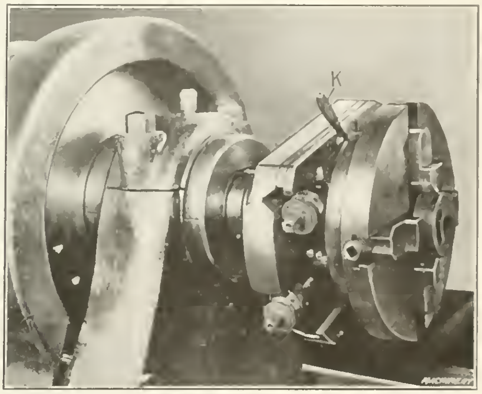


Fig. 3. Wennerstrom Dividing Chuck in Operation

In Fig. 3 the chuck is shown in the operating position where it is held by a hardened plunger *J* (see Fig. 2) which fits in a bushing held in the sliding member of the chuck. The hole in the bushing is longer than the plunger, allowing for wear between the two working surfaces of the sliding and rotating members. When the chuck is set off center as shown in Fig. 1, it is rigidly clamped in position by means of the lever *K* (see Fig. 3), which operates a circular segment fitting in the carriage and binding against the ways.

The chuck is of the four-jaw, independent, reversible type, the jaws of which are operated by the usual form of square threaded screws. The chuck can be taken off by removing the four clamping screws and replaced by a faceplate in order to handle work of irregular shape or of a larger size than the capacity of the chuck jaws. A ten-pitch screw with square threads operates the slide *B* and the collar on this screw has one hundred divisions enabling movements of 0.001 inch to be made. The collar on the screw operating the rotating member *D* is divided into 360 degrees. The collars are held in place by knurled nuts and when these nuts are loosened, the collars can be set to zero. The eccentric capacity of the chuck illustrated is 4⅝ inches.

Fig. 4 illustrates examples of work handled in this chuck and gives some idea of its range. The pieces *A*, *D*, *F* and *H* show what combinations are possible by moving the slide and rotating the chuck. The pieces *A*, *D* and *H* also show what can be done with the chuck in the way of drilling equidistant holes around the circumference of a circle. The piece *E* shows what the chuck can do in the way of eccentric turning. The grooves in this piece were cut with a parting tool and the eccentricity of the different grooves was obtained by adjusting the distance at which the chuck was set off center. The production of the hexagon hole in the piece *H* is rather an interesting operation and was accomplished with a drill and boring tool. Six holes of the required size were first drilled in the proper positions which were obtained by use of the dividing collar. The boring tool was started in one hole and the slide of the chuck moved over until one side of the hexagon was completed. The boring tool was then withdrawn and the work indexed 60 degrees, after which the boring tool was brought up to the work and another side of the hexagon completed. This procedure was followed until the six sides of the hole were machined.

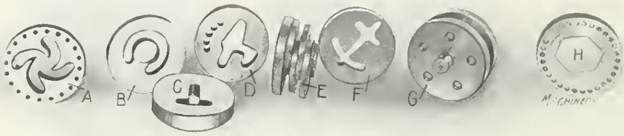


Fig. 4. Examples of Work done in the Wennerstrom Chuck

In starting to produce any shape of hole or boss with this chuck, the work is first turned up with an indicator either from the outside circumference or from a prick punch mark, according to the requirements of individual cases. After this has been done, all subsequent settings are handled by the two collars on the chuck. By working out the correct relative "moves" of the micrometer and dividing collars, which can be obtained by trigonometry, it is possible to generate a perfect ellipse. Other combinations of shapes different from those shown in Fig. 4 can be obtained by using different "moves" of the two operating screws. It will be evident from a careful study of the work shown, and from the preceding description, that this chuck is admirably adapted for tool-room work—especially for the production of punches and dies. The clearance in a die can be obtained by using the compound rest and setting it over to the angle of clearance desired. This chuck will be built in three sizes, capable of handling a large range of work.

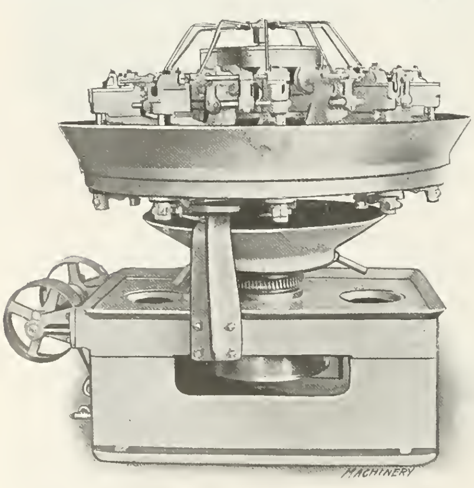


Fig. 1. Front View of Langelier Cotter Pin Hole Drilling Machine

LANGELIER COTTER PIN HOLE DRILLING MACHINE

The illustrations show a machine known as the No. 1 semi-automatic ten-spindle continuous-feed drilling machine which has recently been added to the line of the Langelier Mfg. Co., Providence, R. I. This machine is particularly adapted for drilling small holes, such as cotter pin holes, in long pins, bolts, screws, nuts and work of a similar nature, and is built for various sizes of work with any number of spindles up to and including ten. In the illustrations, ten spindles are shown provided with ten work holders or vises which rotate around a stationary cam. The spindles feed outward as they rotate, each spindle operating on one piece. Nine of the spindles operate simultaneously. The tenth one is in the loading position where the operator removes the finished piece and replaces a blank which is to be drilled. The drill is withdrawn as it passes the loading position and the corresponding vise opens automatically for the operator to remove the work and replace it with a blank.

The operator can either sit or stand, as desired, while inserting fresh blanks in the vises. The vises are closed either automatically or by means of a foot treadle. All that the operator has to do is to remove the finished pieces and insert blanks in the vises which can be made to hold pieces of various sizes and shapes. Either vertical or horizontal vises may be used, the style being determined by the class of work upon which the machine is to operate. When long pieces are to be drilled, the vises are made to hold the work in a vertical position, the work extending up any reasonable length that can be operated upon. On some classes of work an automatic ejecting device can be used to advantage so that when the jaws open automatically the work will be forced out. With a machine equipped in this way, all that the operator has to do is to place fresh blanks in the vises.

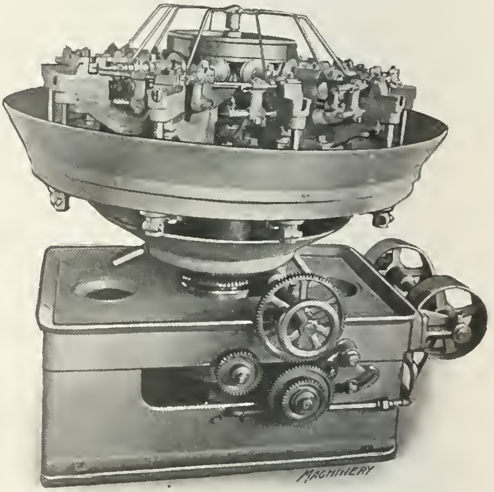


Fig 2. Rear View of Cotter Pin Hole Drilling Machine

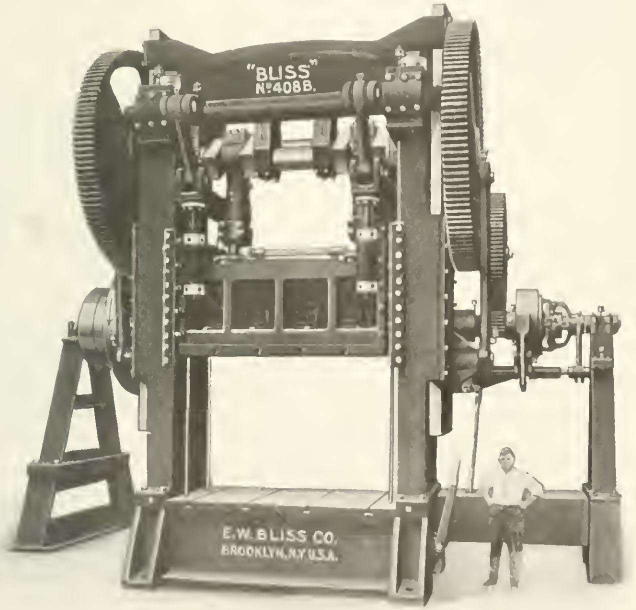
The spindles are hardened and ground and run in phosphor-bronze bearings. The maximum feed travel is 1½ inch, and the chucks will take drills up to ¼ inch in diameter. The feed cam that operates the spindles is easily removed so that cams to give different ranges may readily be substituted. When deep holes are to be drilled, the cams are made to withdraw the drills frequently, thus breaking and clearing the chips from the holes. The feed of the drills can be changed to suit the depth of holes and the sizes of drills.

Provision is made for ample lubrication of the drills, the lubricant being forced between the vise jaws and the work, thus keeping the work flooded at the point of drilling so that the highest possible feed and cutting speed may be employed. A circular pan surrounds the ten drilling heads, this pan having ample capacity for holding the drilled work and chips. The oil is strained and drained into the base, where it is pumped back to the work by a circulating pump. An idea of the productive capacity of the machine will be obtained from the following example: Automobile chain pins ½ inch in diameter are drilled with 0.121-inch drills running at 2200 revolutions per minute, the production being 20 pins per minute. The capacity of the machine for round pieces with two sets of vise jaws is from ¼ to 1 inch, the first set taking from ¼ to ⅝ inch and the second set from ⅝ inch to 1 inch. The jaws carry a drill guide bushing which centers the drill accurately. These jaws can be very quickly changed when it is required to operate the machine on some other class of work.

BLISS DOUBLE-CRANK TOGGLE DRAWING PRESS

The double-crank toggle drawing press illustrated herewith was designed by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., for use in drawing and forming operations on heavy gage sheet metal. The machine is particularly adapted for drawing and forming articles of large area and considerable depth, such as automobile radiators, fenders, stove tops and similar classes of work. For operations of this nature it has several features which make it more efficient than a standard double-crank press used in connection with spring pressure attachments.

The construction is what is known as the tie-rod type, in which the bed, uprights and crown piece are tied together by four vertical steel tie-rods which are shrunk in place and take the entire working strain, thus relieving all cast-iron parts from tensional stresses. The design of the machine is such that power is transferred from the main driving gears to the outside slide or blank-holder through a series of toggles, and a dwell of 110 degrees is provided. The number of toggles and connections used has been reduced as far as possible. In order to maintain this simple and efficient construction in a wide press of the type illustrated and at the same time avoid any torsional strain, it will be noted that power is transferred to the outside slide or blank-holder from both ends of the press. This construction is also followed in connection with the crankshaft which operates the inner slide, a driving gear being mounted on each end of the shaft. The small number of connections or links used in transferring power to the outside slide or blank-holder insures a minimum power consumption, and, in addition, makes a simple, compact and strong construction in which wear is reduced to a minimum. In this connection it may be mentioned that the connecting pins are hardened and ground to reduce wear.



Bliss Double-crank Toggle Drawing Press weighing 120,000 Pounds

Control of the machine is effected by a powerful hand-actuated friction clutch of the double-grip type, by which means the operator has the moving parts under control at all times. Both the flywheel and tight pulley are arranged with safety couplings as a precaution against possible accidents or damage to the machine resulting from dies being incorrectly set. The machine is double geared, the ratio of the gearing being 42 to 1. The entire train of gears is machined from steel castings, the loose pulley and all back shaft bearings are bronze bushed, and the bushings have babbitt with graphite cast in them to aid lubrication.

The inside slide is counterweighted by weights placed in the driving gears and the outside slide or blank-holder is counterweighted by the outside crossheads which, in addition form the direct link between the rocker shafts and driving gears. Adjustment of the outside slide or blank-holder is effected by means of four screws which are plainly shown in the illustration. Adjustment of the inner slide is made by adjusting screws which operate together, keeping the faces of the slide and bed in correct alignment. In the larger sized machines these adjustments are operated by an independent motor mounted on the slide.

The press illustrated is one of a series which the Bliss Co. has recently built, and while this particular machine is not the largest of the series it will be evident from the illustration that it is of very large proportions. The total height is 19 feet; the machine occupies a floor space of 235 by 104 inches and has a total weight of 120,000 pounds.

HOUGHTON & RICHARDS CUTTING-OFF MACHINE

Houghton & Richards, 1394 West Third St., Cleveland, Ohio, are now building the drop-arm type of cutting-off machine illustrated in Figs. 1 and 2. This machine has been designed to meet the demand for a machine that will cut off long bar stock squarely and that will also cut a great variety of irregular shapes in metal. The range of the machine may be gathered from the fact that any class of work that can be done on an ordinary band saw designed for cutting wood can be handled on this metal cutting band saw The feed mechanism is of the gravity type and is operated by the weight of the drop-arm, but the action of this weight is governed by a drum friction equipped with a bank brake. The arm is attached to the winding drum by a ¼-inch steel wire cable and the drum is geared to the large handwheel at the front of the machine by means of small bevel gears. The arm is raised or lowered by turning this handwheel.

There is a cam on the upper driving shaft which can be adjusted for any depth of cut by unscrewing a bolt with a large knob which is located to the left of the pulleys. As the arm descends, this cam engages a steel roller on the shifting lever, and by the aid of a small trigger shifts the belt to the loose pulley. Attached to the shifter rod is a small arm which operates the vertical shaft passing through the curved pedestal. This arm is connected with the horizontal shaft below the table of the machine, which governs a lifting device. This lifting device causes a pawl to lower and engage a ratchet wheel cast on the hub of the large handwheel, which raises and lowers the arm. When the lifting device is down, the pawl is engaged with the ratchet and the handwheel must be turned by hand in order to release the ratchet. If this is not done, the belt shifting rod will not move to start the machine. This device locks the arm as soon as the saw has cut through the piece upon which it is working, and makes it impossible to start the machine until the lock of the arm has been released. This does away with the danger of prematurely starting the machine.

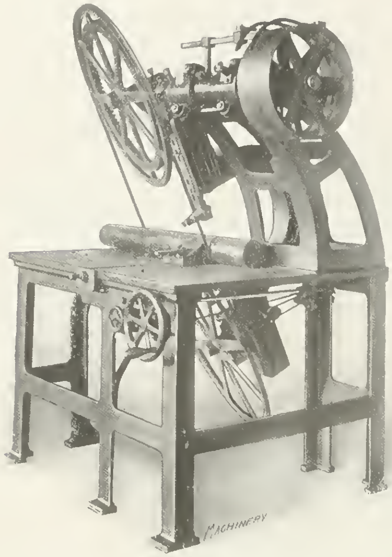


Fig. 1. Houghton & Richards Cutting-off Machine in Use on Bar Stock

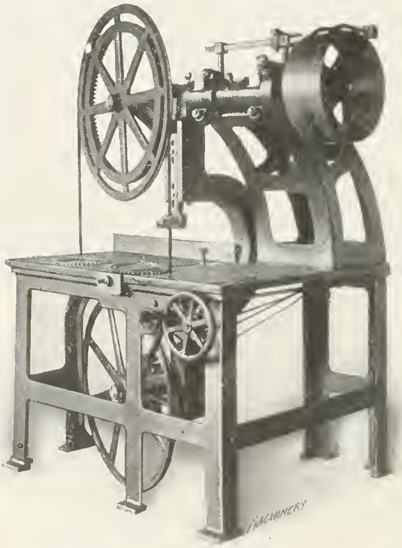
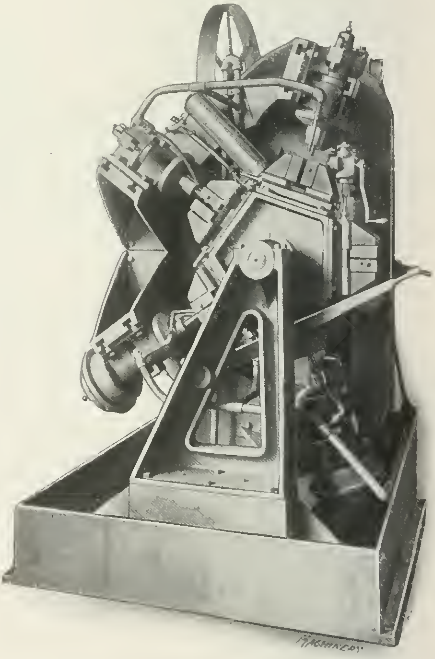


Fig. 2. Houghton & Richards Cutting-off Machine engaged on Die Work

The size of band saw used is 0.031 inch in thickness by ⅝ inch wide. The thinness of this blade is the means of effecting a material saving in cutting expensive material such as high-speed steel, which is said to be great enough to enable the machine to pay for itself in a very short time. Experience has shown that the average life of one of these saws is terminated after it has cut about 1500 square inches of tool steel, the speed at which the band saw is operated averaging from 120 to 135 feet per minute. The actual time required to cut off a six-inch round bar of tungsten steel is from 16 to 20 minutes, depending upon whether a 14-tooth or a 10-tooth saw is used. These machines are built for either belt drive or direct motor drive. In the latter case, the motor is mounted on the curved pedestal and geared direct to the machine, the starting box being fastened to the sides of the pedestal. This makes a very compact arrangement, in which all of the moving parts are above the table. Three sizes of machines are built for cutting up to 6-, 8- and 12-inch square or round stock.

POTTSTOWN REAMING, COUNTERBORING AND TAPPING MACHINE

The machine shown in the accompanying illustration was designed by the Pottstown Machine Co., Pottstown, Pa., for use in reaming, counterboring and tapping superheater return bends or work of a similar nature. The machine has four spindles, two of which are used for reaming and counterboring and two for tapping operations. The reaming spindles are located below the center of the turret and feed upward, thus permitting the chips to drop out by gravity. The taps are fed in by lead-screws having the same pitch as that of the thread which is desired. The machine is equipped with a revolving turret which has five chucks. The work held in four of these chucks is being operated on by the spindles of the machine while the operator is removing the finished piece from the fifth chuck and replacing it with a fresh blank. The turret is revolved and indexed by a pneumatic attachment, and a fixed wrench is provided for closing the chuck jaws.



Pottstown Machine for reaming, counterboring and tapping Superheater Return Bends

The machine is equipped with the standard form of reversing mechanism applied to machines of this company's manufacture. This mechanism does not vary in time of reversing, and thus insures having the work tapped uniformly to gage. A rotary geared pump is provided for furnishing lubricant to the taps and reamers. The four heads are adjustable on the housing brackets to adapt the machine for different sizes of work. The machine proper is mounted on a base which has a deep pan cast integral with it. This pan serves as a reservoir for the lubricant and also catches chips and drippings. All the gears used in the machine are made of 40 carbon cast steel with cut teeth, and all the gearing is entirely enclosed. The total weight of the machine is 15,000 pounds.

EVELAND POWER-DRIVEN ELECTRIC RIVETER

The power-driven electric riveter illustrated in the halftone Fig. 1 is a product of the Eveland Engineering & Mfg. Co., 2324-2328 Market St., Philadelphia, Pa. As in the case of all the electric riveting machines manufactured by this company, the rivet is placed in position and heated by electricity, after which the head is formed by a rivet set carried by the ram of the machine. An interesting feature of the machine shown in the illustration is the application of power for driving the ram. The electric motor used for this purpose is connected to the same alternating-current circuit that is used for heating the rivet. The gears are of ample strength to transmit the necessary pressure, which may vary from a few hundred pounds up to fifty tons according to the requirements of the work.

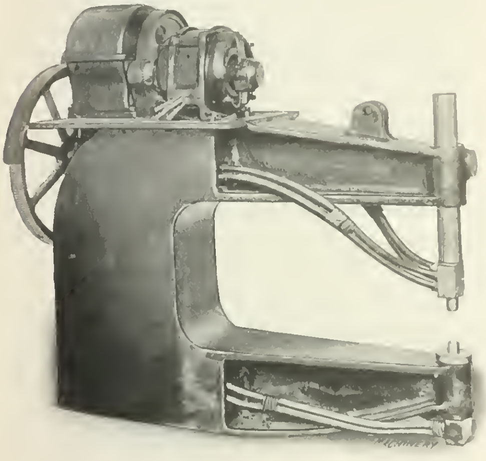


Fig. 1. Eveland Power-driven Electric Riveting Machine

The machine is automatic in its operation, being provided with a motor-driven variable speed attachment by means of which the operator may regulate the pressure as well as the rapidity with which the rivet is heated by merely pressing push-buttons. One operator, with a helper to handle the work, can rivet pieces together on this machine at any angle and on work of any shape, the rivets being placed in position and heated automatically, after which—by simply pressing a push-button—the ram will descend and head the rivet. By pressing another push-button, the ram is returned to its original position. The machine will force a rivet into place, and, if necessary, straighten the bar in which it is carried and then return to its normal position in a period of time varying from 8 to 15 seconds according to the shape of the work and diameter and length of the rivet.

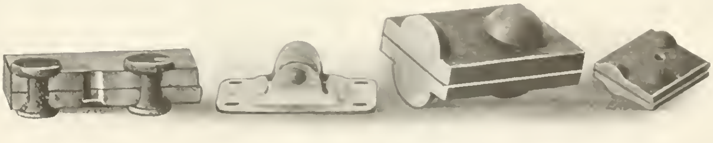


Fig. 2. Examples of Work done on the Eveland Riveter

These electric riveters will handle any size, shape or length of rivets made of iron, steel, brass, copper or other metal. The machines are capable of developing any temperature up to and even exceeding 2000 degrees F., and a regulating device can be provided which enables the rivets to be heated to any required maximum temperature. Where the holes in which the rivets are placed are not reamed, the metal in the rivet may be heated to a sufficiently high temperature so that the pressure will cause the metal to flow enough to completely fill the hole, thus making a very solid joint. The machine shown in Fig. 1 will take a flat plate or sheet up to 36 inches in width and bars or plates up to 20 inches in height.

WESTINGHOUSE SINGLE-PHASE MOTOR

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has placed on the market a new line of single-phase motors,

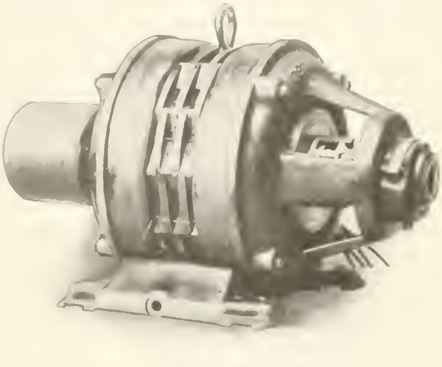


Fig. 1. Westinghouse Type AR Motor

made in capacities of from 2 to 10 horsepower and suitable for the majority of constant-speed applications within their capacities. These motors are of the repulsion-starting type, and when up to speed run as induction motors. For most applications they can be connected directly to the line, but where a very low starting current is desired a starting rheostat can be used.

The frame is so designed that it combines great strength and radiating capacity with the minimum weight and over-all dimensions. The laminations are riveted together under pressure and pressed steel end plates are riveted to the unit thus formed. The foot, or base, is of pressed steel plate securely riveted to the end plates. This use of pressed steel marks an important step forward in the design of large single-phase motors.

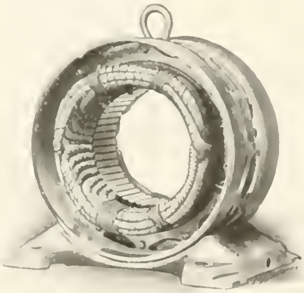
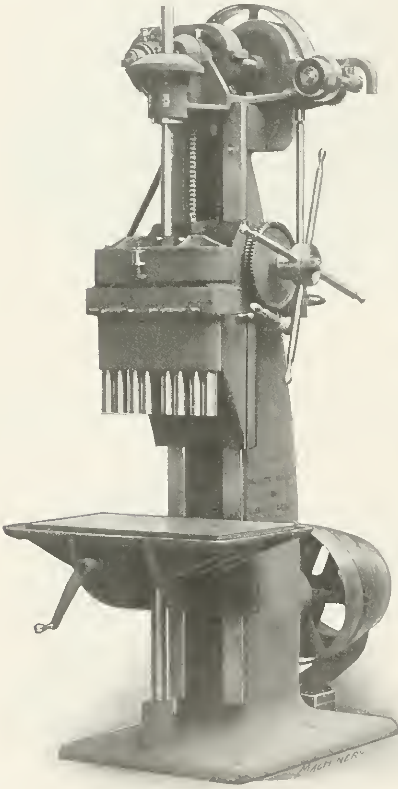


Fig. 2. Stator of Westinghouse Type AR Motor

The bearings are large and dust-proof. The rotor coils are form-wound and arranged to permit excellent ventilation. The commutator is of the radial type with undercut mica segments. The shaft can be pressed out of the rotor without disturbing the windings or the commutator. Each motor can be arranged for operation on either 110 or 220 volt circuits.

FOOTE-BURT MULTIPLE SPINDLE DRILL

The eight-spindle, fixed-center drill illustrated herewith was brought out by the Foote-Burt Co., of Cleveland, Ohio, and is one type of their No. 15½ multiple spindle drills. This machine is built with any desired number of spindles, which can be arranged to be either universally adjustable, adjustable in a straight line, or on fixed centers as shown in the illustration. The machine was designed for handling automobile work and is extensively used on the valve hole work on automobile cylinder castings. It is also used for drilling the sides of a crank-case or for any other multiple work which is required. It has found extensive application on valve hole work for boring large valve port holes and also for machining valve seats and drilling and reaming the valve stem guide hole. With this type of machine having the proper number of spindles—either adjustable in a straight line or with fixed centers—a manufacturer is able to machine the number of valve holes required on the cylinder as quickly as one hole could be machined with a single spindle machine.



Foote-Burt No. 15½ Multiple Spindle Drill

The spindles have large bearings and are bronze bushed. The driving spindle spur gears are made of 3½ per cent nickel-steel and the head slide on the column is of ample length to insure the necessary rigidity. The driving bevel gears are made of high carbon drop-forgings having planed teeth. The machine is arranged with friction throw-out back gears, a Johnson friction clutch being used. This arrangement is for taking care of the large range of sizes between the large valve hole and the valve stem guide hole upon which the machine is operated and also adds to the power of the machine. The drive is from a three-step cone pulley having steps 15, 17 and 19 inches in diameter by 4½ inches face. Six changes of power feed are provided by means of a two-step cone pulley and change feed gears. The column of the machine is of box section and the table has a large working surface with an oil groove entirely surrounding it. The table is raised and lowered by means of a screw and spiral gearing.

NEW MACHINERY AND TOOLS NOTES

Universal Testing Machine: Shore Instrument Co., 555 West 22nd St., New York City. A machine adapted for conducting tension and bending tests on steel and other metals.

Stillson Wrenches: Oswego Tool Co., Oswego, N. Y. Stillson wrenches made in a variety of sizes and styles for different classes of service. These tools are made of drop-forged tool steel.

Power Hacksaw: W. D. Pratt, Canton, Ohio. A hacksaw machine provided with a quick-return mechanism and adjusment for changing the length of the stroke and position of the swivel vise so that either end of the blade can be used.

Boring Mill with Rapid Power Traverse: Betts Machine Co., Wilmington, Del. A boring mill equipped with separate motor drive for providing rapid power traverse. Another feature of this machine is the use of an all-geared feed to the heads.

Bolt Turning Machine: Pawtucket Mfg. Co., Pawtucket, R. I. A machine designed for turning straight or taper bolts within a limit of 0.001 inch. The machine has a capacity for turning bolts up to and including 1½ inch in diameter by 20 inches in length.

Electric Arc Welding Machine: C. & C. Electric & Mfg. Co., Garwood, N. J. An electric welding machine adapted for such work as repairing blowholes in castings, etc., and for repairing breaks in street car tracks, locomotive frames and similar classes of work.

Duplex Milling Machine: Hoefer Mfg. Co., Freeport, Ill. A duplex milling machine adapted for milling both ends of automobile front axles simultaneously, thus avoiding the loss of time involved in changing the work, end for end, between successive milling operations.

Air-driven Breast Drill: Smith Drill & Machinery Co., Chattanooga, Tenn. This tool is driven by a small air turbine and will take drills up to ½ inch in size. The tool operates satisfactorily on 35 pounds per square inch air pressure and consumes 15 cubic feet of air per minute.

Herringbone Gear Hobber: Fawcus Machine Co., Pittsburg, Pa. A machine designed for hobbing herringbone gears of small and medium sizes. The maximum capacity of the machine is for gears 48 inches in diameter by 20 inches face, and the minimum diameter that can be cut is 1½ inch.

High-speed Riveter: H. P. Townsend Mfg. Co., Hartford, Conn. A riveter especially designed for setting the sparking points in automobile spark plugs. The head of the machine contains the regular mechanism of this company's riveters which strikes approximately 15,000 blows per minute.

Motor-driven Grinders: Forbes & Myers, Worcester, Mass. A line of motor-driven grinders adapted for medium and heavy work. The armature spindle of the motor which drives these machines is extended to provide a mounting for the wheels, and the electrical parts are totally enclosed, making them dust-proof.

Oil Grooving Machine: Fischer Machine Co., Philadelphia, Pa. A machine which operates automatically after the bearing has been set in place. The tool-slide is linked to an adjustable connecting-rod which gives a reciprocating motion, and the necessary change gears are provided for cutting different styles of oil grooves.

Electric Hardening Furnace: General Electric Co., Schenectady, N. Y. An electric furnace consisting of a crucible in which the bath is heated by two electrodes. The crucible is surrounded by brickwork to prevent the possibility of the bath being spilled onto the floor, and the entire furnace is enclosed in a sheet-iron case.

Multiple Disk Brake: Cutler Hammer Clutch Co., Milwaukee, Wis. A multiple disk brake intended for use on crane-hoists, rolling mills, etc. The fundamental parts of the brake mechanism consist of a magnetic case, a compression spring, a hub and a series of stationary and rotating disks, the entire mechanism being enclosed in a substantial case.

Screw Cutting Precision Bench Lathe: Cincinnati Precision Lathe Co., Cincinnati, Ohio. A screw cutting precision bench lathe in which no universal joints are used in the screw cutting attachment, the drive being entirely through gears. The machine has a capacity for cutting ten to eighty threads per inch and the spindle takes Rivett No. 4 collets.

Casehardening Boxes: Hess Steel Castings Co., Philadelphia, Pa. This company has recently standardized its line of casehardening boxes to meet the requirements of common practice. The sides of these boxes are made thicker along their upper edge, as experience has shown this to be the point of maximum wear. Special means of handling have also been provided.

Spring Machines: Sleeper & Hartley., Worcester, Mass. A plain spring coiling machine which takes wire from the coil and produces either open or closed extension springs in lengths up to 150 feet or more. The second machine is a helical cutting and hooking machine which produces the helical springs that are used in the manufacture of spring beds.

Combination Punch and Shear: Wiener Machinery Co., 50 Church St., New York City. A combination punch and shear designed for handling practically any class of cutting, shearing, coping, mitering and notching. The frame of the machine is made of steel. The machine is built in three sizes and can be equipped for belt drive or for direct-connected motor drive.

Horizontal Boring Machine: Termaat & Monohan Co., Oshkosh, Wis. A machine designed for boring gas engine cylinders. The work is clamped to the carriage and the spindle is driven through the bore. A facing head is attached at the head end of the spindle, and for facing the other end a stand is mounted on the carriage and the cutter bar extended to slip through the facing head to drive it.

Universal Tool and Cutter Grinder: Woods Engineering Co., Alliance, Ohio. A machine designed to meet the requirements of tool-room grinding. The elevating and cross-travel screws are provided with micrometer dials. The longitudinal table is of deep box section and adjustable stops are clamped to the face of this table in a T-slot to afford a positive stop for grinding up to shoulders. The top table swivels on a central stud and has a bearing for its full length without overhang.

Radial Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. A 6-foot, heavy-duty, radial drill in which the trunnions for the arm are provided with roller bearings and the weight of the arm is supported by a ball thrust bearing. The head is carried on a pair of rollers, backed up by heavy springs, and the gearing in the head is entirely enclosed in an oil-tight casing. The drive is obtained from a variable-speed motor through two nests of back gears, one on each side of the spindle.

Cutter Clearance Gage: Brown & Sharpe Mfg. Co., Providence, R. I. This gage consists of a steel bar 6½ inches long which carries a stud at one end on which the cutters are mounted. Five hardened steel bushings are provided to fit over this stud and carry cutters having holes 1, 1¼, 1½, 1¾ and 2 inches in diameter. The gage is mounted on a slide which is easily moved along the bar. The gage is attached to the slide by means of a pin which allows it to be revolved, one end being used for cutters under 3 inches in diameter and the other end for cutters of 3 inches and over. To test for the correct clearance, the cutter is placed on the stud and the gage pushed forward. The cutter is then revolved sufficiently to bring the face of a tooth into contact with a stop of the gage which gives the correct position for the cutter. The angle of clearance on the tooth should then correspond to the angle on the gage.

* * *

FIELD DAY OF GREENFIELD TAP AND DIE MAKERS

The employes of Wells Bros. Co., Wiley & Russell Mfg. Co., and A. J. Smart Mfg. Co., Greenfield, Mass., had their second annual field day at Island Park, Brattleboro, Vt., July 26. The employes formed a line of march in Greenfield, headed by the grand marshal, Frederick H. Payne and the Greenfield military band. The parade marched to the Boston & Maine R. R. station, and there took a special train for Brattleboro. The events included 100-yard dash; shot put; jumping; sack and potato races; hop, step and jump; tug-of-war, etc. Gold, silver and bronze medals were awarded to the successful contestants; and the banner of the organization was awarded to the employes of the Wiley & Russell shop, for scoring the greatest number of points in the events. In the afternoon, a baseball game between the "Lightnings" and "Little Giants" afforded the "fans" a chance to root for their respective sides. A grand minstrel show was also one of the events of the day. A tastefully arranged program of events contained a list of the old guard, comprising members identified with the concerns dating back to 1872. "The purpose of the old guard is the perpetuation, in a brotherhood, of the personal relations brought into existence through association together as employes, and to provide the employers with a means through which their appreciation of faithful service may be fittingly acknowledged." Membership in the guard is based on ten years' continuous service, regardless of position, and there are seventy-three members.

PERSONALS

C. R. Rothwell, general manager of the Lea-Courtenay Co., Inc., 90 West St., New York City, sailed June 28 for a two-months' trip to England and the Continent. Mr. Rothwell will combine business with pleasure.

W. H. Williams, formerly in the Pittsburg office of the Electric Controller & Mfg. Co., Cleveland, Ohio, has been transferred to the Chicago office of the same company to assume the duties of district manager in the Chicago territory.

Alexander E. Pribil, who has been in charge of the bolt and automobile grease cup departments of the Penberthy Injector Co., Detroit, Mich., is now in the employ of the Winkley Co., of Detroit, in charge of the same departments, which have been sold by the Penberthy Injector Co. to the Winkley Co.

Ysidoro Arnaiz, a Cuban nearly eighty-three years old, has just begun his seventieth year of continuous service with R. Hoe & Co., New York City, builders of printing presses. Mr. Arnaiz was apprenticed to Robert Hoe at thirteen, when only about one hundred people were employed. Now the concern employs nearly three thousand.

L. B. Campbell has resigned his position with Mr. H. L. Thompson, consulting engineer, of Waterbury, Conn., to take a position with the American Chain Co Mr. Campbell, who is the son of Mr. A. C. Campbell, inventor of a new type of cotter pin, is a technical graduate and has had practical experience with a number of manufacturing concerns in New England.

* * *

OBITUARIES

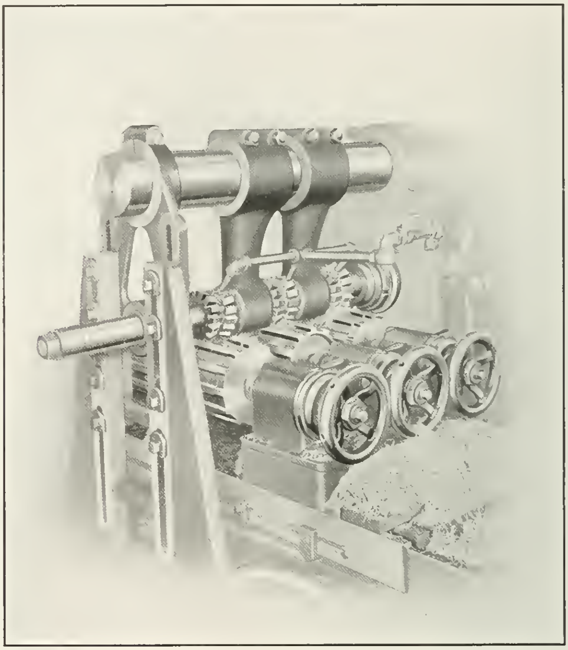
William Mason, who was for twenty-eight years master mechanic of the Winchester Repeating Arms Co., New Haven, Conn., died in Worcester July 18, aged seventy-six years. Mr. Mason retired from his position with the Winchester Repeating Arms Co. several years ago. He was a mechanical genius and inventor of note. More than 125 patents were granted him, most of them being for improvements in looms and weaving, steam pumps, bridge work, arms and ammunition, and machinery used in the manufacture of arms and ammunition. For years Mr. Mason was connected with the Remington Arms Co., at Ilion, N. Y., and later was superintendent of Colts Patent Repeating Arms Co., at Hartford, Conn., for sixteen years.

BERNHARD SCHUCHARDT

Bernhard Schuchardt

Bernhard Schuchardt, of Berlin, Germany, head of the well-known firm of Schuchardt & Schütte, died June 3, after a short illness at his residence in Grunewald, near Berlin. Mr. Schuchardt was for many years closely identified with the American machine tool industry which has lost in him a prominent character. He was born on November 17, 1855, in Cassel, Germany. After graduation from college he entered on a commercial career. In his early years Mr. Schuchardt went to England, and traveled extensively in foreign countries. In 1880, the firm of Schuchardt & Schütte was founded. From a small beginning this house developed with remarkable progress into a large enterprise well known all over the globe. This organization for introducing modern machine tools is not confined to Europe alone, but has been instrumental in opening up many foreign countries for this industry. In 1890 Mr. Schuchardt made his first trip to the United States. Recognizing the higher stage of development of the American machine tool industry of that time, he decided to exert all his energies to introduce and further the sale of its products abroad. Not only has the American machine tool industry been greatly benefited by his work, but also the important manufacturing centers all over the world through gaining knowledge of highly efficient American manufacturing methods. His firm opened branch houses in many foreign countries—Austria-Hungary, Great Britain, Sweden, Norway, Denmark, Russia, North and South America, China, Japan, etc. Mr. Schuchardt's life work was that of no ordinary man. So great an organization, unlimited by borders of countries or languages, could only have been built up by a great commercial genius of his type. He was, without a doubt, a pioneer in developing the machine tool export and import trade, and as such will long be remembered.

SIX CUTS AT ONCE



MILLING GROOVES IN SIX STEEL CORES AT ONE TRAVERSE

The cut shows an unusually heavy milling operation, consisting of cutting two grooves 1.17" wide and 5-16" deep in each of *six steel forgings* at one traverse of the table.

Three sets of heavy index centers are employed with two steel cores mounted on the arbor on each pair of centers.

Each set of cutters is formed to mill two grooves and the top of the intervening space between the grooves.

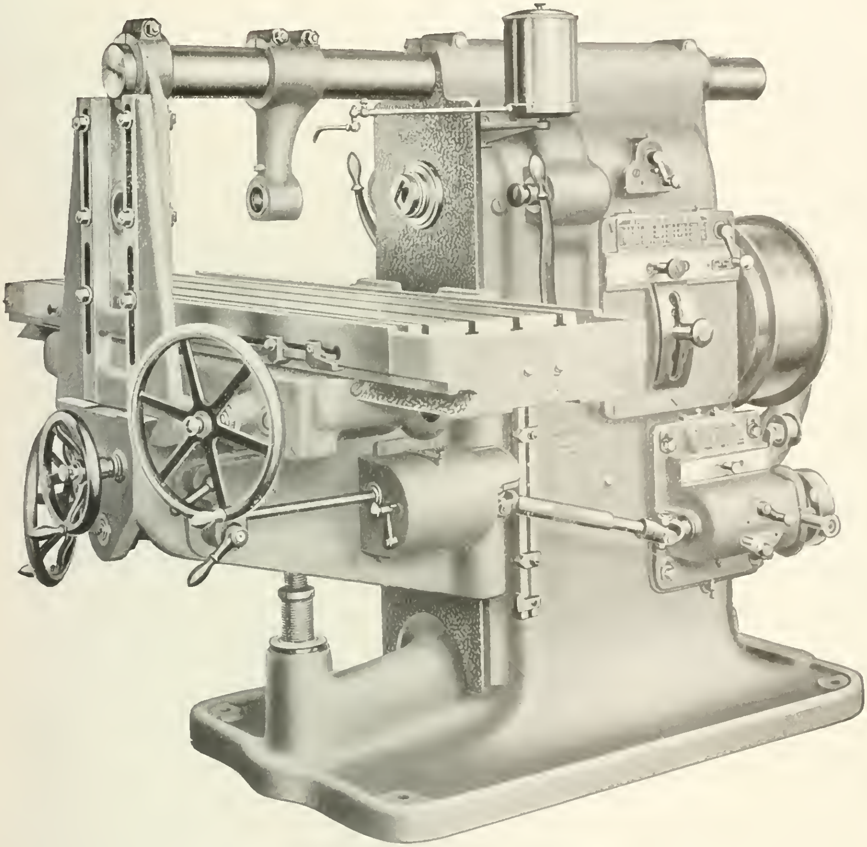
Note the B. & S. method of supporting the arbor under these extreme stresses, by unusually heavy arm braces and arbor supports which hold the arbor firmly in line and effectually prevent springing.

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 634 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

SHOWS AMPLE POWER



No. 5 B HEAVY PLAIN MILLING MACHINE

It is built for just such heavy cuts as these. Notice the extra deep table, giving unusual stiffness; the long bearing of the box form knee.

Recess, not slot, in spindle for driving arbors with clutch collars—complete ring of metal prevents spreading under heavy service.

The ample driving power is backed by consistently rigid design.

Capacity 50″ x 12″ x 21″.

Driving Pulley 20″ dia., runs 320 R. P. M., 7″ belt.

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver St Johns, Saskatoon

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow F G Kretschmer & Co., Frankfurt a M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania Norway Schuchardt & Schutte, St. Petersburg, Russia, Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W Horne, Tokio, Japan L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

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COMING EVENTS

September 18-20.—Eighth annual convention of the Federation of Trade Press Associations in the United States, at the Hotel Astor, New York City. W. H. Ukers, chairman of the committee of arrangements, 79 Wall St., New York City.

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y. last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

SOCIETIES, SCHOOLS AND COLLEGES

University of Utah, Salt Lake City, Utah. Catalogue of the University, including school of arts and sciences, school of education, state school of mines, school of medicine and school of law, for 1913-14.

Pratt Institute, Brooklyn, N. Y. Circular of information on the School of Science and Technology, which offers courses in steam and machine design, applied electricity, applied chemistry, applied leather chemistry, machine construction, carpentry and building, tanning, technical chemistry, mechanical drawing, practical electricity, practical mathematics, strength of materials, carpentry and building patternmaking, sheet-metal work, plumbing, advanced woodworking for teachers, etc. The practical value of the day courses offered in Pratt Institute is attested to by the fact that young men who have taken the course in past years have obtained good positions and with rare exceptions have advanced rapidly in their work. The circular shows views of the work in the mechanical laboratory, pattern shop, machine shop, electrical laboratory, etc.

Massachusetts Institute of Technology has established an electrical research laboratory and bureau, to be devoted to research and engineering investigation. An endowment of over $200,000 has been provided for electrical research and a grant of ten thousand dollars a year for five years has been made by the American Telephone & Telegraph Co. through its president, Theodore N. Vail. Mr. Vail believes that it is becoming more and more to the advantage of commercial firms to endow general research in the laboratories of institutions of education which are fitted to carry them on in an impartial manner. It is true that a great amount of commercial research has been carried on in institutional and private laboratories, but this has been limited to problems having obvious relationships to the firms carrying on the investigations. Mr. Vail believes in a research policy of wider scope, and the gift of his company leaves the direction in which the research shall be made entirely to the school.

NEW BOOKS AND PAMPHLETS

Report of the Commissioner of Education for the Year Ended June 30, 1912. Part I. 647 pages, 6 by 9 inches. Published by the Bureau of Education, Washington, D. C.

Report of the Commissioner of Education for the Year Ended June 30, 1912. Part 2. 669 pages, 6 by 9 inches. Published by the Bureau of Education, Washington, D. C.

Manual for Engineers. Compiled by Charles G. Ferris. 240 pages, 2¾ by 5½ inches. Published by the University of Tennessee, Knoxville, Tenn. Price, 50 cents.

This useful collection of tables and other data for engineers and business men, which was first issued in 1904, has passed into the eighteenth edition. This fact testifies to the general value of the work. In the new edition, instructions are given for procedure in case of electric shock, shop injuries, poisoning, etc. The contents include metric conversion tables; squares, cubes, square roots and cube roots; decimals of a foot for each 1-64 inch; weights and areas of square and round bars; tables of natural sines, tangents and secants; steam tables; tables of common and hyperbolic logarithms; earthwork tables; tables of horsepower of water wheels, etc.

Resuscitation From Electric Shock. By Charles A. Lauffer. 47 pages, 4 by 6½ inches. Published by John Wiley & Sons, New York City. Price, 50 cents.

This book by Dr. Lauffer, medical director of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., describes the mechanism of respiration and the steps necessary to revive a person who has suffered from electric shock, asphyxiation, inhalation of chloroform or ether, overdoses of laudanum, drowning, heavy blows in the solar plexus, etc. The prone pressure or Schafer method of resuscitation, adopted by the National Electric Light Association and a number of other engineering societies, is described in detail. The book is one that can be studied with profit by the responsible men of manufacturing plants in charge, such as foremen, gang bosses, superintendents, welfare directors and others who may have to direct the resuscitation of workmen in emergencies.

Traction Farming and Traction Engineering. By James H. Stephenson. 330 pages, 5¼ by 7½ inches. 150 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $1.50.

The application of the gasoline engine to produce power required on the farm, and the development of the gasoline farm tractor has naturally created a demand from agriculturists for books dealing with the mechanical principles and construction of gas engines. This work was written with the view of furnishing farmers and others with a simple and plain treatise on the subject of gas power. The work treats of the gasoline farm tractors, fuel consumption of gas engines, alcohol as fuel, kerosene as fuel for traction engines, balancing of engines, piston rings, valves, leaky pistons, cylinders, carbureters, ignition, vaporizing of fuel, cooling systems, lubrication, horsepower calculations, gasoline engine troubles, types of gasoline and oil farm tractors, water supply systems, electric light for farm homes, the science of threshing, types of threshing machines, etc.

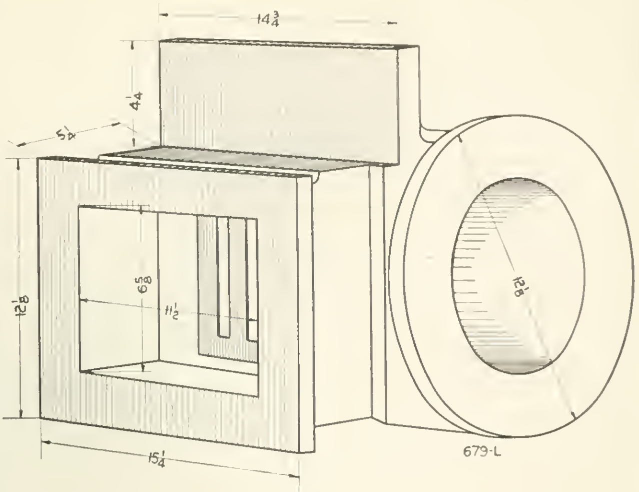
Visit to Germany of the American Society of Mechanical Engineers on the Invitation of the Verein Deutscher Ingenieure, 1913. 171 pages, 4¾ by 7 inches. Illustrated. Folding map. Published by Verein Deutscher Ingenieure, Berlin N. W. 7, Charlottenstr. 43, Germany.

This attractive book descriptive of industrial Germany was published in honor of the visit of the American Society of Mechanical Engineers to Germany and the joint meeting in Leipzig with the Verein Deutscher Ingenieure. The principal cities visited and described are Hamburg, Leipzig, Dresden, Berlin, Dusseldorf, Cologne, Frankfort-on-the-Main, Mannheim, Heidelberg and Munich. The descriptive part of the book is printed in German and English, the German and English texts being on opposing pages. The same arrangement is followed in the detailed itinerary of the trip and the descriptive notes of the principal manufacturing concerns and engineering works on the route. The book is an example of the thorough and painstaking work which characterized the preparations for the comfort and entertainment of the American visitors.

Scientific American Reference Book, 1913. By Albert A. Hopkins and A. Russell Bond. 597 pages, 5½ by 7½ inches. Illustrated. Published by Munn & Co., Inc., New York City.

This book was compiled in response to the demand for information as evidenced by the many thousands of inquiries received every year by the editorial staff of the "Scientific American." These inquiries show the need of a compendium of useful information—a work containing facts not readily obtainable from any other source. The book is one that will be found invaluable by the business man whatever his line may be. The contents are divided into two parts, statistical and scientific. The statistical information comprises population and social statistics; farms, foods and forests; mines and quarries; manufactures; commerce; mercantile marine; railroads; the Panama Canal; telegraphs and cables; wireless telegraphy; telephone statistics of the world; post office affairs; patents, trademarks and copyrights; armies of the world; navies of the world and aviation. The scientific information deals with chemistry; astronomy

Do You Make Anything Like This?



Cast Iron Cylinder with 7″ bore.

From 3-16″ to 1-4″ of metal removed.

Time 53 minutes.

This is the Machine that Does the Work

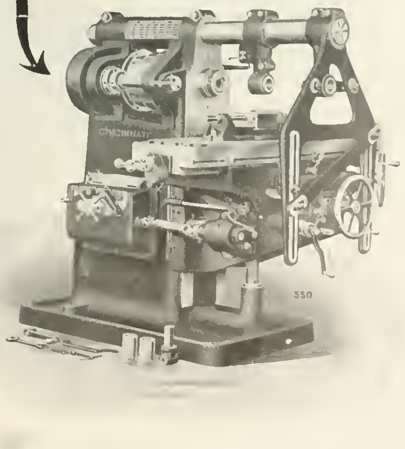
All surfaces must be flat, smooth, and in the right relation to each other.

One of our customers is milling all the shaded surfaces on cylinders like this on a "CINCINNATI" No. 4 HIGH POWER MILLER WITH CONE DRIVE in fifty-three minutes.

This time includes chucking, rough and finish milling, changing of cutters and removing.

There's a high degree of ACCURACY and FINISH produced.

It's the ORIGINAL HIGH POWER CONE DRIVEN MILLER. The equipment for producing these cylinders was developed in our ESTIMATING DEPARTMENT and included in it are some very interesting features. If your product is anything like this, ask for the details. We will gladly send you ALL.



We verify our estimates by thorough tests before shipping the equipment.

Send your blue prints
or samples.

The Cincinnati Milling Machine Company

CINCINNATI OHIO, U. S. A.

and time; meteorology, machine elements and mechanical movements; geometrical constructions; weights and measures.

Principles of Setting Out. By Alfred Parr. Introduction by C. H. Bulleid. 290 pages, 5½ by 8½ inches. 236 illustrations. Published by Longmans, Green & Co., New York City. Price, $2.50 net.

This practical work on laying out, setting up and machining operations is based on British workshop practice, but the general principles explained are, of course, of universal application. The book is designed principally for engineering students and apprentices and students in metal training schools, but mechanics generally should find a perusal of this work and study of some sections of considerable value. Among the subjects treated are: Measuring and measuring instruments; Johansson gages; laying out a high-pressure steam engine cylinder; laying out keyways and fitting keys; dividing in the lathe; lathe mandrels of various types; clamping arrangements; machine vises; design, construction and use of jigs; drilling machines; crank-pin turning machines; boring bars and cutters; setting up and boring an engine cylinder and bearings; slotting machines; shapers; laying out a four-jaw chuck; magnetic chucks; use of hand turning tools; cutting square threads; cutting V-threads; screw cutting and chasing with hand tools; notes on chucking operations; turret lathe work; gear cutting; various types of gear teeth; cutting speeds and feeds for gear cutting; etc.

Theory and Test of An Overshot Water Wheel. By Carl Robert Weidner. 136 pages, 6 by 9 inches. Published by the University of Wisconsin, Madison, Wis., as Bulletin No. 529. Price, 40 cents.

The experiments described were undertaken with the object of securing data on the performance of the modern type of overshot water wheel. Contrary to general impression, the overshot water wheel is by no means out of use. It is still extensively used in Europe and to a limited extent in the United States. The advantages of the overshot wheel are enumerated as follows: (1) High efficiency. (2) Adapatability to varying discharge. (3) Simplicity in construction. (4) Reliability. (5) Non-interference of operation on account of clogging with debris or ice. The efficiency of overshot wheels is high, the tests demonstrating that the efficiency may be as high as 90 per cent. The tests indicate that the economical field of the overshot wheel lies in power developments which range approximately between 2 and 30 second-feet discharge, with heads varying from 10 to 40 feet, corresponding to a maximum development of 75 horsepower. The paper reviews Bach's theory and design of the overshot water wheel, and describes the Wisconsin experiments in detail. A review is given of the experiments made by Smeaton, Franklin Institute and Morin. While the cost of the overshot water wheel is about double that of the turbine wheel, its special advantages within the limits of its practical application make it a desirable means of water power development for certain localities.

Safety: Methods for Preventing Occupational and Other Accidents and Disease. By Dr. William H. Tolman and Leonard B. Kendall. 432 pages, 6 by 9 inches. Illustrated. Published by Harper & Bros., New York City. Price, $3 net.

During the past decade a great change has taken place in the attitude of manufacturers, railway men and others connected with the various departments of industrial life toward accidents and their effects on business and society. Business men have awakened to a realization that a manufacturing or transportation business that neglects to provide proper safeguards for its employes is not a good business. A comprehensive book bearing on the practical aspect of accident prevention in manufacturing plants is bound to be, therefore, of much interest, and this book on safety meets the demand for a broad work on the general principles of safeguarding to be observed in manufacturing conditions. The work is divided into four main parts, viz.: General Conditions, Danger Zones, Industrial Hygiene and Social Welfare. It treats of the philosophy of safety, neglected factors, the working-place, danger zones such as yards, walks, railings, hoists, etc. Chapters are devoted to cutting and grinding tools, illumination, fire, iron and steel, mines and mining, electricity, general aids to safety, organized efforts by employers. The importance of industrial hygiene is fully recognized, four chapters being devoted to it. These are on general aspects of sanitation, industrial poisons, chemical industries and shop sanitation. The fourth and concluding portion of the book devoted to social welfare, is on industrial education, meeting the public, training future workers, welfare in after hours and the American Museum of Safety. Dr. Tolman has devoted years of his life to safety and welfare work and has done much to bring the movement prominently before the world. The work by him and his collaborator, Mr. Kendall, should be an effective means of promoting the movement for greater safety and sanitation.

Das Maschinen-Zeichnen. By A. R. Riedler, 234 pages, 8 by 11 inches. 436 illustrations. Published by Julius Springer, Berlin, Germany. Price, 10 marks.

This work on machine design and drawing is unique, in that it deals not so much with the individual details of machine construction as with the general principles met with in machine design, and with the proper methods of representing designs in drawings. In order to show clearly the methods to be used, the book is profusely illustrated with detail as well as assembly drawings of the most varied character. A feature of the book that especially deserves commendation is that in a great many instances two illustrations are shown side by side, one showing a wrong construction or objectionable method of drawing, while the other shows the correct or preferable design and method of representation in drawings. As examples may be mentioned illustrations showing correct and incorrect methods of dimensioning drawings; objectionable and recommended methods of indicating finished surfaces; correct and incorrect methods of arranging the different views of the drawing, so as to prevent misunderstanding on the part of the shop man; and many illustrations of correct and incorrect designs of machine details. The book deals exclusively with general principles and with the picturing of machine parts in drawings. It contains nothing relative to the methods of calculations or determining the dimensions in machine design. The book, of course, is in German; no doubt there would be a field for a book of this kind in English, and it should be especially useful in technical and engineering schools, as it would show the students in a clear and easily comprehended manner the fundamental principles and requirements in machine drawing and design. One somewhat objectionable feature in the present work is the typographical arrangement; the page is large and the text matter is printed in one long line across the page, making it difficult to read. The arrangement would have been decidedly better if the text had been printed in two columns to a page.

NEW CATALOGUES AND CIRCULARS

Gardner Governor Co., Quincy, Ill. Circular on duplex power pumps.

Reed & Prince Mfg. Co., Worcester, Mass. Leaflet on working gages for users of machine screws, nuts and taps.

Treadwell Engineering Co., West Street Bldg., New York City. Folder on Stoever pipe cutting, threading and bending machines.

Lea Equipment Co., Stenton & Wyoming Aves., Philadelphia, Pa. Bulletin on the Lea Simplex cold cutting-off saw, illustrating 1913 models.

Bristol Co., Waterbury, Conn. Bulletins 175, 176 and 178 on electrical resistance thermometers, model 162, electric pyrometers and wet and dry bulb recording thermometers, respectively.

Springfield Mfg. Co., Bridgeport, Conn. Circular of wet and dry ball bearing grinders. High-grade ball bearings are provided for the spindles, having capacities several times the load these bearings are ordinarily required to sustain.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet illustrating noteworthy examples of the benefits derived from "Cling-Surface" in five prominent railroad shops. The circular gives a list of forty railroads using "Cling-Surface" in their repair shop.

Norma Company of America, 20-24 Vesey St., New York City. Bulletins Nos. 102, 103, 104 on "Norma" ball bearing—combined annular and thrust bearings; roller bearings—combined roller and thrust bearings; single and double ball thrust bearings, respectively.

Electric Controller & Mfg. Co., Cleveland, Ohio. Pamphlet on the automatic control of machine tools, illustrating electrical equipment and applications to punching and coping machines, shapers, slotters, lathes, boring mills, milling machines, grinders, upright drills, etc.

Abbott-Schmidt Co., 328 McCormick Bldg., Chicago, Ill. Catalogue of edited engineering service, which includes a resume of articles dealing with any engineering subject published in technical and scientific journals in America, England and Colonies, France and Germany.

Fairbanks-Morse & Co. Inc., Chicago, Ill. Bulletins Nos. 25 and 35 on direct-current and alternating-current apparatus. Both bulletins are in catechism form and contain valuable technical data for users of electrical apparatus. A glossary is included covering all electrical terms used.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. Booklet on Cling-Surface for belts, showing its use the world over. Installations of "Cling-Surface" treated belts in Germany, England, Scotland, Ireland, Norway, Sweden, France, Spain, Switzerland, Belgium and other foreign countries, are shown.

Mark Mfg. Co., Chicago, Ill. Circular on the Mark cold-drawn steel union, a union made from sheet steel and faced on the female seat with brass. This union is free from the common defects of cast iron, malleable iron and brass unions; it has tapered threads which exactly fit the taper of pipe threads and is sherardized to prevent corrosion.

Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill. Catalogue No. 2 on Armstrong drop-forged steel wrenches, comprising single open-head wrenches; double open-head wrenches; double-head S wrenches; square box wrenches; set-screw wrenches; toolpost wrenches; structural wrenches; wrenches in sets; socket wrenches; alligator wrenches; etc.

C. F. Pease Co., 166 West Adams St., Chicago, Ill. Catalogue of blueprint machinery, blueprint room supplies, direct white print machinery, drafting-room furniture, etc. This catalogue entitled "Everything for Blueprinting" shows a line of machinery for rapid blueprinting. It will be found of general interest to all who have to reproduce drawings, etc.

Davis-Bournonville Co., 30 Church St., New York City. Bulletin on the "Oxygraph," an oxy-acetylene flame apparatus for cutting steel according to pattern. This ingenious device is successfully used for cutting large openings in forgings, cutting the patterns of dies, and for many other kinds of work that ordinarily would require long and expensive machine operations to accomplish.

Ingersoll-Rand Co., 11 Broadway, New York City. Catalogue of Ingersoll-Rand products, comprising steam-driven air compressors, belt-driven air compressors, electrically-driven air compressors, gas compressors, gasoline extrusion compressors, air purifiers, vertical and horizontal after-coolers, air reheaters, steam pumps, rock drills, pneumatic hammers, drill sharpeners, oil furnaces, etc.

General Electric Co., Schenectady, N. Y. Bulletins A4035 on series luminous arc lamps; No. A4109 on belt-driven revolving armature alternators; A4114 on central station oil switches; A4121 on direct current motors, type CVC; A4123 on automatic voltage regulators; A4127 on combined straight and automatic air brake equipment; and A4129 on small feeder voltage regulators.

Standard Machinery Co., 7 Beverly St., Providence, R. I. Catalogue of wire drawing machinery, rotary swaging machines, rotary shears and other swaging machines applicable to the jewelry and machinery trades. This catalogue is one of five different sections of a general catalogue issued to show some departures from the standard line of wire drawing machinery as well as the company's regular lines.

Wiener Machinery Co., 50 Church St., New York City. Catalogue of Oeking solid steel frame triple and quadruple combination punch, shear and bar and angle cutters. These machines are adapted for notching, coping, mitering and cutting off channels, I-beams and angles. The catalogue also illustrates solid steel frame heavy gate shear and the "S. & N." rapid beam shears which will cut a 12-inch I-beam in seven seconds.

Ingersoll Milling Machine Co., Rockford, Ill. Pamphlet entitled "Not Stunts—Facts," illustrating the use of Ingersoll milling machines on gas engine work, machine tool parts, steam pump work, printing press parts, gasoline traction engine frames, woodworking machinery, locomotive work, etc. Data are given on the time of production, which makes the publication of unusual interest to mechanical men responsible for production.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Rail Report Bulletin No. 1. This report covers five consecutive sets of open-hearth steel rails rolled during the early part of 1913 for three different railway systems. The purpose is to place before railway officials the results of comparative tests of standard carbon steel rails and rails of the same general composition treated with titanium. This undertaking is one that should excite general interest in railway circles.

Green Fuel Economizer Co., Matteawan, N. Y. Circular of Green's conical flow fan which differs from both centrifugal and axial flow fans in that the air enters and passes through the fan and through the diffuser or stationary housing obliquely to the shaft. The claim is made that this construction increases air handling capacity with the given diameter of wheel and permits the rotors to be run at high speeds. These fans can be connected directly to standard electric motors and steam turbines.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular on duplex horizontal drills, illustrating a variety of styles and sizes designed for horizontal drilling. The advantages of simultaneously machining work from opposite directions on the same axis are pointed out. Facing is done in practically one-half the time consumed in single spindle operations and in perfect alignment. A variety of fixtures is furnished with these machines, making them especially adapted to the needs of automobile manufacturers, etc.

Cleveland Planer Works, 3150-3152 Superior Ave., N. E., Cleveland, Ohio. Catalogue of Cleveland open-side planers, illustrating details of design. Some of the details shown are: Top of bed, bottom of bed, knee, column, table, bull gear pinion and side gear, etc. The illustrations of planers include the following sizes: 30 inches by 30 inches by 8 feet; 36 inches by 36 inches by 12 feet; 42 inches by 42 inches by 12 feet; 48 inches by 48 inches by 14 feet; 60 inches by 60 inches by 14 feet; and 72 inches by 72 inches by 16 feet.

L. S. Starrett Co., Athol, Mass. Catalogue No. 20 of mechanics' fine tools, containing 320 pages. The new catalogue contains 46 more pages than the previous catalogue, the new matter comprising data and tables such as metric conversion tables, decimal equivalents, weight computing tables, tapers and angles, wire gage tables, etc., and new tools. The following new tools are listed: Six- and eight-foot straightedges, new attachment for combination squares, new caliper squares, twenty-four-inch vernier caliper, heavy micrometers, screw thread micrometers, tubing micrometer, micrometer head, hub micrometer, soft leather cases for micrometers, bench micrometer, vernier depth gage, new hacksaws and new type of calipers.

National Machinery Co., Tiffin, Ohio. Booklet entitled "Perfect Threads," illustrating the National opening die head and interchangeable case die which were demonstrated at the late conventions of the American Railway Master Mechanics and Master Car Builders at Atlantic City under unusually difficult conditions. The demonstrations were made on the company's double, triple and quadruple bolt cutters. Threads were cut on stay-bolts having very pronounced humps and on tapered bolt blanks. Tests failed to show any difference in the diameters or shapes of the threads cut under the humped portions as compared with those cut under the normal sections of the specimens. The booklet illustrates the double, triple and quadruple bolt cutters, motor-driven, and the company's plant in Tiffin, Ohio.

Nicholson File Co., Providence, R. I. Booklet entitled "File Filosophy," containing useful hints on the proper methods of using files and the various

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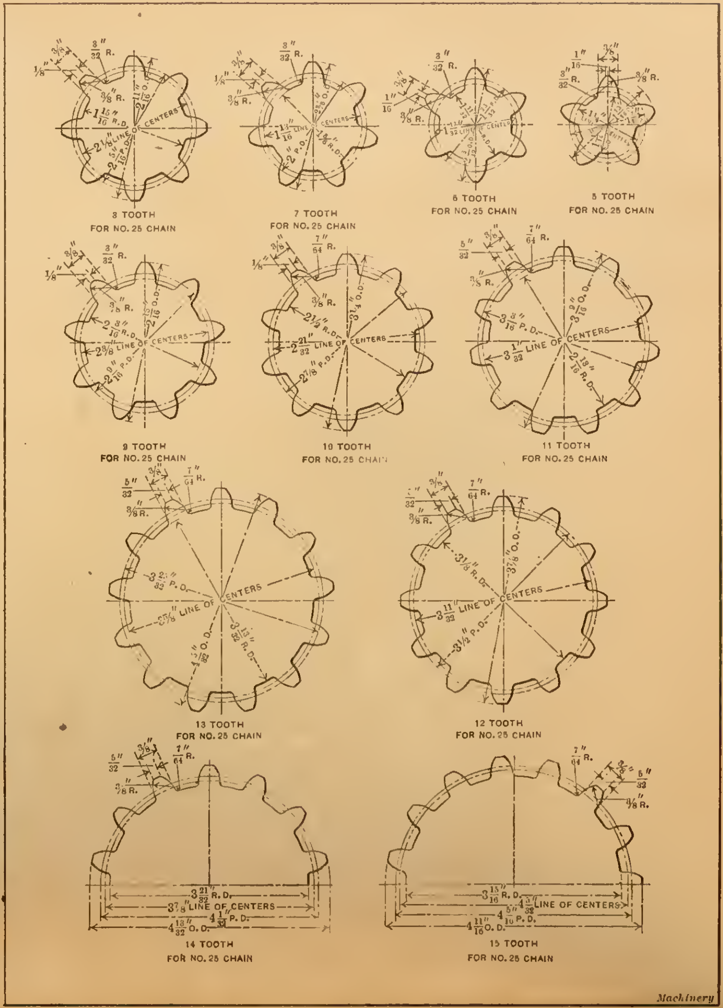
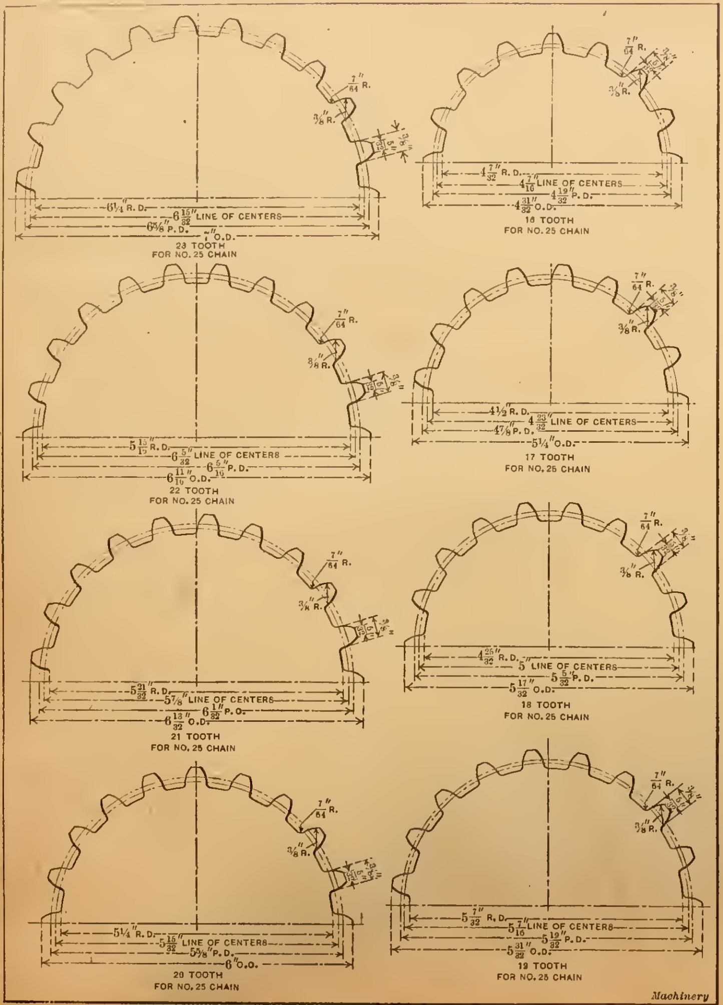
SPROCKETS FOR DETACHABLE LINK BELT—I



Contributed by J. R. Bowen

No. 169, Data Sheet, MACHINERY, August, 1913

SPROCKETS FOR DETACHABLE LINK BELT—II

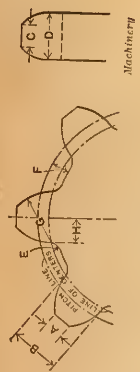


Contributed by J. R. Bowen

No. 169, Data Sheet, MACHINERY, August, 1913

1 "Sprockets for Detachable Link Belt"

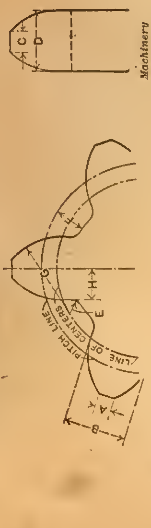
SPROCKETS FOR DETACHABLE LINK BELT—III



Chain No.		Number of Teeth																		
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
25	Pitch diameter	1 7/16	1 23/32	2	2 5/16	2 9/16	2 7/8	3 3/16	3 1/2	3 25/32	4 1/32	4 5/16	4 19/32	4 7/8	5 5/32	5 15/32	5 3/4	6 1/32	6 5/16	6 5/8
	Outside diameter	1 13/16	2 3/32	2 3/8	2 11/16	2 15/16	3 1/4	3 9/16	3 7/8	4 5/32	4 15/32	4 11/16	4 31/32	5 1/4	5 17/32	5 27/32	6	6 13/32	6 11/16	7
	Root diameter	1 1/16	1 11/32	1 5/8	1 15/16	2 3/16	2 1/2	2 13/16	3 1/8	3 13/32	3 21/32	3 15/16	4 7/32	4 1/2	4 25/32	5 3/32	5 3/8	5 21/32	5 15/16	6 1/4
	Line of centers	1 1/4	1 17/32	1 13/16	2 1/8	2 3/8	2 21/32	3 1/32	3 11/32	3 5/8	3 7/8	4 5/32	4 7/16	4 23/32	5	5 9/32	5 19/32	5 7/8	6 5/32	6 15/32
	Width at point = *A*	1/16	1/16	1/8	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Width on P. D. = *B*	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Thick. at point = *C*	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
	Thick. at root = *D*	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Radius *E*	3/32	3/32	3/32	3/32	3/32	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64	7/64
	Height *F*	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
	Radius *G*	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Dimension *H*	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
32	Pitch diameter	1 13/16	2 3/16	2 9/16	2 15/16	3 13/32	3 11/16	4 1/32	4 13/32	4 25/32	5 5/32	5 1/2	5 27/32	6 1/4	6 5/8	6 31/32	7 11/32	7 23/32	8 3/32	8 15/32
	Outside diameter	2 1/4	2 5/8	3	3 3/8	3 27/32	4 1/8	4 15/32	4 27/32	5 7/32	5 19/32	5 15/16	6 9/32	6 11/16	7 1/16	7 13/32	7 25/32	8 5/32	8 17/32	8 29/32
	Root diameter	1 3/8	1 3/4	2 1/8	2 1/2	2 31/32	3 1/4	3 19/32	3 31/32	4 11/32	4 23/32	5 1/16	5 13/32	5 13/16	6 3/16	6 17/32	6 29/32	7 9/32	7 21/32	8 1/32
	Line of centers	1 7/16	1 13/16	2 5/32	2 21/32	3 1/8	3 3/8	3 23/32	4 3/32	4 15/32	4 13/16	5 5/32	5 1/2	5 29/32	6 5/16	6 5/8	7 1/16	7 13/32	7 13/16	8 5/32
	Width at point = *A*	1/8	1/8	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Width on P. D. = *B*	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
	Thick. at point = *C*	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Thick. at root = *D*	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32	17/32
	Radius *E*	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32	5/32
	Height *F*	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32
	Radius *G*	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
	Dimension *H*	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32	9/32
42	Pitch diameter	2 3/16	2 5/8	3 1/16	3 1/2	3 15/16	4 3/8	4 13/16	5 1/4	5 11/16	6 1/8	6 9/16	7	7 7/16	7 7/8	8 5/16	8 3/4	9 3/16	9 5/8	10 1/16
	Outside diameter	2 13/16	3 1/4	3 11/16	4 1/8	4 9/16	5	5 7/16	5 7/8	6 5/16	6 3/4	7 3/16	7 5/8	8 1/16	8 1/2	8 15/16	9 3/8	9 13/16	10 1/4	10 11/16
	Root diameter	1 9/16	2	2 7/16	2 7/8	3 5/16	3 3/4	4 3/16	4 5/8	5 1/16	5 1/2	5 15/16	6 3/8	6 13/16	7 1/4	7 11/16	8 1/8	8 9/16	9	9 7/16
	Line of centers	1 29/32	2 3/8	2 13/16	3 1/4	3 23/32	4 5/32	4 19/32	5	5 7/16	5 7/8	6 3/8	6 13/16	7 1/4	7 11/16	8 1/8	8 9/16	9	9 7/16	9 7/8
	Width at point = *A*	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Width on P. D. = *B*	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
	Thick. at point = *C*	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Thick. at root = *D*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Radius *E*	11/64	3/16	3/16	3/16	13/64	13/64	13/64	3/16	3/16	3/16	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32	7/32
	Height *F*	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Radius *G*	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
	Dimension *H*	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16

Contributed by J. R. Bowen

SPROCKETS FOR DETACHABLE LINK BELT—IV



Chain No.		Number of Teeth																		
		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
		ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins.
52	Pitch diameter	2 5/8	2 7/8	3 3/8	3 13/16	4 5/16	4 13/16	5 1/4	5 3/4	6 3/16	6 3/4	7 3/16	7 5/8	8 1/8	8 5/8	9 1/8	9 9/16	10 1/16	10 9/16	11
	Outside diameter	3 1/16	3 9/16	4 1/16	4 1/2	5	5 1/2	5 15/16	6 7/16	6 7/8	7 5/16	7 7/8	8 5/16	8 13/16	9 5/16	9 13/16	10 1/4	10 3/4	11 1/4	11 11/16
	Root diameter	1 13/16	2 5/16	2 13/16	3 1/8	3 5/8	4 1/8	4 9/16	5 1/16	5 1/2	6 1/16	6 1/2	6 15/16	7 7/16	7 15/16	8 7/16	8 7/8	9 3/8	9 7/8	10 5/16
	Line of centers	2 1/16	2 9/16	3 1/8	3 9/16	4 1/16	4 9/16	5	5 1/2	5 15/16	6 15/32	7	7 13/32	7 29/32	8 13/32	8 29/32	9 11/32	9 27/32	10 11/32	10 27/32
	Width at point = *A*	1/8	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Width on P. D. = *B*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Thick. at point = *C*	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Thick. at root = *D*	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
	Radius *E*	3/16	3/16	7/32	7/32	7/32	7/32	7/32	7/32	7/32	13/64	13/64	13/64	13/64	13/64	13/64	13/64	13/64	13/64	13/64
	Height *F*	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32
	Radius *G*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Dimension *H*	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32
55	Pitch diameter	2 9/16	3 3/32	3 5/8	4 1/8	4 5/8	5 1/8	5 11/16	6 3/16	6 21/32	7 1/8	7 5/8	8 1/8	8 19/32	9 1/16	9 9/16	10 1/32	10 1/2	11 1/32	11 1/2
	Outside diameter	3 1/4	3 25/32	4 5/16	4 13/16	5 5/16	5 13/16	6 3/8	6 7/8	7 11/32	7 13/16	8 5/16	8 13/16	9 11/32	10	10 1/4	11 1/32	11 9/16	12 1/32	12 9/16
	Root diameter	1 7/8	2 13/32	2 15/16	3 7/16	3 15/16	4 9/16	5	5 1/2	5 31/32	6 9/16	7 1/16	7 9/16	8 3/32	8 5/8	9 1/8	9 21/32	10 3/16	10 21/32	11 3/16
	Line of centers	2 1/4	2 25/32	3 5/16	3 13/16	4 3/8	5	5 13/32	5 15/16	6 13/32	7	7 7/16	7 31/32	8 1/2	9 3/32	9 9/16	10 3/32	10 5/8	11 1/8	11 21/32
	Width at point = *A*	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16
	Width on P. D. = *B*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Thick. at point = *C*	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
	Thick. at root = *D*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Radius *E*	3/16	3/16	3/16	3/16	7/32	7/32	13/64	7/32	7/32	7/32	3/16	13/64	13/64	13/64	7/32	7/32	7/32	13/64	13/64
	Height *F*	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32
	Radius *G*	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16	11/16
	Dimension *H*	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32	11/32
62	Pitch diameter	2 5/8	3 5/32	3 11/16	4 7/32	4 3/4	5 5/16	5 13/16	6 5/16	6 7/8	7 3/8	7 7/8	8 7/16	8 15/16	9 1/2	10	10 1/2	11 1/16	11 9/16	12 1/8
	Outside diameter	3 7/16	3 31/32	4 1/2	5 1/32	5 9/16	6 1/8	6 5/8	7 1/8	7 11/16	8 3/16	8 11/16	9 1/4	9 3/4	10 5/16	10 13/16	11 5/16	11 7/8	12 3/8	12 15/16
	Root diameter	1 13/16	2 11/32	2 7/8	3 13/32	3 15/16	4 1/2	5	5 1/2	6 1/16	6 9/16	7 1/16	7 5/8	8 1/8	8 11/16	9 3/16	9 11/16	10 1/4	10 3/4	11 5/16
	Line of centers	2 15/32	2 7/8	3 7/16	4	4 9/16	5 3/32	5 21/32	6 5/32	6 23/32	7 7/32	7 23/32	8 9/32	8 25/32	9 11/32	9 27/32	10 11/32	10 27/32	11 13/32	11 31/32
	Width at point = *A*	1/8	1/8	1/4	1/4	5/16	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8	3/8
	Width on P. D. = *B*	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
	Thick. at point = *C*	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
	Thick. at root = *D*	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8	7/8
	Radius *E*	17/64	17/64	9/32	19/64	5/16	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64	21/64
	Height *F*	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32	13/32
	Radius *G*	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
	Dimension *H*	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8

Contributed by J. R. Bowen

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